

Under the Paperwork Reduction Act of 1995 no persons are required to respond to a collection of information unless it displays a valid OMB control number.

|                                                                                                                              |                                     |                                                              |
|------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|--------------------------------------------------------------|
| <b>UTILITY<br/>PATENT APPLICATION<br/>TRANSMITTAL</b><br><br>(Only for new nonprovisional applications under 37 CFR 1.53(b)) | Attorney Docket No.                 | IBTH 13318Aa                                                 |
|                                                                                                                              | First Named Inventor                | Shinji YUASA                                                 |
|                                                                                                                              | Title                               | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEM |
|                                                                                                                              | Priority Mail Express®<br>Label No. |                                                              |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>APPLICATION ELEMENTS</b><br><i>See MPEP chapter 600 concerning utility patent application contents.</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>ADDRESS TO:</b><br><b>Commissioner for Patents</b><br><b>P.O. Box 1450</b><br><b>Alexandria, VA 22313-1450</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <ol style="list-style-type: none"><li><input type="checkbox"/> <b>Fee Transmittal Form</b><br/>(PTO/SB/17 or equivalent)</li><li><input type="checkbox"/> <b>Applicant asserts small entity status.</b><br/>See 37 CFR 1.27</li><li><input type="checkbox"/> <b>Applicant certifies micro entity status.</b> See 37 CFR 1.29.<br/>Applicant must attach form PTO/SB/15A or B or equivalent.</li><li><input checked="" type="checkbox"/> <b>Specification</b> [Total Pages <u>21</u>]<br/>Both the claims and abstract must start on a new page.<br/>(See MPEP § 608.01(a) for information on the preferred arrangement)</li><li><input checked="" type="checkbox"/> <b>Drawing(s)</b> (35 U.S.C. 113) [Total Sheets <u>10</u>]</li><li><input type="checkbox"/> <b>Inventor's Oath or Declaration</b> [Total Pages <u>1</u>]<br/>(including substitute statements under 37 CFR 1.64 and assignments<br/>serving as an oath or declaration under 37 CFR 1.63(e))<ol style="list-style-type: none"><li><input type="checkbox"/> Newly executed (original or copy)</li><li><input checked="" type="checkbox"/> A copy from a prior application (37 CFR 1.63(d))</li></ol></li><li><input checked="" type="checkbox"/> <b>Application Data Sheet</b> * See note below.<br/>See 37 CFR 1.76 (PTO/AIA/14 or equivalent)</li><li><input type="checkbox"/> <b>CD-ROM or CD-R</b><br/>in duplicate, large table, or Computer Program (Appendix)<br/><input type="checkbox"/> Landscape Table on CD</li><li><input type="checkbox"/> <b>Nucleotide and/or Amino Acid Sequence Submission</b><br/>(if applicable, items a. – c. are required)<ol style="list-style-type: none"><li><input type="checkbox"/> Computer Readable Form (CRF)</li><li><input type="checkbox"/> Specification Sequence Listing on:<ol style="list-style-type: none"><li><input type="checkbox"/> CD-ROM or CD-R (2 copies); or</li><li><input type="checkbox"/> Paper</li></ol></li><li><input type="checkbox"/> Statements verifying identity of above copies</li></ol></li></ol> | <b>ACCOMPANYING APPLICATION PAPERS</b> <ol style="list-style-type: none"><li><input type="checkbox"/> <b>Assignment Papers</b><br/>(cover sheet &amp; document(s))<br/>Name of Assignee _____</li><li><input type="checkbox"/> <b>37 CFR 3.73(c) Statement</b> <input checked="" type="checkbox"/> <b>Power of Attorney</b><br/>(when there is an assignee)</li><li><input type="checkbox"/> <b>English Translation Document</b><br/>(if applicable)</li><li><input checked="" type="checkbox"/> <b>Information Disclosure Statement</b><br/>(PTO/SB/08 or PTO-1449)<br/><input type="checkbox"/> Copies of citations attached</li><li><input checked="" type="checkbox"/> <b>Preliminary Amendment</b></li><li><input type="checkbox"/> <b>Return Receipt Postcard</b><br/>(MPEP § 503) (Should be specifically itemized)</li><li><input type="checkbox"/> <b>Certified Copy of Priority Document(s)</b><br/>(if foreign priority is claimed)</li><li><input type="checkbox"/> <b>Nonpublication Request</b><br/>Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35<br/>or equivalent.</li><li><input checked="" type="checkbox"/> <b>Other:</b> Authorization to Extend and Charge Deposit Account<br/>Internet Communication Authorization form<br/>IDS transmittal<br/>Track 1 Request form</li></ol> |

**\*Note:** (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must** be included in an Application Data Sheet (ADS).  
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

|                                                                                                                                                        |                  |          |  |                                      |                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|----------|--|--------------------------------------|-----------------|
| <b>19. CORRESPONDENCE ADDRESS</b>                                                                                                                      |                  |          |  |                                      |                 |
| <input checked="" type="checkbox"/> The address associated with Customer Number: <u>61650</u> OR <input type="checkbox"/> Correspondence address below |                  |          |  |                                      |                 |
| Name                                                                                                                                                   |                  |          |  |                                      |                 |
| Address                                                                                                                                                |                  |          |  |                                      |                 |
| City                                                                                                                                                   | State            | Zip Code |  |                                      |                 |
| Country                                                                                                                                                | Telephone        | Email    |  |                                      |                 |
| Signature                                                                                                                                              | /Brian S. Myers/ |          |  | Date                                 | August 10, 2023 |
| Name<br>(Print/Type)                                                                                                                                   | Brian S. Myers   |          |  | Registration No.<br>(Attorney/Agent) | 46947           |

A Federal agency may not conduct or sponsor, and a person is not required to respond to, nor shall a person be subject to a penalty for failure to comply with an information collection subject to the requirements of the Paperwork Reduction Act of 1995, unless the information collection has a currently valid OMB Control Number. The OMB Control Number for this information collection is 0651-0032. Public burden for this form is estimated to average 12 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the information collection. Send comments regarding this burden estimate or any other aspect of this information collection, including suggestions for reducing this burden to the Chief Administrative Officer, United States Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450 or email InformationCollection@uspto.gov. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. If filing this completed form by mail, send to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

WD EX1086

Western Digital v IP Bridge, IPR2024-01494

Page 1

## Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. The United States Patent and Trademark Office (USPTO) collects the information in this record under authority of 35 U.S.C. 2. The USPTO's system of records is used to manage all applicant and owner information including name, citizenship, residence, post office address, and other information with respect to inventors and their legal representatives pertaining to the applicant's/owner's activities in connection with the invention for which a patent is sought or has been granted. The applicable Privacy Act System of Records Notice for the information collected in this form is COMMERCE/PAT-TM-7 Patent Application Files, available in the Federal Register at 78 FR 19243 (March 29, 2013). <https://www.govinfo.gov/content/pkg/FR-2013-03-29/pdf/2013-07341.pdf>

Routine uses of the information in this record may include disclosure to: 1) law enforcement, in the event that the system of records indicates a violation or potential violation of law; 2) a Federal, state, local, or international agency, in response to its request; 3) a contractor of the USPTO having need for the information in order to perform a contract; 4) the Department of Justice for determination of whether the Freedom of Information Act (FOIA) requires disclosure of the record; 5) a Member of Congress submitting a request involving an individual to whom the record pertains, when the individual has requested the Member's assistance with respect to the subject matter of the record; 6) a court, magistrate, or administrative tribunal, in the course of presenting evidence, including disclosures to opposing counsel in the course of settlement negotiations; 7) the Administrator, General Services Administration (GSA), or their designee, during an inspection of records conducted by GSA under authority of 44 U.S.C. 2904 and 2906, in accordance with the GSA regulations and any other relevant (i.e., GSA or Commerce) directive, where such disclosure shall not be used to make determinations about individuals; 8) another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)); 9) the Office of Personnel Management (OPM) for personnel research purposes; and 9) the Office of Management and Budget (OMB) for legislative coordination and clearance.

If you do not furnish the information requested on this form, the USPTO may not be able to process and/or examine your submission, which may result in termination of proceedings, abandonment of the application, and/or expiration of the patent.

## Additional Uses

Additional USPTO uses of the information in this record may include disclosure to: 1) the International Bureau of the World Intellectual Property Organization, if the record is related to an international application filed under the Patent Cooperation Treaty; 2) the public i) after publication of the application pursuant to 35 U.S.C. 122(b), ii) after issuance of a patent pursuant to 35 U.S.C. 151, iii) if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections, or an issued patent, or iv) without publication of the application or patent under the specific circumstances provided for by 37 CFR 1.14(a)(1)(v)-(vii); and/or 3) the National Archives and Records Administration, for inspection of records.

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

**Applicant:** Shinji YUASA

**Serial No.:** TBD

**Filing Date:** August 10, 2023

**Title:** METHOD OF MANUFACTURING A MAGNETORESISTIVE  
RANDOM ACCESS MEMORY (MRAM)

**Examiner:** TBD

**Art Unit:** TBD

**Confirmation No.:** TBD

**Attorney Docket No.:** IBTH 13318Aa

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**INFORMATION DISCLOSURE STATEMENT**

Sir:

To comply with rules 37 CFR §§1.97 and 1.98, attached hereto is a copy of Form PTO-1449 with documents listed thereon. These documents contain information which the Examiner may consider to be important in deciding whether to issue a patent in the instant application.

As all foreign patent documents and non-patent literature cited herein were submitted in the parent application **18/219,320** filed **July 7, 2023**, now pending, and in the grandparent case **17/560,922** filed **December 23, 2021**, now pending, copies of such documents are not being provided herewith.

The present Information Disclosure Statement is being submitted in compliance with 37 CFR §1.56, as an Examiner might consider any cited document important in deciding whether to allow the application to issue as a patent, but the citation of each document is not to be construed as an admission that such document is necessarily relevant or prior art. No representation is intended that the cited documents represent the results of a complete search, and it is anticipated that the Examiner, in the normal course of examination, will make an independent search and will determine the best prior art consistent with 37 CFR §§1.104 (a) and 1.106 (b), and in the course of such search will review for relevance every document cited on the attached form even if not initialed.

Any fee due with this paper not already paid through an EFS-Web filing may be charged to Deposit Account No. 50-3894. Any overpayment may be credited to Deposit Account No. 50-3894.

Respectfully submitted,  
MYERS WOLIN, LLC

/Brian S. Myers/  
Brian S. Myers  
Reg. No. 46,947

**CUSTOMER NUMBER 61650**  
PHONE: (973) 828-1284  
FAX: (866) 864-3948

|                                                                                                     |                        |              |            |  |
|-----------------------------------------------------------------------------------------------------|------------------------|--------------|------------|--|
| <b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br>( Not for submission under 37 CFR 1.99) | Application Number     |              |            |  |
|                                                                                                     | Filing Date            |              | 2023-08-10 |  |
|                                                                                                     | First Named Inventor   | Shinji YUASA |            |  |
|                                                                                                     | Art Unit               |              |            |  |
|                                                                                                     | Examiner Name          |              |            |  |
|                                                                                                     | Attorney Docket Number | IBTH 13318Aa |            |  |

| U.S.PATENTS       |         |               |                        |            |                                                 |                                                                        |
|-------------------|---------|---------------|------------------------|------------|-------------------------------------------------|------------------------------------------------------------------------|
| Examiner Initial* | Cite No | Patent Number | Kind Code <sup>1</sup> | Issue Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear |
|                   | 1       | 11233193      | B2                     | 2022-01-25 | Shinji YUASA                                    |                                                                        |

If you wish to add additional U.S. Patent citation information please click the Add button.

| U.S.PATENT APPLICATION PUBLICATIONS |         |                    |                        |                  |                                                 |                                                                        |
|-------------------------------------|---------|--------------------|------------------------|------------------|-------------------------------------------------|------------------------------------------------------------------------|
| Examiner Initial*                   | Cite No | Publication Number | Kind Code <sup>1</sup> | Publication Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear |
|                                     | 1       | 20040109347        | A1                     | 2004-06-10       | DEBROSSE et al.                                 |                                                                        |

If you wish to add additional U.S. Published Application citation information please click the Add button.

| FOREIGN PATENT DOCUMENTS |         |                                      |                           |                        |                  |                                                 |                                                                        |                          |
|--------------------------|---------|--------------------------------------|---------------------------|------------------------|------------------|-------------------------------------------------|------------------------------------------------------------------------|--------------------------|
| Examiner Initial*        | Cite No | Foreign Document Number <sup>3</sup> | Country Code <sup>2</sup> | Kind Code <sup>4</sup> | Publication Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear | T <sup>5</sup>           |
|                          | 1       |                                      |                           |                        |                  |                                                 |                                                                        | <input type="checkbox"/> |

If you wish to add additional Foreign Patent Document citation information please click the Add button

| NON-PATENT LITERATURE DOCUMENTS |         |                                                                                                                                                                                                                                                                 |                |
|---------------------------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Examiner Initials*              | Cite No | Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published. | T <sup>5</sup> |
|                                 |         |                                                                                                                                                                                                                                                                 |                |

|                                                                                                     |                        |              |            |
|-----------------------------------------------------------------------------------------------------|------------------------|--------------|------------|
| <b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br>( Not for submission under 37 CFR 1.99) | Application Number     |              |            |
|                                                                                                     | Filing Date            |              | 2023-08-10 |
|                                                                                                     | First Named Inventor   | Shinji YUASA |            |
|                                                                                                     | Art Unit               |              |            |
|                                                                                                     | Examiner Name          |              |            |
|                                                                                                     | Attorney Docket Number | IBTH 13318Aa |            |

|   |                                                                                                                                                                            |                          |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| 1 | Non-Final Office Action issued by the United States Patent and Trademark Office for U.S. Patent Application No. 17/560,922, electronically delivered on November 17, 2022. | <input type="checkbox"/> |
| 2 | Notice of Allowance issued by the United States Patent and Trademark Office for U.S. Patent Application No. 17/560,922, electronically delivered on March 22, 2023.        | <input type="checkbox"/> |

If you wish to add additional non-patent literature document citation information please click the Add button

#### EXAMINER SIGNATURE

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |                 |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-----------------|--|
| Examiner Signature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |  | Date Considered |  |
| <p>*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.</p>                                                                                                                                                                                                                                                                                                                                                                         |  |                 |  |
| <p><sup>1</sup> See Kind Codes of USPTO Patent Documents at <a href="http://www.USPTO.GOV">www.USPTO.GOV</a> or MPEP 901.04. <sup>2</sup> Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). <sup>3</sup> For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. <sup>4</sup> Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. <sup>5</sup> Applicant is to place a check mark here if English language translation is attached.</p> |  |                 |  |

|                                                                                                     |                        |              |            |
|-----------------------------------------------------------------------------------------------------|------------------------|--------------|------------|
| <b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br>( Not for submission under 37 CFR 1.99) | Application Number     |              |            |
|                                                                                                     | Filing Date            |              | 2023-08-10 |
|                                                                                                     | First Named Inventor   | Shinji YUASA |            |
|                                                                                                     | Art Unit               |              |            |
|                                                                                                     | Examiner Name          |              |            |
|                                                                                                     | Attorney Docket Number | IBTH 13318Aa |            |

### CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

**OR**

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

### SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

|            |                  |                     |            |
|------------|------------------|---------------------|------------|
| Signature  | /Brian S. Myers/ | Date (YYYY-MM-DD)   | 2023-08-10 |
| Name/Print | Brian S. Myers   | Registration Number | 46947      |

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

## Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Doc code: IDS

PTO/SB/08a (02-18)

Doc description: Information Disclosure Statement (IDS) Filed

Approved for use through 11/30/2020. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

|                                                                                                     |                        |              |  |
|-----------------------------------------------------------------------------------------------------|------------------------|--------------|--|
| <b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br>( Not for submission under 37 CFR 1.99) | Application Number     |              |  |
|                                                                                                     | Filing Date            |              |  |
|                                                                                                     | First Named Inventor   | Shinji YUASA |  |
|                                                                                                     | Art Unit               |              |  |
|                                                                                                     | Examiner Name          |              |  |
|                                                                                                     | Attorney Docket Number | IBTH 13318Aa |  |

### U.S.PATENTS

| Examiner Initial* | Cite No | Patent Number | Kind Code <sup>1</sup> | Issue Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear |
|-------------------|---------|---------------|------------------------|------------|-------------------------------------------------|------------------------------------------------------------------------|
|                   | 1       | 10680167      | B2                     | 2020-06-09 | Yuasa                                           |                                                                        |
|                   | 2       | 6621730       | B1                     | 2003-09-16 | Lage                                            |                                                                        |

If you wish to add additional U.S. Patent citation information please click the Add button.

### U.S.PATENT APPLICATION PUBLICATIONS

| Examiner Initial* | Cite No | Publication Number | Kind Code <sup>1</sup> | Publication Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear |
|-------------------|---------|--------------------|------------------------|------------------|-------------------------------------------------|------------------------------------------------------------------------|
|                   | 1       |                    |                        |                  |                                                 |                                                                        |

If you wish to add additional U.S. Published Application citation information please click the Add button.

### FOREIGN PATENT DOCUMENTS

| Examiner Initial* | Cite No | Foreign Document Number <sup>3</sup> | Country Code <sup>2</sup> | Kind Code <sup>4</sup> | Publication Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear | T <sup>5</sup>           |
|-------------------|---------|--------------------------------------|---------------------------|------------------------|------------------|-------------------------------------------------|------------------------------------------------------------------------|--------------------------|
|                   | 1       |                                      |                           |                        |                  |                                                 |                                                                        | <input type="checkbox"/> |

If you wish to add additional Foreign Patent Document citation information please click the Add button

### NON-PATENT LITERATURE DOCUMENTS

Doc code: IDS

PTO/SB/08a (02-18)

Doc description: Information Disclosure Statement (IDS) Filed

Approved for use through 11/30/2020. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

|                                                                                                     |                        |              |  |  |
|-----------------------------------------------------------------------------------------------------|------------------------|--------------|--|--|
| <b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br>( Not for submission under 37 CFR 1.99) | Application Number     |              |  |  |
|                                                                                                     | Filing Date            |              |  |  |
|                                                                                                     | First Named Inventor   | Shinji YUASA |  |  |
|                                                                                                     | Art Unit               |              |  |  |
|                                                                                                     | Examiner Name          |              |  |  |
|                                                                                                     | Attorney Docket Number | IBTH 13318Aa |  |  |

### U.S.PATENTS

| Examiner Initial* | Cite No | Patent Number | Kind Code <sup>1</sup> | Issue Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear |
|-------------------|---------|---------------|------------------------|------------|-------------------------------------------------|------------------------------------------------------------------------|
|                   | 1       | 10367138      | B2                     | 2019-07-30 | Yuasa                                           |                                                                        |

If you wish to add additional U.S. Patent citation information please click the Add button.

### U.S.PATENT APPLICATION PUBLICATIONS

| Examiner Initial* | Cite No | Publication Number | Kind Code <sup>1</sup> | Publication Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear |
|-------------------|---------|--------------------|------------------------|------------------|-------------------------------------------------|------------------------------------------------------------------------|
|                   | 1       |                    |                        |                  |                                                 |                                                                        |

If you wish to add additional U.S. Published Application citation information please click the Add button.

### FOREIGN PATENT DOCUMENTS

| Examiner Initial* | Cite No | Foreign Document Number <sup>3</sup> | Country Code <sup>2</sup> | Kind Code <sup>4</sup> | Publication Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear | T <sup>5</sup>           |
|-------------------|---------|--------------------------------------|---------------------------|------------------------|------------------|-------------------------------------------------|------------------------------------------------------------------------|--------------------------|
|                   | 1       |                                      |                           |                        |                  |                                                 |                                                                        | <input type="checkbox"/> |

If you wish to add additional Foreign Patent Document citation information please click the Add button

### NON-PATENT LITERATURE DOCUMENTS

| Examiner Initials* | Cite No | Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published. | T <sup>5</sup> |
|--------------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
|                    |         |                                                                                                                                                                                                                                                                 |                |

# INFORMATION DISCLOSURE STATEMENT BY APPLICANT

( Not for submission under 37 CFR 1.99)

|                        |              |  |
|------------------------|--------------|--|
| Application Number     |              |  |
| Filing Date            |              |  |
| First Named Inventor   | Shinji YUASA |  |
| Art Unit               |              |  |
| Examiner Name          |              |  |
| Attorney Docket Number | IBTH 13318Aa |  |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | YUASA, S. et al., "Giant tunnel magnetoresistance in magnetic tunnel junctions with a crystalline MgO(001) barrier", Journal of Physics D: Applied Physics, 40, (2007), R337-R354, which is Evidence Otsu 29 (Evidence submitted by the Defendant 29) for 2014(wa)25200 Case of Claiming Damages in Japan, already submitted as IDS on August 12, 2019                                                             |
| 2 | TSUNODA, M. et al., "Orientational Control of Barrier Layer with Interfacial Modification and Its Effect on Tunnel Magnetoresistance in CoFeB/MgO/CoFeB Magnetic Tunnel Junctions", Journal of Vacuum Society of Japan, Vol.51, No.9, (2008), pp.583-588, which is Evidence Otsu 38 (Evidence submitted by the Defendant 38) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation |
| 3 | YUASA, S. et al., "High Tunnel Magnetoresistance at Room Temperature in Fully Epitaxial Fe/MgO/Fe Tunnel Junctions due to Coherent Spin-Polarized Tunneling", Japanese Journal of Applied Physics, Vol. 43, No. 4B, (2004), pp. L588-L590, which is Evidence Otsu 48 (Evidence submitted by the Defendant 48) for 2014(wa)25200 Case of Claiming Damages in Japan, already submitted as IDS on August 12, 2019     |
| 4 | Defendant Technical briefing Documents Page 42 - Page 67, which is Evidence Otsu 55 (Evidence submitted by the Defendant 55) for 2014(wa)25200 Case of Claiming Damages in Japan, with English translation                                                                                                                                                                                                         |
| 5 | YUASA, S. et al., "Tunneling Magnetoresistance and Interface Structure of Magnetic Tunnel Junctions with a MgO (001) Barrier", Surface Science Vol. 28, No. 1, pp.15-21, 2007, which is Evidence Otsu 56 (Evidence submitted by the Defendant 56) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                            |
| 6 | "Part VI Chapter 1 Section 1" of "Examination Guidelines for Patent and Utility Model in Japan" of September 2015, which is Evidence Otsu 60 (Evidence submitted by the Defendant 60) for 2014(wa)25200 Case of Claiming Damages in Japan, with English translation                                                                                                                                                |
| 7 | MACHIDA, K. et al., "Spatial Light Modulator with Tunnel Magnetoresistance Driven by Spin Transfer Switching - Toward the Development of a 3D Television System with Low Power Consumption-", NHK STRL R&D, No.138, (2013), pp.51-60, which is Evidence Otsu 65 (Evidence submitted by the Defendant 65) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                     |
| 8 | MACHIDA, K. et al., "Magnetic tunnel junctions using Co/Pt multilayered free layers with perpendicular magnetic anisotropy", Journal of Physics: Conference Series, 303, (2011), 012100, which is an original paper of MACHIDA, K. et al., NHK STRL R&D, No.138, (2013), pp.51-60                                                                                                                                  |

If you wish to add additional non-patent literature document citation information please click the Add button

## EXAMINER SIGNATURE

|                    |  |                 |  |
|--------------------|--|-----------------|--|
| Examiner Signature |  | Date Considered |  |
|--------------------|--|-----------------|--|

\*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

<sup>1</sup> See Kind Codes of USPTO Patent Documents at [www.USPTO.GOV](http://www.USPTO.GOV) or MPEP 901.04. <sup>2</sup> Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). <sup>3</sup> For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. <sup>4</sup> Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. <sup>5</sup> Applicant is to place a check mark here if English language translation is attached.

Doc code: IDS

PTO/SB/08a (02-18)

Doc description: Information Disclosure Statement (IDS) Filed

Approved for use through 11/30/2020. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

|                                                                                                     |                        |                          |  |
|-----------------------------------------------------------------------------------------------------|------------------------|--------------------------|--|
| <b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br>( Not for submission under 37 CFR 1.99) | Application Number     |                          |  |
|                                                                                                     | Filing Date            |                          |  |
|                                                                                                     | First Named Inventor   | Shinji YUASA             |  |
|                                                                                                     | Art Unit               |                          |  |
|                                                                                                     | Examiner Name          |                          |  |
|                                                                                                     | Attorney Docket Number | IBTH 13318A <sub>a</sub> |  |

| U.S.PATENTS       |         |               |                        |            |                                                 | Remove                                                                                                         |
|-------------------|---------|---------------|------------------------|------------|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| Examiner Initial* | Cite No | Patent Number | Kind Code <sup>1</sup> | Issue Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear                                         |
|                   | 1       | 8294228       | B2                     | 2012-10-23 | PENG et al.                                     | Evidence Kou 16 (Evidence submitted by the Plaintiffs 16) for 2014(wa) 25200 Case of Claiming Damages in Japan |
|                   | 2       | 8091209       | B2                     | 2012-01-10 | GAO et al.                                      | Evidence Kou 29 (Evidence submitted by the Plaintiffs 29) for 2014(wa) 25200 Case of Claiming Damages in Japan |

If you wish to add additional U.S. Patent citation information please click the Add button.

Add

| U.S.PATENT APPLICATION PUBLICATIONS |         |                    |                        |                  |                                                 | Remove                                                                                                                                                                                              |
|-------------------------------------|---------|--------------------|------------------------|------------------|-------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Examiner Initial*                   | Cite No | Publication Number | Kind Code <sup>1</sup> | Publication Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear                                                                                                                              |
|                                     | 1       | 20040144995        | A1                     | 2004-07-29       | NAGAHAMA et al.                                 | Corresponds to JP2003-318465, which is Evidence Otsu 34 (Evidence submitted by the Defendant 34) for 2014(wa) 25200 Case of Claiming Damages in Japan, already <span style="float: right;">+</span> |
|                                     | 2       | 20020064069        | A1                     | 2002-05-30       | GOEBEL et al.                                   | Corresponds to JP2002-540594, which is Evidence Otsu 35 (Evidence submitted by the Defendant 35) for 2014(wa) 25200 Case of Claiming Damages in Japan                                               |
|                                     | 3       | 20030203189        | A1                     | 2003-10-30       | FUTAMOTO et al.                                 | Corresponds to JP2001-023140, which is Evidence Otsu 49 (Evidence submitted by the Defendant 49) for 2014(wa) 25200 Case of Claiming Damages in Japan, already <span style="float: right;">+</span> |
|                                     | 4       | 20030080363        | A1                     | 2003-05-01       | MARUYAMA et al.                                 | Corresponds to JP2003-133531, which is Evidence Otsu 52 (Evidence submitted by the Defendant 52) for 2014(wa) 25200 Case of Claiming Damages in Japan                                               |

If you wish to add additional U.S. Published Application citation information please click the Add button.

Add

| FOREIGN PATENT DOCUMENTS |  |  |  |  |  | Remove |
|--------------------------|--|--|--|--|--|--------|
|--------------------------|--|--|--|--|--|--------|

# **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** ( Not for submission under 37 CFR 1.99)

|                        |              |  |
|------------------------|--------------|--|
| Application Number     |              |  |
| Filing Date            |              |  |
| First Named Inventor   | Shinji YUASA |  |
| Art Unit               |              |  |
| Examiner Name          |              |  |
| Attorney Docket Number | IBTH 13318Aa |  |

| Examiner Initial* | Cite No | Foreign Document Number <sup>3</sup> | Country Code <sup>2</sup> i | Kind Code <sup>4</sup> | Publication Date | Name of Patentee or Applicant of cited Document   | Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear                                      | T <sup>5</sup> |
|-------------------|---------|--------------------------------------|-----------------------------|------------------------|------------------|---------------------------------------------------|---------------------------------------------------------------------------------------------------------------|----------------|
|                   | 1       | 4963744                              | JP                          | B2                     | 2012-06-27       | JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.        | Evidence Kou 2 (Evidence submitted by the Plaintiffs 2), for 2014 (wa) 25200 Case of Claiming Damages in +    |                |
|                   | 2       | 5002788                              | JP                          | B2                     | 2012-08-15       | JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.        | Evidence Kou 4 (Evidence submitted by the Plaintiffs 4), for 2014 (wa) 25200 Case of Claiming Damages in +    |                |
|                   | 3       | 5120680                              | JP                          | B2                     | 2013-01-16       | JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.        | Evidence Kou 6 (Evidence submitted by the Plaintiffs 6), for 2014 (wa) 25200 Case of Claiming Damages in +    |                |
|                   | 4       | 5152734                              | JP                          | B2                     | 2013-02-27       | JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.        | Evidence Kou 8 (Evidence submitted by the Plaintiffs 8), for 2014 (wa) 25200 Case of Claiming Damages in +    |                |
|                   | 5       | 4774092                              | JP                          | B2                     | 2011-09-14       | JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.        | Evidence Kou 10 (Evidence submitted by the Plaintiffs 10), for 2014(wa) 25200 Case of Claiming Damages in +   |                |
|                   | 6       | 2005/88745                           | WO                          | A1                     | 2005-09-22       | JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.        | Evidence Otsu 3-1 (Evidence submitted by the Defendant 3-1), for 2014(wa) 25200 Case of Claiming Damages in + |                |
|                   | 7       | 2006-196612                          | JP                          | A                      | 2006-07-27       | SONY CORP.                                        | Evidence Otsu 28 (Evidence submitted by the Defendant 28), for 2014(wa) 25200 Case of Claiming Damages in +   |                |
|                   | 8       | 2003-318465                          | JP                          | A                      | 2003-11-07       | ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY et al. | Evidence Otsu 34 (Evidence submitted by the Defendant 34) for 2014(wa) 25200 Case of Claiming Damages in +    |                |
|                   | 9       | 2002-540594                          | JP                          | T                      | 2002-11-26       | INFINEON TECHNOLOGIES AG                          | Evidence Otsu 35 (Evidence submitted by the Defendant 35) for 2014(wa) 25200 Case of Claiming Damages in +    |                |
|                   | 10      | 2001-23140                           | JP                          | A                      | 2001-01-26       | HITACHI, LTD.                                     | Evidence Otsu 49 (Evidence submitted by the Defendant 49) for 2014(wa) 25200 Case of Claiming Damages in +    |                |

# **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** ( Not for submission under 37 CFR 1.99)

|                        |              |  |
|------------------------|--------------|--|
| Application Number     |              |  |
| Filing Date            |              |  |
| First Named Inventor   | Shinji YUASA |  |
| Art Unit               |              |  |
| Examiner Name          |              |  |
| Attorney Docket Number | IBTH 13318Aa |  |

|    |             |    |   |            |                                                  |                                                                                                                      |   |
|----|-------------|----|---|------------|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|---|
| 11 | H08-181289  | JP | A | 1996-07-12 | NISSAN MOTOR CORP.                               | Evidence Otsu 50<br>(Evidence submitted by<br>the Defendant 50) for<br>2014(wa) 25200 Case of<br>Claiming Damages in | + |
| 12 | 2004-227667 | JP | A | 2004-08-12 | FUJITSU LIMITED                                  | Evidence Otsu 51<br>(Evidence submitted by<br>the Defendant 51) for<br>2014(wa) 25200 Case of<br>Claiming Damages in | + |
| 13 | 2003-133531 | JP | A | 2003-05-09 | FUJITSU LIMITED                                  | Evidence Otsu 52<br>(Evidence submitted by<br>the Defendant 52) for<br>2014(wa) 25200 Case of<br>Claiming Damages in | + |
| 14 | 2009-21626  | JP | A | 2009-01-29 | JAPAN SCIENCE AND<br>TECHNOLOGY AGENCY<br>et al. | Evidence Otsu 58<br>(Evidence submitted by<br>the Defendant 58) for<br>2014(wa) 25200 Case of<br>Claiming Damages in | + |
| 15 | 2008-4956   | JP | A | 2008-01-10 | JAPAN SCIENCE AND<br>TECHNOLOGY AGENCY<br>et al. | Evidence Otsu 59<br>(Evidence submitted by<br>the Defendant 59) for<br>2014(wa) 25200 Case of<br>Claiming Damages in | + |

If you wish to add additional Foreign Patent Document citation information please click the Add button

Add

## **NON-PATENT LITERATURE DOCUMENTS**

Remove

| Examiner<br>Initials* | Cite<br>No | Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item<br>(book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s),<br>publisher, city and/or country where published. | T <sup>5</sup> |
|-----------------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
|                       | 1          | Defendant Preliminary Documents (1) Page 33 line 11 - Page 57 submitted on January 30, 2015 for 2014(wa)25200<br>Case of Claiming Damages in Japan, with English machine translation                                                                                  |                |
|                       | 2          | Plaintiffs Preliminary Documents (1) Page 69 - Page 74 submitted on March 13, 2015 for 2014(wa)25200 Case of<br>Claiming Damages in Japan, with English machine translation                                                                                           |                |
|                       | 3          | Defendant Preliminary Documents (2) Page 23 line 16 - Page 46 submitted on June 4, 2015 for 2014(wa)25200 Case<br>of Claiming Damages in Japan, with English machine translation                                                                                      |                |
|                       | 4          | Plaintiffs Preliminary Documents (2) Page 31 line 13 - Page 32 submitted on July 23, 2015 for 2014(wa)25200 Case of<br>Claiming Damages in Japan, with English machine translation                                                                                    |                |

# **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** ( Not for submission under 37 CFR 1.99)

|                        |                          |  |
|------------------------|--------------------------|--|
| Application Number     |                          |  |
| Filing Date            |                          |  |
| First Named Inventor   | Shinji YUASA             |  |
| Art Unit               |                          |  |
| Examiner Name          |                          |  |
| Attorney Docket Number | IBTH 13318A <sub>a</sub> |  |

|    |                                                                                                                                                                                                                                                  |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5  | Defendant Preliminary Documents (3) Page 47 line 14 - Page 79 submitted on October 1, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                 |
| 6  | Plaintiffs Preliminary Documents (4) Page 2 - Page 16 submitted on November 20, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                       |
| 7  | Defendant Preliminary Documents (5) Page 5 - Page 39 submitted on February 5, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                         |
| 8  | Plaintiffs Preliminary Documents (6) submitted on March 4, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                            |
| 9  | Defendant Preliminary Documents (7) Page 4 - Page 23 submitted on April 4, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                            |
| 10 | Defendant Preliminary Documents (10) Page 4 line 4 from the bottom - Page 8 line 3 from the bottom and Page 23 line 9 - Page 24 submitted on July 29, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation |
| 11 | Plaintiffs Preliminary Documents (9) Page 8 - Page 14 line 13 and Page 18 line 19 - Page 22 submitted on August 9, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                    |
| 12 | Defendant Preliminary Documents (11) Page 17 line 3 - Page 21 line 5 from the bottom and Page 22 line 5 - Page 27 line 12 submitted on October 14, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation    |
| 13 | Plaintiffs Preliminary Documents (10) Page 8 - Page 10 submitted on October 21, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                       |
| 14 | Plaintiffs Preliminary Documents (11) Page 2 - Page 8 and Page 15 - Page 19 submitted on November 18, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                 |
| 15 | Defendant Preliminary Documents (12) Page 10 line 5 - Page 14 line 8 and Page 16 - Page 35 submitted on January 20, 2017 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                   |

**INFORMATION DISCLOSURE  
STATEMENT BY APPLICANT**  
( Not for submission under 37 CFR 1.99)

|                        |              |  |
|------------------------|--------------|--|
| Application Number     |              |  |
| Filing Date            |              |  |
| First Named Inventor   | Shinji YUASA |  |
| Art Unit               |              |  |
| Examiner Name          |              |  |
| Attorney Docket Number | IBTH 13318Aa |  |

|    |                                                                                                                                                                                                                                                                                                                                                                                                             |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 16 | Plaintiffs Preliminary Documents (12) Page 12 - Page 16 submitted on January 25, 2017 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                                                                                 |
| 17 | Plaintiffs Preliminary Documents (13) submitted on January 26, 2017 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                                                                                                   |
| 18 | Defendant Preliminary Documents(13) Page 3 line 6 - Page 6 line 6 from the bottom and Page 8 line 13 - Page 19 submitted on March 17, 2017 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                            |
| 19 | Plaintiffs Preliminary Documents (16) Page 6 line 21 - Page 7 submitted on August 25, 2017 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                                                                            |
| 20 | Defendant Preliminary Documents(15) Page 2 line 3 from the bottom - Page 3 line 7 submitted on September 19, 2017 for 2014(wa)25200 Case of Claiming Damages in Japan, with English translation                                                                                                                                                                                                             |
| 21 | Defendant Preliminary Documents (19) Page 15 line 9 - Page 19 submitted on April 13, 2018 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                                                                             |
| 22 | Plaintiffs Preliminary Documents (20) Page 3 line 7 from the bottom - Page 6 submitted on April 17, 2018 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                                                              |
| 23 | Plaintiffs Preliminary Documents (22) submitted on July 20, 2018 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                                                                                                      |
| 24 | Plaintiffs Preliminary Documents (23) submitted on August 9, 2018 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                                                                                                     |
| 25 | Defendant Preliminary Documents (21) submitted on September 14, 2018 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                                                                                                  |
| 26 | YUASA, S., "Recent Developments of Spintronics Device Technologies Based on Magnetic Tunnel Junctions with Magnesium Oxide Tunnel Barrier", IEEJ Transactions on Electronics, Information and Systems, Vol.133, No.3, pp.471-478, which is Attachment(1) of Evidence Kou 11 (Evidence submitted by the Plaintiffs 11) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation |

**INFORMATION DISCLOSURE  
STATEMENT BY APPLICANT**  
( Not for submission under 37 CFR 1.99)

|                        |                          |  |
|------------------------|--------------------------|--|
| Application Number     |                          |  |
| Filing Date            |                          |  |
| First Named Inventor   | Shinji YUASA             |  |
| Art Unit               |                          |  |
| Examiner Name          |                          |  |
| Attorney Docket Number | IBTH 13318A <sub>a</sub> |  |

|    |                                                                                                                                                                                                                                                                                                                                                                                   |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 27 | Plaintiffs Technical briefing Documents Page 26 - Page 30, which is Evidence Kou 38 (Evidence submitted by the Plaintiffs 38) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                               |
| 28 | YUASA, S. et al., "Giant Room-Temperature Magnetoresistance in Single-Crystal Fe/MgO/Fe Magnetic Tunnel Junctions", Nature Materials, Vol. 3, (October 31, 2004), pp. 868-871, which is Evidence Kou 41 (Evidence submitted by the Plaintiffs 41) for 2014(wa)25200 Case of Claiming Damages in Japan, already submitted as IDS on August 12, 2019                                |
| 29 | DONG, K.F. et, al., "Nanocomposite L10 FePt-SiNx and FePt-SiNx-C films with large coercivity and small grain size on a TiN intermediate layer", Journal of Magnetism and Magnetic Materials, 324, (2012), 2637-2644, which is Evidence Kou 45 (Evidence submitted by the Plaintiffs 45) for 2014(wa)25200 Case of Claiming Damages in Japan                                       |
| 30 | Research report (7) Page 8- Page 12 line14, which is Evidence Kou 47 (Evidence submitted by the Plaintiffs 47) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                              |
| 31 | Decision on Appeal (Correction 2016-390151) on January 17, 2017 for Japanese Patent No.4963744, which is Evidence Kou 48 (Evidence submitted by the Plaintiffs 48) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                          |
| 32 | Decision on Appeal (Correction 2017-390051) on August 17, 2017 for Japanese Patent No.5120680, which is Evidence Kou 57 (Evidence submitted by the Plaintiffs 57) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                           |
| 33 | HAYAKAWA J. et al., "Dependence of Giant Tunnel Magnetoresistance of Sputtered CoFeB/MgO/CoFeB Magnetic Tunnel Junctions on MgO Barrier Thickness and Annealing Temperature", Japanese Journal of Applied Physics, Vol. 44, No. 19, (2005), pp. L587-L589, which is Evidence Kou 58 (Evidence submitted by the Plaintiffs 58) for 2014(wa)25200 Case of Claiming Damages in Japan |
| 34 | Written Statement submitted on August 10, 2007 for Japanese Patent Application No.2006-511062, which is Evidence Otsu 3-2 (Evidence submitted by the Defendant 3-2) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                         |
| 35 | Written Statement submitted on August 10, 2007 for Japanese Patent Application No.2007-210197, which is Evidence Otsu 4 (Evidence submitted by the Defendant 4) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                             |
| 36 | Notice of Reasons for Refusal drafted on December 8, 2010 for Japanese Patent Application No.2008-238154, which is Evidence Otsu 5-1 (Evidence submitted by the Defendant 5-1) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                              |
| 37 | Written Statement submitted on November 11, 2011 for Japanese Patent Application No.2011-226906, which is Evidence Otsu 6-1 (Evidence submitted by the Defendant 6-1) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                       |

**INFORMATION DISCLOSURE  
STATEMENT BY APPLICANT**  
( Not for submission under 37 CFR 1.99)

|                        |              |  |
|------------------------|--------------|--|
| Application Number     |              |  |
| Filing Date            |              |  |
| First Named Inventor   | Shinji YUASA |  |
| Art Unit               |              |  |
| Examiner Name          |              |  |
| Attorney Docket Number | IBTH 13318Aa |  |

|    |                                                                                                                                                                                                                                                                                                                                                                                                      |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 38 | Written Opinion submitted on March 23, 2012 for Japanese Patent Application No.2011-226907, which is Evidence Otsu 7-1 (Evidence submitted by the Defendant 7-1) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                               |
| 39 | Notice of Reasons for Refusal drafted on January 18, 2012 for Japanese Patent Application No.2011-226907, which is Evidence Otsu 7-2 (Evidence submitted by the Defendant 7-2) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation, already submitted as IDS on August 12, 2019                                                                                    |
| 40 | Written Statement submitted on April 20, 2012 for Japanese Patent Application No.2012-067089, which is Evidence Otsu 8 (Evidence submitted by the Defendant 8) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                 |
| 41 | Written Opinion submitted on October 9, 2012 for Japanese Patent Application No.2011-226908, which is Evidence Otsu 9-2 (Evidence submitted by the Defendant 9-2) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                              |
| 42 | Written Statement submitted on November 11, 2011 for Japanese Patent Application No.2011-226908, which is Evidence Otsu 9-3 (Evidence submitted by the Defendant 9-3) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                          |
| 43 | Written Amendment submitted on March 10, 2008 for Japanese Patent Application No.2004-259280, which is Evidence Otsu 10-1 (Evidence submitted by the Defendant 10-1) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                           |
| 44 | Notice of Reasons for Refusal drafted on July 29, 2008 for Japanese Patent Application No.2004-259280, which is Evidence Otsu 10-2 (Evidence submitted by the Defendant 10-2) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                  |
| 45 | Written Amendment submitted on October 3, 2008 for Japanese Patent Application No.2004-259280, which is Evidence Otsu 10-3 (Evidence submitted by the Defendant 10-3) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                          |
| 46 | Written Opinion submitted on October 3, 2008 for Japanese Patent Application No.2004-259280, which is Evidence Otsu 10-4 (Evidence submitted by the Defendant 10-4) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                            |
| 47 | DJYAPRAWIRA, D.D. et al, "230% Room-Temperature Magnetoresistance in CoFeB/MgO/CoFeB Magnetic Tunnel Junctions", Appl. Phys. Lett., vol. 86, (2005), pp. 092502-1 – 092502-3, which is Evidence Otsu 12 (Evidence submitted by the Defendant 12) for 2014(wa)25200 Case of Claiming Damages in Japan, and which is also called as "Djyaprawira article", already submitted as IDS on August 12, 2019 |
| 48 | "Part I Chapter 1" of "Examination Guidelines for Patent and Utility Model in Japan" of July 2013, which is Evidence Otsu 13 (Evidence submitted by the Defendant 13) for 2014(wa)25200 Case of Claiming Damages in Japan, with English translation                                                                                                                                                  |

# **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** ( Not for submission under 37 CFR 1.99)

|                        |               |  |
|------------------------|---------------|--|
| Application Number     |               |  |
| Filing Date            |               |  |
| First Named Inventor   | Shinji YUASA  |  |
| Art Unit               |               |  |
| Examiner Name          |               |  |
| Attorney Docket Number | IBTH 13318A a |  |

|    |                                                                                                                                                                                                                                                                                   |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 49 | YUASA, S. et al., " Creating non-volatile electronics by spintronics technology", Synthesiology, Vol.2, No.3, (2009), p.211-222, which is Evidence Otsu 22 (Evidence submitted by the Defendant 22) for 2014(wa)25200 Case of Claiming Damages in Japan, with English translation |
| 50 | 'IT Appliances with Zero Standby Power: Is the Dream Close to Reality?', AIST Stories, No.1, (2013), pp.4-9, which is Evidence Otsu 26 (Evidence submitted by the Defendant 26) for 2014(wa)25200 Case of Claiming Damages in Japan, with English translation                     |

If you wish to add additional non-patent literature document citation information please click the Add button

## **EXAMINER SIGNATURE**

|                    |  |                 |  |
|--------------------|--|-----------------|--|
| Examiner Signature |  | Date Considered |  |
|--------------------|--|-----------------|--|

\*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

<sup>1</sup> See Kind Codes of USPTO Patent Documents at [www.USPTO.GOV](http://www.USPTO.GOV) or MPEP 901.04. <sup>2</sup> Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). <sup>3</sup> For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. <sup>4</sup> Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. <sup>5</sup> Applicant is to place a check mark here if English language translation is attached.

Customized PTO/SB/08a+b (07-09)

|                                                                                              |                |                          |  |
|----------------------------------------------------------------------------------------------|----------------|--------------------------|--|
| Substitute for Form 1449/PTO<br><br><b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b> | Application #  |                          |  |
|                                                                                              | Confirmation # |                          |  |
|                                                                                              | Filing Date    |                          |  |
|                                                                                              | First Inventor | Shinji YUASA             |  |
|                                                                                              | Art Unit       |                          |  |
|                                                                                              | Examiner       |                          |  |
| Sheet 1 of 3                                                                                 | Docket #       | IBTH 13318A <sub>a</sub> |  |

| U.S. PATENT DOCUMENTS |                                    |                          |                               |                   |
|-----------------------|------------------------------------|--------------------------|-------------------------------|-------------------|
| Initial<br>(*)        | Document No.<br>Number – Kind Code | Publ. Date<br>MM-DD-YYYY | Name<br>Patentee or Applicant | Corresponds<br>to |
|                       | US-2006/003185                     | 01-05-2006               | PARKIN                        |                   |
|                       | US-7,252,852                       | 08/07/2007               | PARKIN                        |                   |
|                       |                                    |                          |                               |                   |

| FOREIGN PATENT DOCUMENTS |                                       |                          |                               |                  |
|--------------------------|---------------------------------------|--------------------------|-------------------------------|------------------|
| Initial<br>(*)           | Country-Number-<br>Kind Code if known | Publ. Date<br>MM-DD-YYYY | Name<br>Patentee or Applicant | Trans-<br>lation |
|                          |                                       |                          |                               |                  |
|                          |                                       |                          |                               |                  |
|                          |                                       |                          |                               |                  |
|                          |                                       |                          |                               |                  |

| NON PATENT LITERATURE DOCUMENTS |                                                                                                                                              |                  |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Exam.<br>Initial*               | Include NAME of the author (in CAPS), Title of Article/Item, Date, Page(s), Volume-Issue No., Publisher, City and/or Country where published | Trans-<br>lation |
|                                 |                                                                                                                                              |                  |
|                                 |                                                                                                                                              |                  |
|                                 |                                                                                                                                              |                  |

|                    |  |                 |  |
|--------------------|--|-----------------|--|
| Examiner Signature |  | Date Considered |  |
|--------------------|--|-----------------|--|

\* Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP §609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.

Customized PTO/SB/08a+b (07-09)

|                                                                                              |                |               |
|----------------------------------------------------------------------------------------------|----------------|---------------|
| Substitute for Form 1449/PTO<br><br><b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b> | Application #  |               |
|                                                                                              | Confirmation # |               |
|                                                                                              | Filing Date    |               |
|                                                                                              | First Inventor | Shinji YUASA  |
|                                                                                              | Art Unit       |               |
|                                                                                              | Examiner       |               |
| Sheet <u>2</u> of <u>3</u>                                                                   | Docket #       | IBTH 13318A a |

| U.S. PATENT DOCUMENTS |                                    |                          |                               |                   |
|-----------------------|------------------------------------|--------------------------|-------------------------------|-------------------|
| Initial<br>(*)        | Document No.<br>Number – Kind Code | Publ. Date<br>MM-DD-YYYY | Name<br>Patentee or Applicant | Corresponds<br>to |
|                       | US-2007/0128470                    | 06/07/2007               | Nagahama et al.               |                   |
|                       | US-2004/0144995                    | 07/29/2004               | Nagahama et al.               |                   |
|                       | US-2004/0245553                    | 12/09/2004               | Hosomi et al.                 |                   |
|                       | US-2006/0056115                    | 03/16/2006               | Djayaprawira et al.           |                   |
|                       | US-2002/0159203                    | 10/31/2002               | Saito et al.                  |                   |
|                       | US-2005/0207071                    | 09/22/2005               | Sato et al.                   |                   |
|                       | US-2002/0191355                    | 12/19/2002               | Hiramoto et al.               |                   |
|                       | US-2002/0149962                    | 10/17/2002               | Horiguchi                     |                   |
|                       | US-2007/0195592                    | 08/23/2007               | Yuasa                         |                   |
|                       | US-2009/0324814                    | 12/31/2009               | Parkin                        |                   |
|                       | US-2008/0062581                    | 03/13/2008               | Parkin                        |                   |
|                       | US-2007/0258170                    | 11/08/2007               | Yuasa                         |                   |
|                       | US-7,884,403                       | 02/08/2011               | Yuasa                         |                   |
|                       | US-6,544,801                       | 04/08/2003               | Slaughter et al.              |                   |
|                       | US-5,514,484                       | 05/07/1996               | Nishimoto                     |                   |
|                       | US-6,379,978                       | 04/30/2002               | Goebel et al.                 |                   |
|                       | US-7,276,384                       | 10/02/2007               | Parkin et al.                 |                   |
|                       | US-5,759,265                       | 06/02/1998               | Nashimoto et al.              |                   |
|                       | US-6,911,685                       | 06/28/2005               | Anthony et al.                |                   |
|                       | US-6,767,655                       | 07/27/2004               | Hiramoto et al.               |                   |
|                       | US-6,054,226                       | 04/25/2000               | Takeda et al.                 |                   |
|                       | US-2008/0055793                    | 03/06/2008               | Djayaprawira et al.           |                   |
|                       | US-2002/0080641                    | 06/27/2002               | Asao et al.                   |                   |
|                       | US-2002/0064595                    | 05/30/2002               | Nomura et al.                 |                   |
|                       | US-2003/0128483                    | 07/10/2003               | Kamijo                        |                   |
|                       | US-2004/0082201                    | 04/29/2004               | Sharma et al.                 |                   |
|                       | US-2004/0136232                    | 07/15/2004               | Hosomi et al.                 |                   |
|                       | US-2004/0139914                    | 07/22/2004               | Yamazaki et al.               |                   |
|                       | US-2004/0234818                    | 11/25/2004               | Tanahashi et al.              |                   |
|                       | US-2004/0257719                    | 12/23/2004               | Ohba et al.                   |                   |
|                       | US-2005/0110004                    | 05/26/2005               | Parkin et al.                 |                   |
|                       | US-2006/0012926                    | 01/19/2006               | Parkin                        |                   |
|                       | US-2006/0125034                    | 06/15/2006               | Ohba et al.                   |                   |
|                       | US-2006/0261425                    | 11/23/2006               | Suemitsu et al.               |                   |
|                       | US-2008/0124454                    | 05/29/2008               | Djayaprawira et al.           |                   |
|                       | US-2008/0180862                    | 07/31/2008               | Djayaprawira et al.           |                   |
|                       | US-2008/0182342                    | 07/31/2008               | Parkin                        |                   |
|                       | US-2008/0212243                    | 09/04/2008               | Zhao et al.                   |                   |

|  |                 |            |                  |              |
|--|-----------------|------------|------------------|--------------|
|  | US-2008/0253039 | 10/16/2008 | Nagamine et al.  |              |
|  | US-2009/0128167 | 05/21/2009 | Hamada et al.    |              |
|  | US-5,506,063    | 04/09/1996 | Kamijo et al.    |              |
|  | US-5,817,366    | 10/06/1998 | Arai et al.      |              |
|  | US-5,945,694    | 08/31/1999 | Reyes et al.     |              |
|  | US-6,181,537    | 01/30/2001 | Gill             |              |
|  | US-6,201,672    | 03/13/2001 | Pinarbasi        |              |
|  | US-6,252,750    | 06/26/2001 | Gill             |              |
|  | US-6,275,362    | 08/14/2001 | Pinarbasi        |              |
|  | US-6,828,260    | 12/07/2004 | Sharma et al.    |              |
|  | US-6,831,312    | 12/14/2004 | Slaughter et al. |              |
|  | US-6,839,206    | 01/04/2005 | Saito et al.     |              |
|  | US-6,927,952    | 08/09/2005 | Shimizu et al.   |              |
|  | US-6,999,287    | 02/14/2006 | Hayashi et al.   |              |
|  | US-7,149,105    | 12/12/2006 | Brown            |              |
|  | US-7,220,498    | 05/22/2007 | Nagahama et al.  |              |
|  | US-7,252,852    | 08/07/2007 | Parkin           |              |
|  | US-7,262,064    | 08/28/2007 | Ohba et al.      |              |
|  | US-7,270,896    | 09/18/2007 | Parkin           |              |
|  | US-2006/0003185 | 01/05/2006 | Parkin           |              |
|  | US-7,408,749    | 08/05/2008 | Gill             |              |
|  | US-7,443,639    | 10/28/2008 | Parkin           |              |
|  | US-7,453,672    | 11/18/2008 | Dieny et al.     |              |
|  | US-7,570,463    | 08/04/2009 | Parkin           |              |
|  | US-7,598,555    | 10/06/2009 | Papworth Parkin  |              |
|  | US-6,828,260    | 12/07/2004 | Sharma et al.    |              |
|  | US-2006/0049441 | 03-09-2006 | Janesky, et al.  |              |
|  | US-5,800,635    | 09-01-1998 | Collins, et al.  |              |
|  | US-5,239,504    | 08-24-1993 | Brady, et al.    |              |
|  | US-2003/0203189 | 10-30-2003 | FUTAMOTO et al.  | JP2001023140 |
|  | US-2004/0001372 | 01-01-2004 | HIGO et al.      | JP2004031694 |
|  | US-6,819,586    | 11-16-2004 | ANTHONY et al.   |              |
|  | US-2005/0047027 | 03-03-2005 | LIN, et al.      |              |
|  | US-8,319,263    | 11-27-2012 | YUASA, Shinji    |              |
|  | US-9,123,463    | 09-01-2015 | YUASA, Shinji    |              |
|  | US-8,405,134    | 03-26-2013 | YUASA, Shinji    |              |
|  | US-9,608,198    | 03-28-2017 | YUASA            |              |
|  |                 |            |                  |              |

### FOREIGN PATENT DOCUMENTS

| Initial<br>(*) | Country-Number-<br>Kind Code <small>if known</small> | Publ. Date<br>MM-DD-YYYY | Name<br>Patentee or Applicant              | Trans-<br>lation |
|----------------|------------------------------------------------------|--------------------------|--------------------------------------------|------------------|
|                | JP 2002-204004                                       | 7/19/2002                |                                            | Abst             |
|                | JP 2003-318465                                       | 11/7/2003                |                                            | Abst             |
|                | JP 2002-289943                                       | 10/4/2002                |                                            |                  |
|                | JP 2003-304010                                       | 10/24/2003               | Sony Corp                                  | Abst             |
|                | WO 2002/099905                                       | 5/24/2002                | Nat. Inst. Of Adv. Ind. & Technol., et al. | Abst             |
|                | EP 1 391 942                                         | 5/24/2002                | Nat. Inst. Of Adv. Ind. & Technol., et al. | Yes              |
|                | WO 2003/085750                                       | 10/16/2003               | Sony Corp                                  | Abst             |

|  |                 |            |                                            |                |
|--|-----------------|------------|--------------------------------------------|----------------|
|  | EP 1 494 295    | 1/5/2005   | Sony Corp                                  | Yes            |
|  | JP 2006-080116  | 3/23/2006  |                                            | Abst           |
|  | EP 1 633 007    | 3/8/2006   | Anelva Corporation                         | Yes            |
|  | EP 1 633 007    | 3/8/2006   | Anelva Corporation                         | Yes            |
|  | EP 1 085 586    | 3/21/2001  | Kabushiki Kaisha Toshiba                   | Yes            |
|  | JP 2000-030236  | 1/28/2000  | Hitachi Ltd.                               | Yes            |
|  | JP 2001-101645  | 4/13/2001  | Akita Prefecture                           | Yes            |
|  | JP 2004-022599  | 1/22/2004  | Sony Corp                                  | Yes            |
|  | JP 2002-270921  | 9/20/2002  | Toshiba Corp                               | Abst           |
|  | JP 2002-319722  | 10/31/2002 | Matsushita Electric Ind Co Ltd             | Abst           |
|  | WO 2004/025744  | 3/25/2004  | Fujitsu Limited                            | Abst           |
|  | JP 2003-283001  | 10/3/2003  | Toshiba Corp                               | Yes            |
|  | JP 2002-246567  | 8/30/2002  | Toshiba Corp                               | Abst           |
|  | WO 2005/088745  | 9/22/2005  | JP Science & Technology Agency, et al.     | Abst           |
|  | JP 11-097766    | 4/9/1999   | Res Inst Electric Magnetic Alloys          | Abst,<br>22,23 |
|  | JP 2008-004956  | 01/10/2008 | JP Science & Technology Agency, et al.     | Abst           |
|  | JP 2002-270790  | 09/20/2002 | Toshiba Corp.                              | Abst           |
|  | JP 2003-304012  | 10/24/2003 | Matsushita Electric Ind Co. Ltd.           | Partial        |
|  | JP H05-144729   | 06/11/1993 | Hitachi Ltd.                               | Partial        |
|  | EP 0 145 403    | 06/19/1985 | Energy Conversion Devices, Inc.            | Yes            |
|  | EP 1 061 592    | 12/20/2000 | Odagawa et al.                             | Yes            |
|  | EP 1 793 434    | 06/06/2007 | Japan Science and Technology Agency        | Yes            |
|  | JP 2002-359413  | 12/13/2002 | Nat. Inst. Of Adv. Ind. & Technol., et al. | Abstr          |
|  | JP 2003-86863   | 03/20/2003 | Nat. Inst. Of Adv. Ind. & Technol, et al.  | Abst           |
|  | JP 2004-063592  | 02/26/2004 | Sony Corp.                                 | Abst           |
|  | JP 2004-128015  | 04/22/2004 | Sony Corp.                                 |                |
|  | JP 2004-153258  | 05/27/2004 | Hewlett Packard Development Co.            | Abst           |
|  | KR 2002-0042448 | 06/05/2002 | Anelva Corp.                               | Abst           |
|  | KR 2003-0097904 | 12/31/2003 | Nagahama et al.                            | Partial        |
|  | WO 01/056090    | 08/02/2001 | Takahashi                                  | Abst           |
|  | JP2004022599    | 01-22-2004 | MIZUGUCHI TETSUA et al.                    | Yes            |
|  |                 |            |                                            |                |

### NON PATENT LITERATURE DOCUMENTS

| Exam. Initial* | Include NAME of the author (in CAPS), Title of Article/Item, Date, Page(s), Volume-Issue No., Publisher, City and/or Country where published                | Translation |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
|                | International Search Report of PCT/JP2005/004720 mailed June 21, 2005                                                                                       | Yes         |
|                | WOLF, S.A. et al., "Spintronics: A Spin-Based Electronics Vision for the Future", Science, Vol. 294, November 16, 2001, pp. 1488-1495.                      | Yes         |
|                | WULFHEKEL, W. et al., "Single-Crystal Magnetotunnel Junctions", Applied Physics Letters, Vol. 78, No. 4, January 22, 2001, pp. 509-511                      | Yes         |
|                | JULLIERE, M., "Tunneling Between Ferromagnetic Films", Physics Letters, Vol. 54A, No. 3, September 8, 1975, pp.225-226.                                     | Yes         |
|                | SOULEN, R.J., Jr. et al., "Measuring the Spin Polarization of a Metal with a Superconducting Point Contact", Science, Vol. 282, October 2, 1998, pp. 85-88. | Yes         |

|  |                                                                                                                                                                                                                                                          |     |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|  | SAITO, Y. et al., "Correlation between Barrier Width, Barrier Height, and DC Bias Voltage Dependences on the Magnetoresistance Ratio in Ir-Mn Exchange Biased Single and Double Tunnel Junctions", Jpn. J. Appl. Phys., Vol. 39 (2000), pp. L1035-L1-38. | Yes |
|  | IURA, S. et al., "Enhancement of Thermal Stability in Ferromagnetic Tunnel Junctions Prepared by the Radical Oxidation Method", Journal of the Magnetism Society of Japan, Vol. 26, No. 6 (2002), pp. 839-842, abstract only in English.                 | Yes |
|  | BOWEN, M. et al., "Large Magnetoresistance in Fe/MgO/FeCo(001) Epitaxial Tunnel Junctions on GaAs(001)", Applied Physics Letters, Vol. 79, No. 11, September 10, 2001, pp. 1655-1657.                                                                    | Yes |
|  | SIMMONS, JOHN G., "Generalized Formula for the Electric Tunnel Effect between Similar Electrodes Separated by a Thin Insulating Film", Journal of Applied Physics, Vol. 34, NO. 6, June 1963, pp. 1793-1803.                                             | Yes |
|  | VASSENT, J.L. et al., "A Study of Growth and the Relaxation of Elastic Strain in MgO on Fe(001)", J. Appl. Phys. Vol. 80, No. 10, November 15, 1996, pp. 5727-5735.                                                                                      | Yes |
|  | FAURE-VINCENT, J. et al., "High Tunnel Magnetoresistance in Expitaxial Fe/MgO/Fe Tunnel Junctions", Applied Physics Letters, Vol. 82, No. 25, June 23, 2003, pp. 4507-4509. X                                                                            | Yes |
|  | MEYERHEIM, H.L. et al., "Geometrical and Compositional Structure at Metal-Oxide Interfaces: MgO on Fe(001)", Physical Review Letters, Vol. 87, No. 7, August 13, 2001, pp. 076102-1 – 076102-4.                                                          | Yes |
|  | MATHON, J. et al., "Theory of Tunneling Magnetoresistance of an Epitaxial Fe/MgO/Fe(001) Junction", Physical Review B., Vol. 63, 220403(R), 2001, pp. 220403-1 – 220403-4.                                                                               | Yes |
|  | ZHANG, X.-G. et al., "Effects of the Iron-Oxide Layer in Fe-FeO-MgO-Fe Tunneling Junctions", Physical Review B, Vol. 68, 092402, 2003, pp. 092402-1 – 092402-4.                                                                                          | Yes |
|  | ZHANG, X.-G. et al., "Large Magnetoresistance in bcc Co/MgO/Co and FeCo/MgO/FeCo Tunnel Junctions", Physical Review B., Vol. 70, 172407, 2004, pp. 172407-1 – 172407-4.                                                                                  | Yes |
|  | GIBSON, A. et al., "Stability of Vacancy Defects in MgO: The Role of Charge Neutrality", Physical Review B., Vol. 50, No. 4, July 15, 1994-II, pp. 2582-2592.                                                                                            | Yes |
|  | YUASA, S. et al., "High Tunnel Magnetoresistance at Room Temperature in Fully Expitaxial Fe/MgO/Fe Tunnel Junctions Due to Coherent Spin-Polarized Tunneling", Japanese Journal of Applied Physics, Vol. 43, No. 4B, 2004, pp. L588-L590.                | Yes |
|  | MITANI, S., et al., "Fe/MgO/FeCo (100) Epitaxial Magnetic Tunnel Junctions Prepared by Using in situ Plasma Oxidation", Journal of Applied Physics, Vol. 93, No. 10, Parts 2 and 3, May 15, 2003, pp. 8041 8043.                                         | Yes |
|  | POPOVA, E., et al., "Epitaxial MgO Layer for Low-Resistance and Coupling-Free Magnetic Tunnel Junctions", Applied Physics Letters, Vol. 81, No. 6, August 5, 2002, pp.1035-1037.                                                                         | Yes |
|  | BOUBETA, C. MARTINEZ, et al., "Magnetic Coupling in Epitaxial TM/MgO/Fe(001) (TM=FeCo, Fe/Co, Fe) Macroscopic and Microscopic Trilayers", Journal of Applied Physics, Vo. 94, No. 6, September 15, 2003, pp. 4006-4012.                                  | Yes |
|  | Supplementary European Search Report from European Patent Office for Application No. 05720955.3 2222, Patent No. 1737055, PCT/JP2005004720 dated July 2, 2008.                                                                                           |     |

|  |                                                                                                                                                                                                                                        |          |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|  | Office Action from European Patent Office dated November 6, 2009                                                                                                                                                                       |          |
|  | F. ERNULT et al., "Preparation of Nanometer-Scale Iron Dots on Insulating Layer", Science and Technology of Advanced Materials, Vol. 4, (2003), pp. 383-389                                                                            | Yes      |
|  | DAVID J. SMITH et al., "Structural Characterization of Thin Film Ferromagnetic Tunnel Junctions", Journal of Applied Physics, Vol. 83, No. 10, 15 May 1998, pp. 5154-5158                                                              | Yes      |
|  | X. W. LI et al., "Fabrication and Properties of Heteroepitaxial Magnetite (Fe <sub>3</sub> O <sub>4</sub> ) Tunnel Junctions", Applied Physics Letters, Vol. 73, No. 22, 30 November 1998, pp.3282-3284                                | Yes      |
|  | C. L. PLATT, et al., "Spin Polarized Tunneling in Reactively Sputtered Tunnel Junctions", Journal of Applied Physics, Vol. 81, No. 8, 15 April 1997, pp. 5523-5525                                                                     | Yes      |
|  | P. TURBAN et al., "Growth and Characterization of Single Crystalline NiMnSb Thin Films and Epitaxial NiMnSb/MgO/NiMnSb(001) Trilayers", 2002 The American Physical Society, Physical Review B., Vol. 65, pp. 134417-1 to 134417-13     | Yes      |
|  | T. MORIYAMA et al., "Preparation and Magnetoresistance in Single-Crystal and Polycrystal Fe/MgO/FeCo Tunnel Junctions", The Physical Society of Japan, 2003 Spring meeting, Abstracts Book 58(1-3), 460, (2003-03-06)                  | Yes      |
|  | MOODERA et al., "Ferromagnetic-Insulator-Ferromagnetic Tunneling: Spin-Dependent Tunneling and Large Magnetoresistance in Trilayer Junctions (Invited)", Journal of Physics DF, Vol. 79, No. 8, 15 April 1996, pp. 4724-4729           | Yes      |
|  | MASAYOSHI TONOUCHI et al., "Epitaxial Growth of NbN on an Ultrathin MgO/Semiconductor System", Journal of Applied Physics, Vol. 62, No. 3, 1 August 1987, pp. 961-966                                                                  | Yes      |
|  | "Giant tunnel magnetoresistance in magnetic tunnel junctions with a crystalline MgO(001) barrier," S. Yuasa and D.D. Djayaprawira, Journal of Physics D: Applied Physics, 1 Phys. D: Appl. Phys. 40 (2007) R337-R354                   | Yes      |
|  | Office Action issued from Japanese Patent Office, in corresponding Japanese Patent Application No. 2011-226907, dated January 31, 2012, pp. 1-3.                                                                                       | Yes      |
|  | ARAKI et al., "Fabrication and Electric Properties of Lapped Type of TMR Heads for ~50 Gb/In <sup>2</sup> and Beyond," IEEE Transactions on Magnetics, Vol. 38, No. 1, pp. 72-77, January 2002.                                        | Yes      |
|  | David D. DJAYAPRAWIRA et al., "Novel Sputtering Technology of Magnetic Tunnel Junctions for MRAM Application," Papers 01 the 66 <sup>th</sup> Symposium on Semiconductors and Integrated Circuits Technology, Vol. 66, pp. 58-61, 2004 | Yes      |
|  | H. DOMON et al., "Effect of Ge Addition on Postannealed CoCrGePt Thin Film Media," Journal of Applied Physics, Vol. 91, No. 10, pp. 8632-8634, May 15, 2002.                                                                           | Yes      |
|  | H. DOMON et al. "Reduction of Magnetic Interaction in CoB/Pd Multilayer Perpendicular Media Using a Phase-Separated Pd-SiO Underlayer," Journal of Applied Physics, Vol. 93, No. 10, pp. 8164-8166, May 15, 2003.                      | Yes      |
|  | Extended European Search Report, issued from European Patent Office, of European Application No. 08159511.8, dated June 5, 2009.                                                                                                       | Yes      |
|  | Office Action issued from Japanese Patent Office, in corresponding Japanese Patent Application No. 2011-226907, dated January 31, 2012, pp. 1-3.                                                                                       | Yes      |
|  | T. KAKUTA et al., " Novel PVD Tool for Magnetoresistive Random Access Memory (MRAM) Mass Production," Anelva Technical Report, Vol. 10, pp. 27-33, January 25, 2004.                                                                   | Abstract |

|                                                                                                                                                                                                                                          |          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| A. KOBAYASHI et al., "TMR Devices Fabricated with RIE Etching Using Co+NH <sub>3</sub> ," Journal of the Magnetism Society of Japan, Vol. 28, No. 2, February 1, 2004.                                                                   | Abstract |
| J.S. MOODERA et al., "Large Magnetoresistance at Room Temperature in Ferromagnetic Thin Film Tunnel Junctions," Physical Review Letters, Vol. 74, No. 16, pp. 3273-3276, April 17, 1995.                                                 | Yes      |
| J.S. MOODERA, "Interface Magnetism and Spin Wave Scattering in Ferromagnet-Insulator-Ferromagnet Tunnel Junctions," Physical Review Letters, Vol. 80, No. 13, pp. 2941-2944, March 30, 1998.                                             | Yes      |
| J. MURAI et al., "Direct Observation of Magnon Excitation in a Ferromagnetic Tunnel Junction Using Inelastic-Electron-Tunneling Spectroscopy," Japanese Journal of Applied Physics, Vol. 38, pp. L1106-L1108, October 1, 1999.           | Yes      |
| K. NAGASAKA et al., "CPP Operational Mode of GMR Head," Fujitsu Sci. Tech. J., Vol. 37, No. 2, pp. 192-200, December 2001.                                                                                                               | Yes      |
| T. OSADA et al., "Dry Etching of Magnetic Thin Film Stacks Using CO/NH <sub>3</sub> and CH <sub>3</sub> OH Gases for Tunneling Magneto-Resistance Devices," 2004 Dry Process International Symposium, Vol. 4, pp. 127-131, 2004.         | Yes      |
| Stuart S.P. PARKIN et al., "Giant Tunneling Magnetoresistance At Room Temperature with MgO (100) Tunnel Barriers," Nature Materials, Vol. 3, pp. 862-867, December 2004.                                                                 | Yes      |
| M. TAKAGISHI et al., "The Applicability of CPP-GMR Heads for Magnetic Recording," IEEE Transactions on Magnetism, Vol. 38, No. 5, pp. 2277-2282, September 2002.                                                                         | Yes      |
| A. TANAKA et al., "Spin-Valve Heads in the Current-Perpendicular-to-Plane Mode for Ultrahigh-Density Recording," IEEE Transactions on Magnetism, Vol. 38, No. 1, January 2002.                                                           | Yes      |
| K. TSUNEKAWA et al., "Surface Treatment Techniques in Fabrication of GMR and TMR Films," Journal of the Magnetism Society of Japan, Vol. 28, No. 11, pp. 1074-1080, November 1, 2004.                                                    | Yes      |
| D. WANG et al., "70% TMR at Room Temperature for SDT Sandwich Junctions With CoFeB as Free and Reference Layers," IEEE Transactions on Magnetism, Vol. 40, No. 4, pp. 2270-2271, July 2004. 004                                          | Yes      |
| S. YOSHIMURA et al., "Magnetic Grain Size Reduction by Using Oxygen Exposure Process Onto Very Thin Islandlike WCr Seedlayer in Longitudinal Recording Media," Journal of Applied Physics, Vol. 91, No. 10, pp. 8629-8631, May 15, 2002. | Yes      |
| S. YOSHIMURA et al. "Grain Size Reduction by Utilizing A Very Thin, High-Melting-Point WCr Seedlayer in Longitudinal Media: Media Noise Reduction in High H <sub>k</sub> <sup>grain</sup> Media, Vol. 25, No. 4-2, pp. 627-630 (2001).   | Abstract |
| YU et al., "Electron Transport Properties in Magnetic Tunnel Junctions with Epitaxial NiFe (111) Ferromagnetic Bottom Electrodes," Applied Physics Letters, Vol. 82, No. 26, pp. 4735-4737, June 30, 2003.                               | Yes      |
| S. YUASA et al. "Magnetic Tunnel Junctions With Single-Crystal Electrodes: A Crystal Anisotropy of Tunnel Magneto-Resistance," Europhysics Letters, Vol. 52, No. 3, pp. 344-350 November 1, 2000.                                        | Yes      |
| S. YUASA et al., "Giant Room-Temperature Magnetoresistance in Single-Crystal Fe/MgO/Fe Magnetic Tunnel Junctions," Nature Materials Vol. 3, pp. 868-871, October 31, 2004                                                                | Yes      |
| S. YUASA et al., "Spin-Polarized Resonant Tunneling In Magnetic Tunnel Junctions," Science, Vol. 297, pp. 234-237, July 12, 2002.                                                                                                        | Yes      |

|  |                                                                                                                                                                                                                    |     |
|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|  | S. Zhang et al. "Quenching of Magnetoresistance by Hot Electrons in Magnetic Tunnel Junctions," Physical Review Letters, Vol. 79, No. 19, pp. 3744-3747, November 10, 1997.                                        | Yes |
|  | SHANG, et al "The First-principles Study of Electronic Structure of Fe/MgO/Fe Magnetic Tunnel Junctions Interface", 2005, pp.2255-2258, vols. 475-479, Materials Science Forum                                     |     |
|  | MEYERHEIM, et al "Surface X-Ray Diffraction Analysis of the MGO/FE(001) Interface: Evidence for an FEO Layer", 2002, pp. 144433-1- 144433-7, vol. 65, Physical Review B                                            |     |
|  | DJAYAPRAWIRA, et al, "230% Room-Temperature Magnetoresistance in COFEB/MGO/COFEB Magnetic Tunnel Junctions" 2005, pp. 092502-1 – 092502-3, vol. 86, Appl. Phys. Lett.                                              |     |
|  | MIYOKAWA, et al., "X-Ray Absorption and X-Ray Magnetic Circular Dichroism Studies of a Monatomic FE(001) Layer Facing a Single-Crystalline", 2005, pp. L9-L11, vol. 44, no. 1, Japanese Journal of Applied Physics |     |
|  | KLAUA, et al, "Growth, Structure, Electronic, and Magnetic Properties of MGO/FE(001) Bilayers and FE/MGO/FE(001) Trilayers" 2001, vol. 64, pp. 134411-1 – 134411-8, Physical Review B                              |     |
|  | NOZAKI, et al, "Bias Voltage Effect on Tunnel Magnetoresistance in Fully Epitaxial MGO Double-Barrier Magnetic Tunnel Junctions" 2005, pp. 082501-1-082501-3, vol. 86, Appl. Phys. Lett.                           |     |
|  | BUTLER, et al. "Spin-Dependent Tunneling and Conductance of FE/MGO/FE Sandwiches", 2001, pp. 054416-1 – 054416-11, vol. 63, Physical Review                                                                        |     |
|  | ZHANG, et al, "Large Magnetoresistance in BCC. CO/MGO/CO and FECO/MGO/FECO Tunneling Junctions", November 17, 2012, pp. 1-9                                                                                        |     |
|  | BOUBETA, et al "Magnetization Reversal and Magnetic Anisotropies in Epitaxial FE/MGO and Fe/MgO/Fe heterostructures grown on Si(001)", February 15, 2003, pp. 2126-2134, vol. 93, no. 4, J. Appl. Phys.            |     |

|                    |  |                 |  |
|--------------------|--|-----------------|--|
| Examiner Signature |  | Date Considered |  |
|--------------------|--|-----------------|--|

\* Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP §609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.

Customized PTO/SB/08a+b (07-09)

|                                                                                              |                |  |                          |
|----------------------------------------------------------------------------------------------|----------------|--|--------------------------|
| Substitute for Form 1449/PTO<br><br><b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b> | Application #  |  |                          |
|                                                                                              | Confirmation # |  |                          |
|                                                                                              | Filing Date    |  |                          |
|                                                                                              | First Inventor |  | Shinji YUASA             |
|                                                                                              | Art Unit       |  |                          |
|                                                                                              | Examiner       |  |                          |
| Sheet <u>3</u> of <u>3</u>                                                                   | Docket #       |  | IBTH 13318A <sub>a</sub> |

| U.S. PATENT DOCUMENTS |                                    |                          |                               |                   |
|-----------------------|------------------------------------|--------------------------|-------------------------------|-------------------|
| Initial<br>(*)        | Document No.<br>Number – Kind Code | Publ. Date<br>MM-DD-YYYY | Name<br>Patentee or Applicant | Corresponds<br>to |
|                       |                                    |                          |                               |                   |
|                       |                                    |                          |                               |                   |
|                       |                                    |                          |                               |                   |

| FOREIGN PATENT DOCUMENTS |                                                      |                          |                               |                  |
|--------------------------|------------------------------------------------------|--------------------------|-------------------------------|------------------|
| Initial<br>(*)           | Country-Number-<br>Kind Code <small>if known</small> | Publ. Date<br>MM-DD-YYYY | Name<br>Patentee or Applicant | Trans-<br>lation |
|                          | JPA-2004-31605                                       | 01-29-2004               | SONY CORPORATION              | Yes              |
|                          |                                                      |                          |                               |                  |
|                          |                                                      |                          |                               |                  |

| NON PATENT LITERATURE DOCUMENTS |                                                                                                                                              |                  |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Exam.<br>Initial*               | Include NAME of the author (in CAPS), Title of Article/Item, Date, Page(s), Volume-Issue No., Publisher, City and/or Country where published | Trans-<br>lation |
|                                 |                                                                                                                                              |                  |
|                                 |                                                                                                                                              |                  |

|                    |  |                 |  |
|--------------------|--|-----------------|--|
| Examiner Signature |  | Date Considered |  |
|--------------------|--|-----------------|--|

\* Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP §609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.

1/10

FIG. 1 (A)

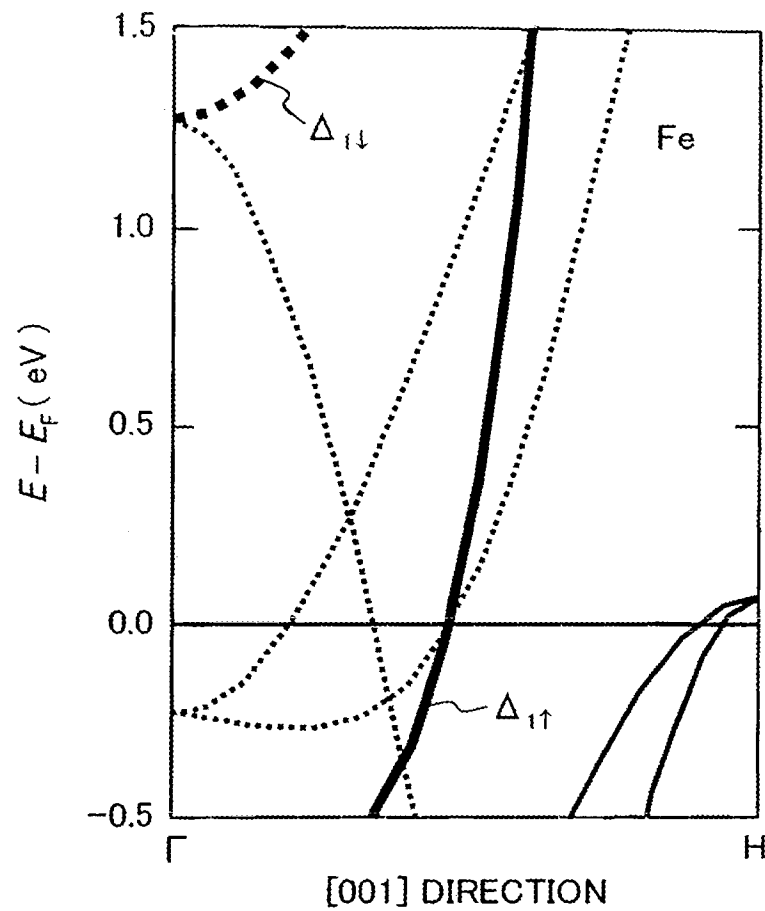
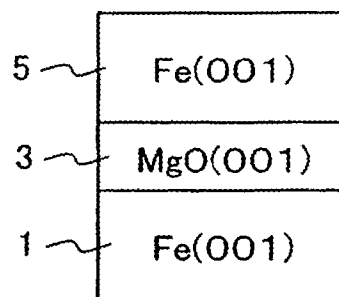


FIG. 1 (B)



2/10

FIG. 2 (A)

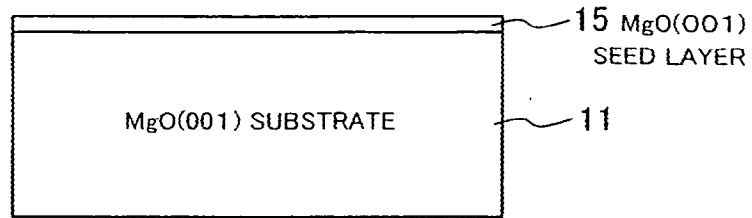


FIG. 2 (B)

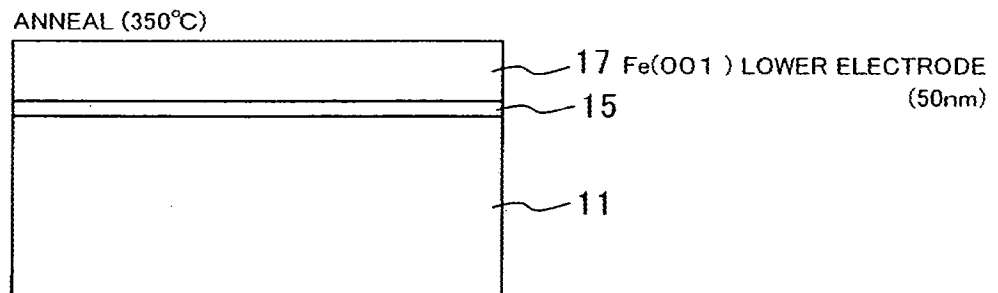


FIG. 2 (C)

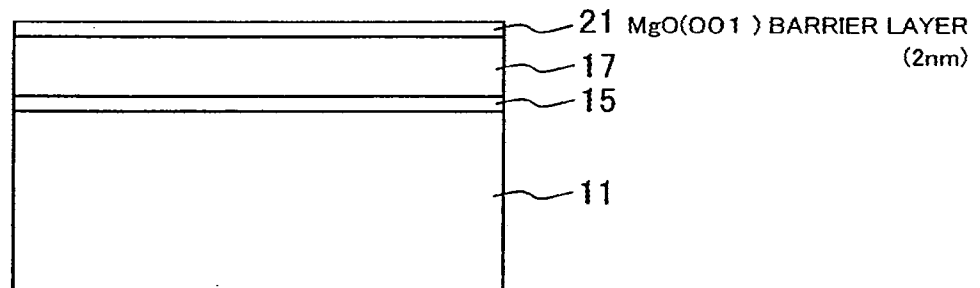
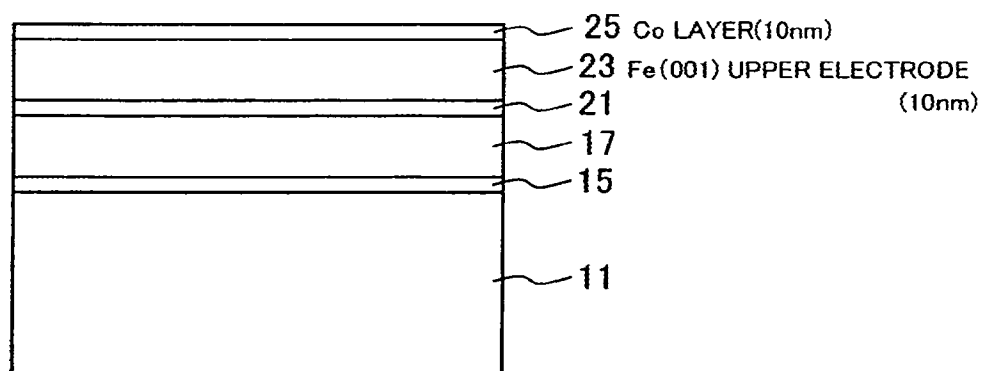


FIG. 2 (D)



3/10

FIG. 3 (A)

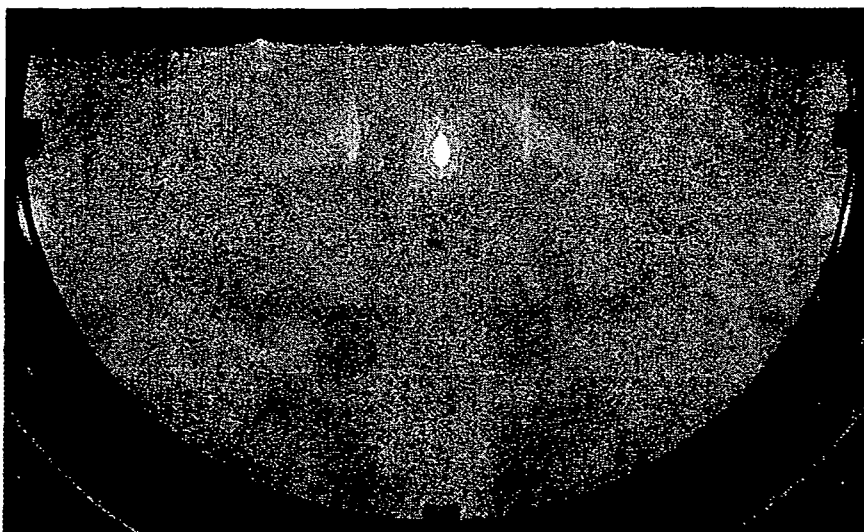
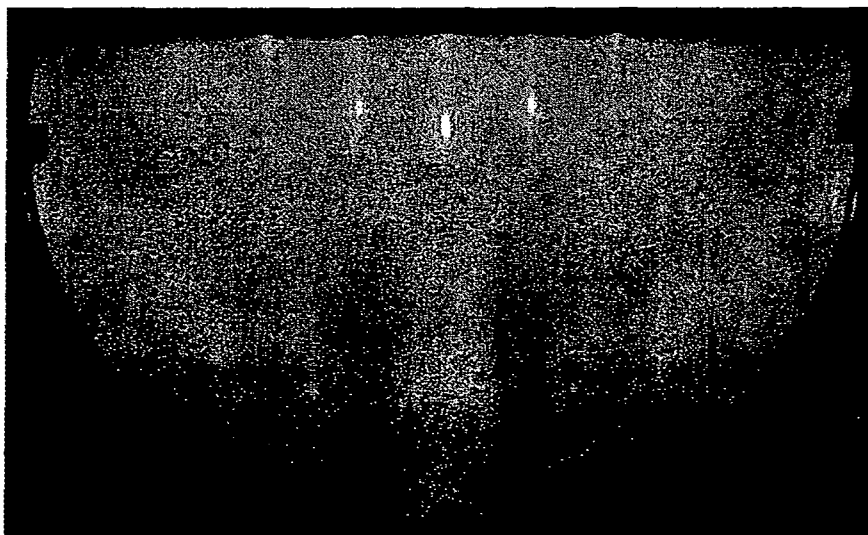


FIG. 3 (B)



4/10

FIG. 4

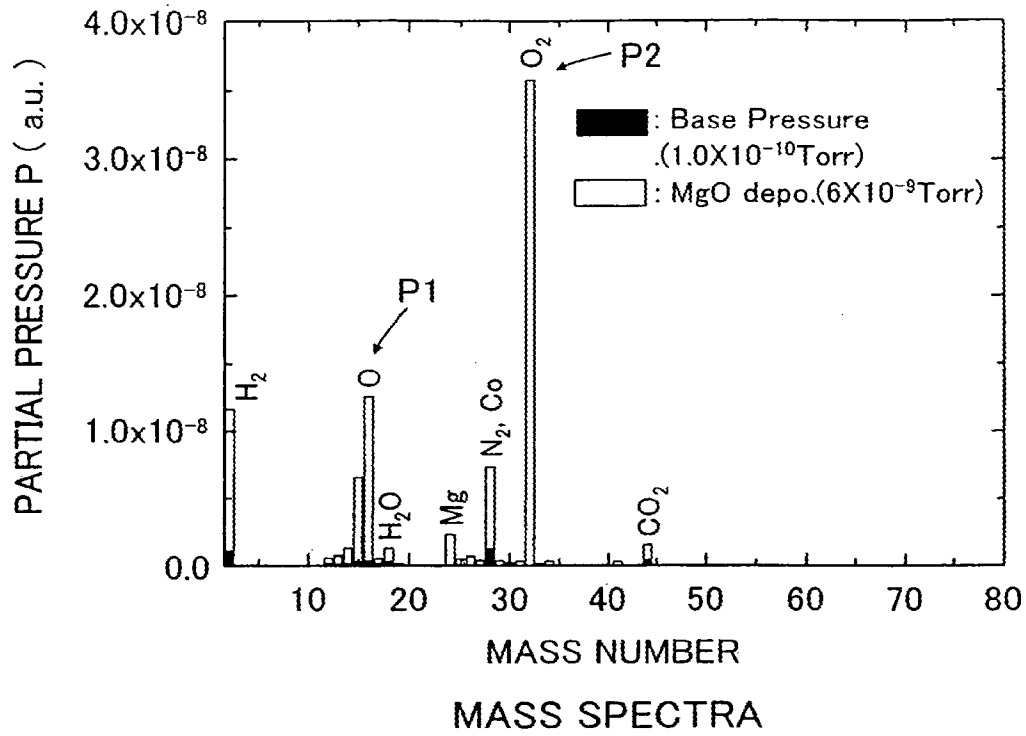


FIG. 5

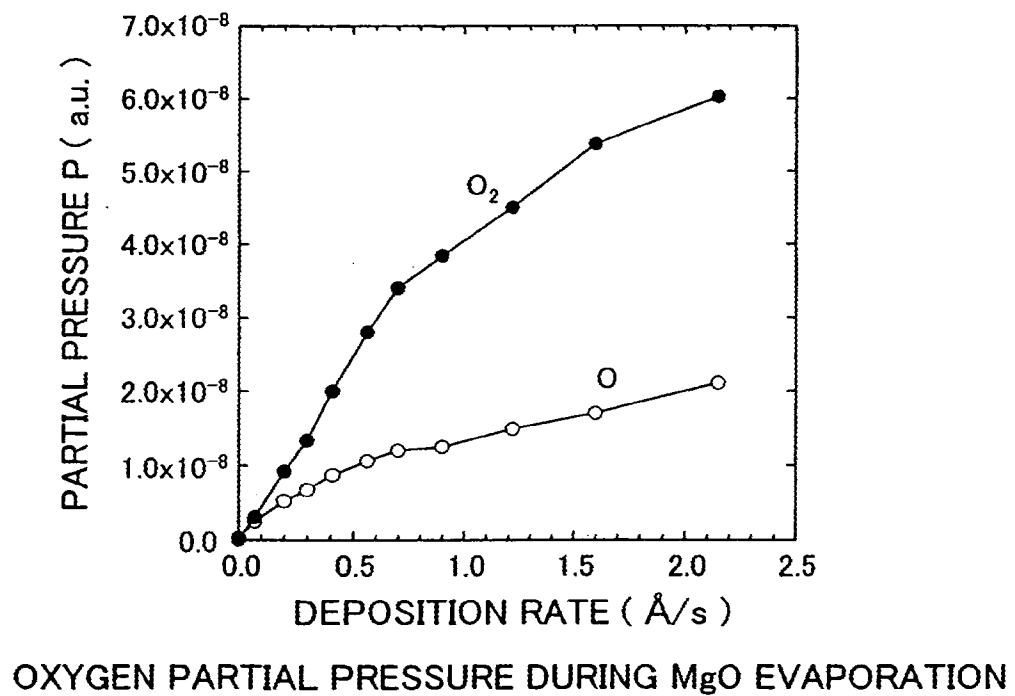


FIG. 6

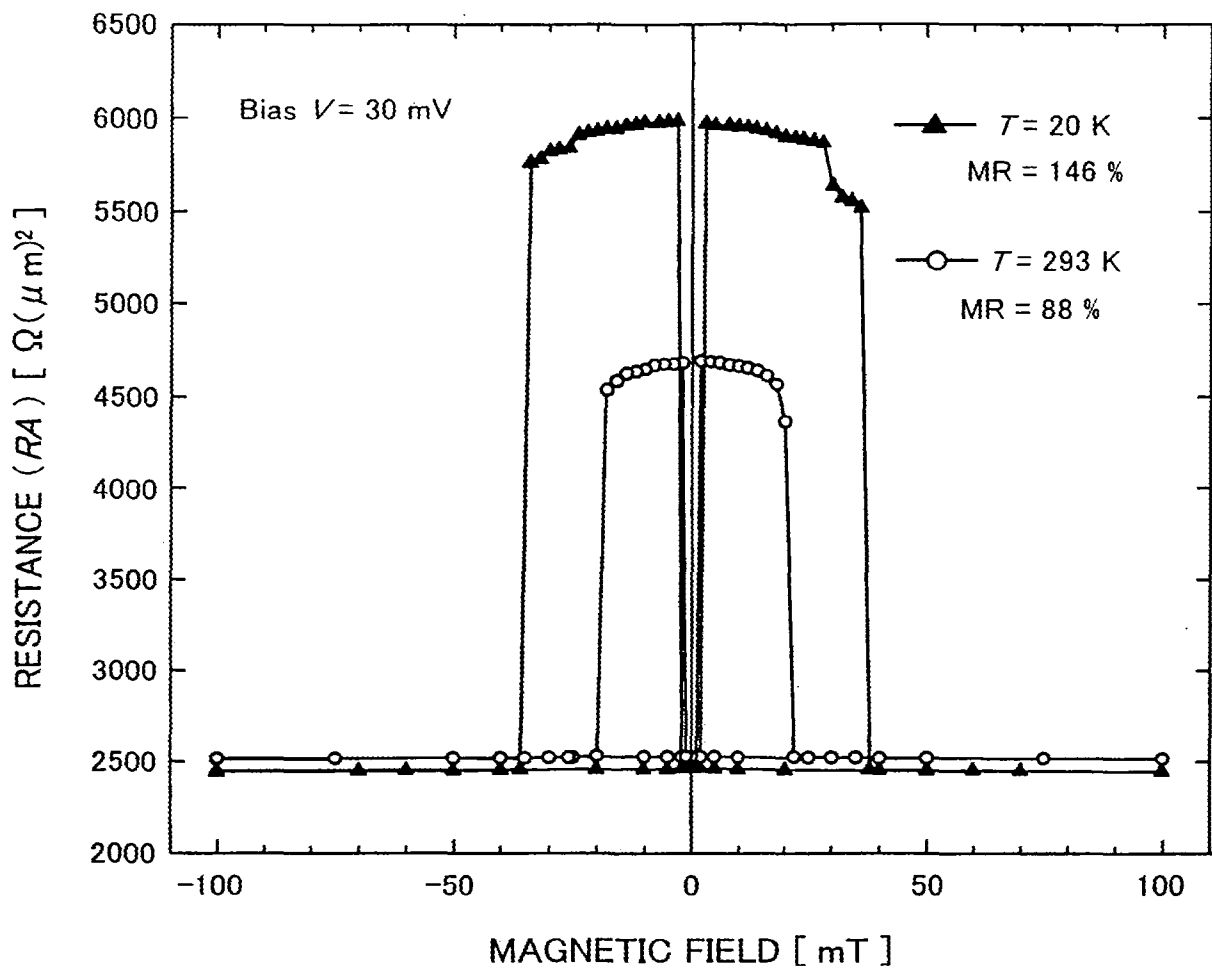


FIG. 7 (A)

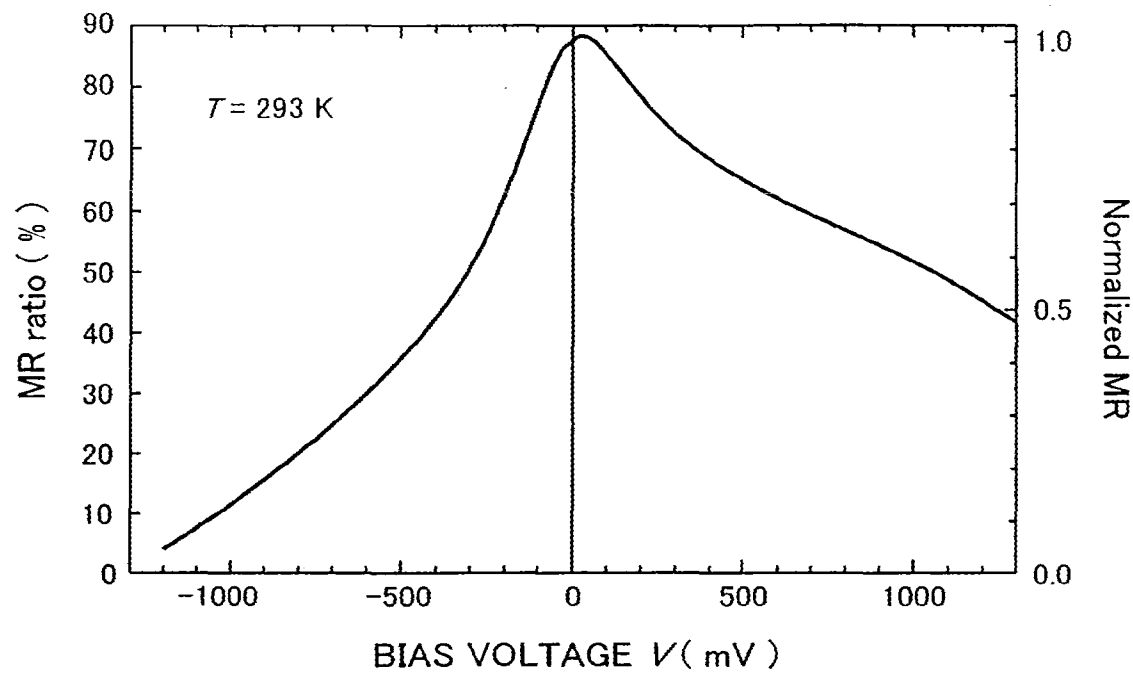
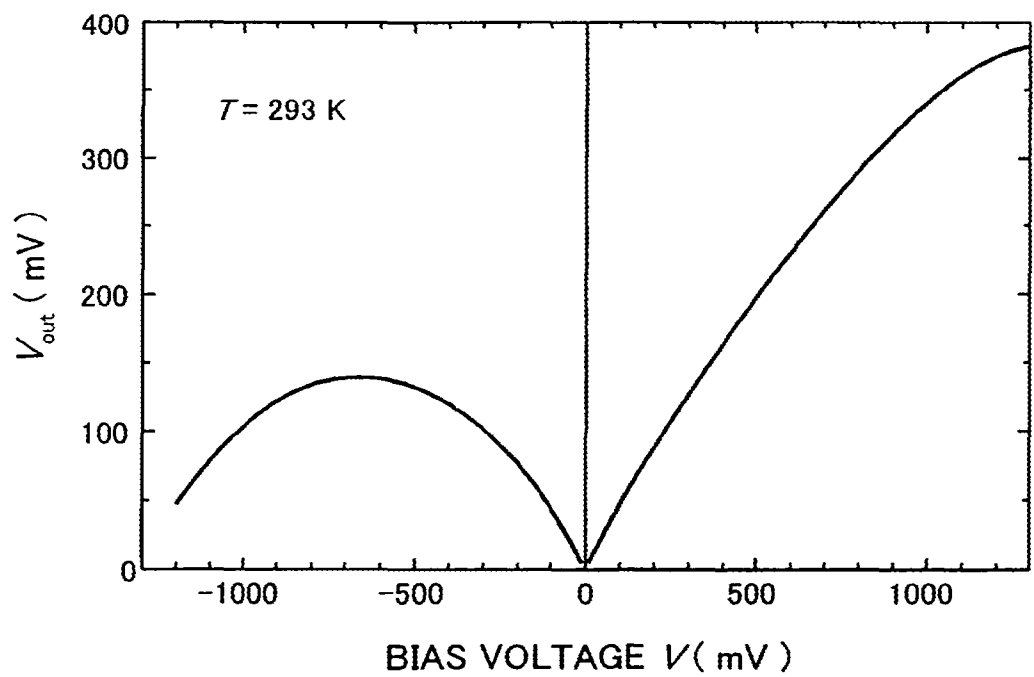


FIG. 7 (B)



7/10

FIG. 8 (A)

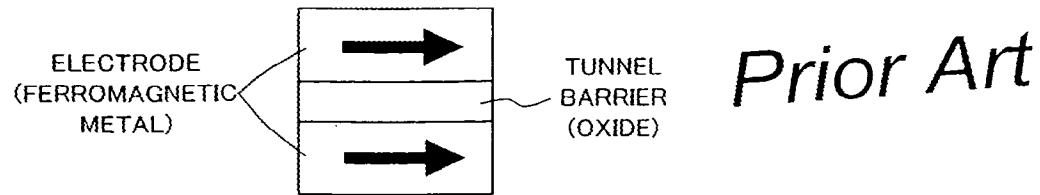


FIG. 8 (B)



8/10

FIG. 9 (A)

*Prior Art*

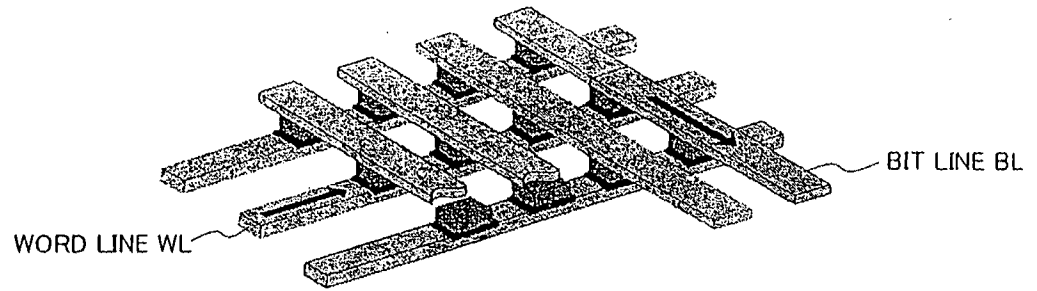


FIG. 9 (B)

*Prior Art*

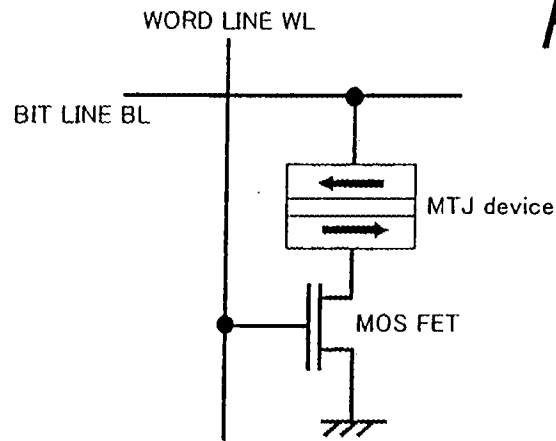


FIG. 9 (C)

*Prior Art*

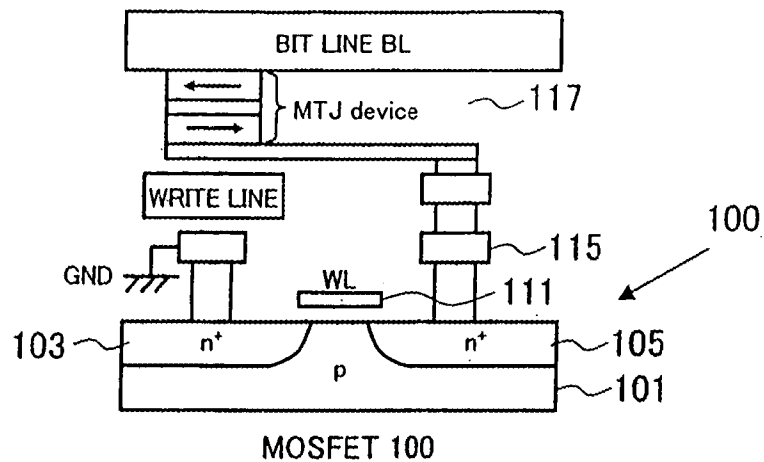
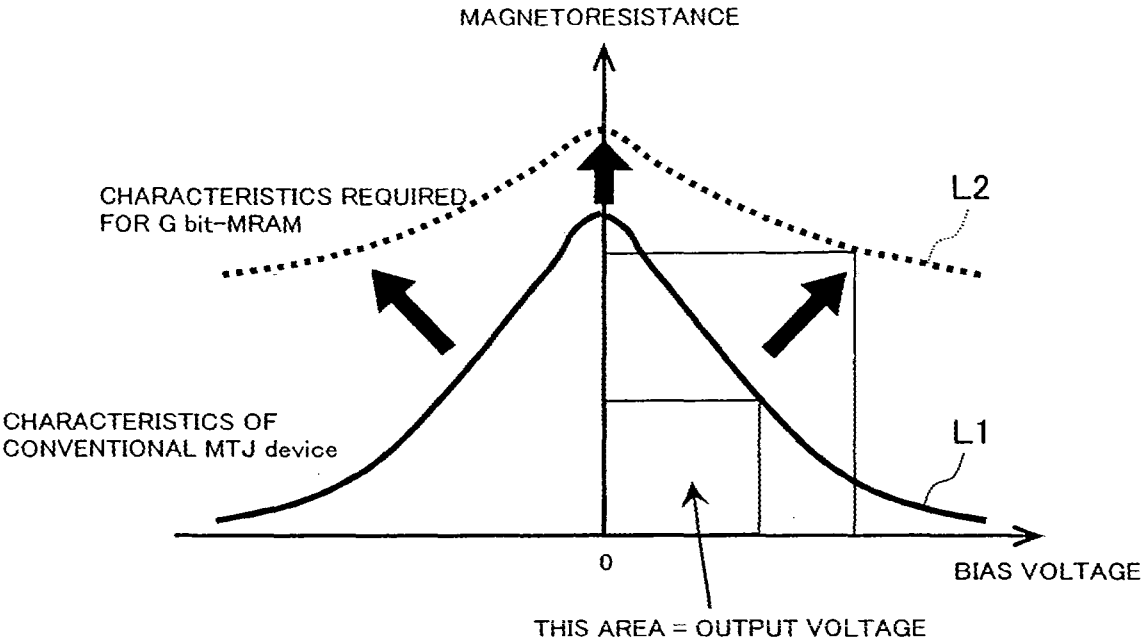
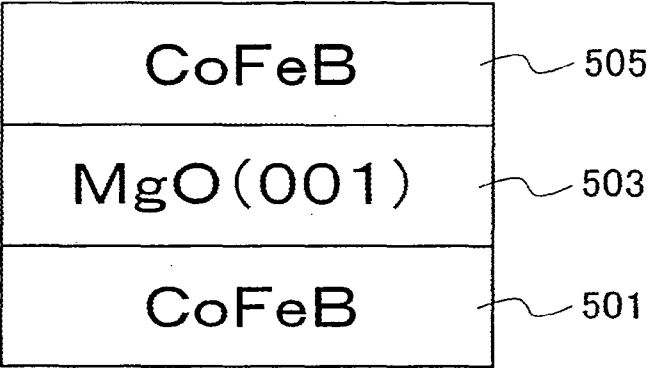


FIG. 10



10/10

FIG. 11



| Electronic Patent Application Fee Transmittal                                                    |          |                                                                        |        |                      |
|--------------------------------------------------------------------------------------------------|----------|------------------------------------------------------------------------|--------|----------------------|
| Application Number:                                                                              |          |                                                                        |        |                      |
| Filing Date:                                                                                     |          |                                                                        |        |                      |
| Title of Invention:                                                                              |          | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM) |        |                      |
| First Named Inventor/Applicant Name:                                                             |          | Shinji YUASA                                                           |        |                      |
| Filer:                                                                                           |          | Brian S. Myers/Oleksandra Onishchuk                                    |        |                      |
| Attorney Docket Number:                                                                          |          | IBTH 13318Aa                                                           |        |                      |
| Filed as Large Entity                                                                            |          |                                                                        |        |                      |
| Filing Fees for Track I Prioritized Examination - Nonprovisional Application under 35 USC 111(a) |          |                                                                        |        |                      |
| Description                                                                                      | Fee Code | Quantity                                                               | Amount | Sub-Total in USD(\$) |
| Basic Filing:                                                                                    |          |                                                                        |        |                      |
| UTILITY APPLICATION FILING                                                                       | 1011     | 1                                                                      | 320    | 320                  |
| UTILITY SEARCH FEE                                                                               | 1111     | 1                                                                      | 700    | 700                  |
| UTILITY EXAMINATION FEE                                                                          | 1311     | 1                                                                      | 800    | 800                  |
| REQUEST FOR PRIORITIZED EXAMINATION                                                              | 1817     | 1                                                                      | 4200   | 4200                 |
| Pages:                                                                                           |          |                                                                        |        |                      |
| Claims:                                                                                          |          |                                                                        |        |                      |
| Miscellaneous-Filing:                                                                            |          |                                                                        |        |                      |
| PROCESSING FEE, EXCEPT PROV. APPLS.                                                              | 1830     | 1                                                                      | 140    | 140                  |

| Description                       | Fee Code | Quantity | Amount | Sub-Total in USD(\$) |
|-----------------------------------|----------|----------|--------|----------------------|
| Petition:                         |          |          |        |                      |
| Patent-Appeals-and-Interference:  |          |          |        |                      |
| Post-Allowance-and-Post-Issuance: |          |          |        |                      |
| Extension-of-Time:                |          |          |        |                      |
| Miscellaneous:                    |          |          |        |                      |
| Total in USD (\$)                 |          |          |        | 6160                 |

## Electronic Acknowledgement Receipt

|                                             |                                                                        |
|---------------------------------------------|------------------------------------------------------------------------|
| <b>EFS ID:</b>                              | 48422595                                                               |
| <b>Application Number:</b>                  | 18232576                                                               |
| <b>International Application Number:</b>    |                                                                        |
| <b>Confirmation Number:</b>                 | 1021                                                                   |
| <b>Title of Invention:</b>                  | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM) |
| <b>First Named Inventor/Applicant Name:</b> | Shinji YUASA                                                           |
| <b>Customer Number:</b>                     | 61650                                                                  |
| <b>Filer:</b>                               | Brian S. Myers/Christine Connolly                                      |
| <b>Filer Authorized By:</b>                 | Brian S. Myers                                                         |
| <b>Attorney Docket Number:</b>              | IBTH 13318Aa                                                           |
| <b>Receipt Date:</b>                        | 10-AUG-2023                                                            |
| <b>Filing Date:</b>                         |                                                                        |
| <b>Time Stamp:</b>                          | 15:02:32                                                               |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)                                            |

### Payment information:

|                                          |                  |
|------------------------------------------|------------------|
| Submitted with Payment                   | yes              |
| Payment Type                             | CARD             |
| Payment was successfully received in RAM | \$6160           |
| RAM confirmation Number                  | E202380F03319008 |
| Deposit Account                          |                  |
| Authorized User                          |                  |

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

|                 |                                                     |                                       |                                          |                  |                  |
|-----------------|-----------------------------------------------------|---------------------------------------|------------------------------------------|------------------|------------------|
|                 |                                                     |                                       |                                          |                  |                  |
| File Listing:   |                                                     |                                       |                                          |                  |                  |
| Document Number | Document Description                                | File Name                             | File Size(Bytes)/ Message Digest         | Multi Part /.zip | Pages (if appl.) |
| 1               | Track One Request                                   | ibth_13318Aa_20230810_Track1_form.pdf | 134308                                   | no               | 2                |
|                 |                                                     |                                       | 8a7e75a6de25c69b0b5f3a9a7808d2e604b3fe   |                  |                  |
| Warnings:       |                                                     |                                       |                                          |                  |                  |
| Information:    |                                                     |                                       |                                          |                  |                  |
| 2               | Application Data Sheet                              | ibth_13318Aa_20230810_ADS.pdf         | 1257079                                  | no               | 9                |
|                 |                                                     |                                       | 617823174fea0db8e193c7a18eaa6899fb306122 |                  |                  |
| Warnings:       |                                                     |                                       |                                          |                  |                  |
| Information:    |                                                     |                                       |                                          |                  |                  |
| 3               | Oath or Declaration filed                           | ibth_13318Aa_20230810_Declaration.pdf | 70135                                    | no               | 1                |
|                 |                                                     |                                       | 1a4df05de2b4bad5e30784ff4a839a211d257417 |                  |                  |
| Warnings:       |                                                     |                                       |                                          |                  |                  |
| Information:    |                                                     |                                       |                                          |                  |                  |
| 4               |                                                     | ibth_13318Aa_20230810_spec_21.pdf     | 1958783                                  | yes              | 21               |
|                 |                                                     |                                       | 4062f082cb6c591e8e460ea0c0bcc0912883d1fb |                  |                  |
|                 | Multipart Description/PDF files in .zip description |                                       |                                          |                  |                  |
|                 | Document Description                                |                                       | Start                                    | End              |                  |
|                 | Specification                                       |                                       | 1                                        | 19               |                  |
|                 | Claims                                              |                                       | 20                                       | 20               |                  |
|                 | Abstract                                            |                                       | 21                                       | 21               |                  |
| Warnings:       |                                                     |                                       |                                          |                  |                  |
| Information:    |                                                     |                                       |                                          |                  |                  |
| 5               |                                                     | ibth_13318Aa_20230810_pre-amdt_r1.pdf | 124109                                   | yes              | 9                |
|                 |                                                     |                                       | 5b9c12327b7ea6b4bd58bdc1c7b16aee853963d4 |                  |                  |
| WD EX108        |                                                     |                                       |                                          |                  |                  |

|                                                 |                                                     |                                                       |                                          |     |    |  |  |  |  |
|-------------------------------------------------|-----------------------------------------------------|-------------------------------------------------------|------------------------------------------|-----|----|--|--|--|--|
|                                                 | Multipart Description/PDF files in .zip description |                                                       |                                          |     |    |  |  |  |  |
|                                                 | Document Description                                |                                                       | Start                                    | End |    |  |  |  |  |
|                                                 | Preliminary Amendment                               |                                                       | 1                                        | 1   |    |  |  |  |  |
|                                                 | Specification                                       |                                                       | 2                                        | 5   |    |  |  |  |  |
|                                                 | Claims                                              |                                                       | 6                                        | 8   |    |  |  |  |  |
|                                                 | Applicant Arguments/Remarks Made in an Amendment    |                                                       | 9                                        | 9   |    |  |  |  |  |
| Warnings:                                       |                                                     |                                                       |                                          |     |    |  |  |  |  |
| Information:                                    |                                                     |                                                       |                                          |     |    |  |  |  |  |
| 6                                               | Authorization for Extension of Time all replies     | ibth_13318Aa_20230810_auth_to_ext.pdf                 | 233508                                   | no  | 1  |  |  |  |  |
|                                                 |                                                     |                                                       | 3a74ca2a7f74abd247851071a4e82e297f22d146 |     |    |  |  |  |  |
| Warnings:                                       |                                                     |                                                       |                                          |     |    |  |  |  |  |
| Information:                                    |                                                     |                                                       |                                          |     |    |  |  |  |  |
| 7                                               | Internet Communications Authorization               | ibth_13318Aa_20230810_Internet_comm.pdf               | 229210                                   | no  | 2  |  |  |  |  |
|                                                 |                                                     |                                                       | a8336d0eceedf46c8fa153de6bf6c16f2539971e |     |    |  |  |  |  |
| Warnings:                                       |                                                     |                                                       |                                          |     |    |  |  |  |  |
| Information:                                    |                                                     |                                                       |                                          |     |    |  |  |  |  |
| 8                                               | Power of Attorney                                   | ibth_13318Aa_20230810_POA.pdf                         | 94546                                    | no  | 1  |  |  |  |  |
|                                                 |                                                     |                                                       | e10fcae3442fb95806c93298bfdceee35e87c754 |     |    |  |  |  |  |
| Warnings:                                       |                                                     |                                                       |                                          |     |    |  |  |  |  |
| Information:                                    |                                                     |                                                       |                                          |     |    |  |  |  |  |
| 9                                               | Transmittal of New Application                      | ibth_13318Aa_20230810_trans.pdf                       | 431599                                   | no  | 2  |  |  |  |  |
|                                                 |                                                     |                                                       | 1a4e9707b5fb2511784dd74603b905e66fa4c30  |     |    |  |  |  |  |
| Warnings:                                       |                                                     |                                                       |                                          |     |    |  |  |  |  |
| Information:                                    |                                                     |                                                       |                                          |     |    |  |  |  |  |
| 10                                              | Information Disclosure Statement (IDS) Form (SB08)  | ibth_13318Aa_20230010_ids_with_statement_complete.pdf | 3848760                                  | no  | 25 |  |  |  |  |
|                                                 |                                                     |                                                       | 04eb25de5222b8b658e235de91d212b8587985be |     |    |  |  |  |  |
| Warnings:                                       |                                                     |                                                       |                                          |     |    |  |  |  |  |
| Information:                                    |                                                     |                                                       |                                          |     |    |  |  |  |  |
| This is not an USPTO supplied IDS fillable form |                                                     |                                                       |                                          |     |    |  |  |  |  |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                             |                                        |                                          |    |    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|----------------------------------------|------------------------------------------|----|----|
| 11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Drawings-only black and white line drawings | ibth_13318Aa_20230810_Drawings_10_.pdf | 1368302                                  | no | 10 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                             |                                        | cdd3c3c185e42e32033abcad65a55fc97e016a09 |    |    |
| Warnings:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                             |                                        |                                          |    |    |
| Information:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                             |                                        |                                          |    |    |
| 12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Fee Worksheet (SB06)                        | fee-info.pdf                           | 48243                                    | no | 2  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                             |                                        | 4c3b011b63f7b91f609551379a8a62ec63d76d7c |    |    |
| Warnings:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                             |                                        |                                          |    |    |
| Information:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                             |                                        |                                          |    |    |
| Total Files Size (in bytes):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                             |                                        | 9798582                                  |    |    |
| <p><b>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</b></p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b><br/>If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</p> <p><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b><br/>If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</p> <p><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b><br/>If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</p> |                                             |                                        |                                          |    |    |

**CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION  
UNDER 37 CFR 1.102(e) (Page 1 of 1)**

|                       |                                                                        |                                               |  |
|-----------------------|------------------------------------------------------------------------|-----------------------------------------------|--|
| First Named Inventor: | Shinji YUASA                                                           | Nonprovisional Application Number (if known): |  |
| Title of Invention:   | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM) |                                               |  |

**APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.**

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently \$0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.
2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.
3. The applicable box is checked below:

**I. ☒ Original Application (Track One) - Prioritized Examination under § 1.102(e)(1)**

- i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via EFS-Web.  
---OR---  
(b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.
- ii. An executed inventor's oath or declaration under 37 CFR 1.63 or 37 CFR 1.64 for each inventor, or the application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) is filed with the application.

**II. ☐ Request for Continued Examination - Prioritized Examination under § 1.102(e)(2)**

- i. A request for continued examination has been filed with, or prior to, this form.
- ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
- iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C. 371.
- iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
- v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

|                                          |                                               |
|------------------------------------------|-----------------------------------------------|
| Signature <u>/Brian S. Myers/</u>        | Date <u>August 10, 2023</u>                   |
| Name (Print/Typed) <u>Brian S. Myers</u> | Practitioner Registration Number <u>46947</u> |

**Note:** This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required.\*

☐ \*Total of \_\_\_\_\_ forms are submitted.

## Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                        |                        |              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|------------------------|--------------|
| <b>Application Data Sheet 37 CFR 1.76</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                        | Attorney Docket Number | IBTH 13318Aa |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                        | Application Number     |              |
| Title of Invention                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM) |                        |              |
| The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application. |                                                                        |                        |              |

**Secrecy Order 37 CFR 5.2:**

|                          |                                                                                                                                                                                                                                       |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <input type="checkbox"/> | Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.) |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**Inventor Information:**

|                                                                                                                                                                  |                                                |                                   |             |        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-----------------------------------|-------------|--------|
| Inventor                                                                                                                                                         | 1                                              | <button>Remove</button>           |             |        |
| Legal Name                                                                                                                                                       |                                                |                                   |             |        |
| Prefix                                                                                                                                                           | Given Name                                     | Middle Name                       | Family Name | Suffix |
|                                                                                                                                                                  | Shinji                                         |                                   | YUASA       |        |
| Residence Information (Select One)    US Residency    •    Non US Residency    Active US Military Service                                                        |                                                |                                   |             |        |
| City                                                                                                                                                             | Ibaraki                                        | Country of Residence <sup>i</sup> | JP          |        |
| Mailing Address of Inventor:                                                                                                                                     |                                                |                                   |             |        |
| Address 1                                                                                                                                                        | c/o Nat. Inst. of Adv. Industrial Sci. & Tech. |                                   |             |        |
| Address 2                                                                                                                                                        | Tsukuba Central 2, 1-1, Umezono 1-chome        |                                   |             |        |
| City                                                                                                                                                             | Tsukuba-shi, Ibaraki                           | State/Province                    |             |        |
| Postal Code                                                                                                                                                      | 305-8568                                       | Country <sup>i</sup>              | JP          |        |
| All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the <b>Add</b> button. <button>Add</button> |                                                |                                   |             |        |

**Correspondence Information:**

|                                                                                                                                       |                      |                            |                               |
|---------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------------|-------------------------------|
| Enter either Customer Number or complete the Correspondence Information section below.<br>For further information see 37 CFR 1.33(a). |                      |                            |                               |
| <input type="checkbox"/> An Address is being provided for the correspondence Information of this application.                         |                      |                            |                               |
| Customer Number                                                                                                                       | 61650                |                            |                               |
| Email Address                                                                                                                         | patent@myerswoln.com | <button>Add Email</button> | <button>Remove Email</button> |

**Application Information:**

|                                         |                                                                        |                                           |                          |
|-----------------------------------------|------------------------------------------------------------------------|-------------------------------------------|--------------------------|
| Title of the Invention                  | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM) |                                           |                          |
| Attorney Docket Number                  | IBTH 13318Aa                                                           | Small Entity Status Claimed               | <input type="checkbox"/> |
| Application Type                        | Nonprovisional                                                         |                                           |                          |
| Subject Matter                          | Utility                                                                |                                           |                          |
| Total Number of Drawing Sheets (if any) | 10                                                                     | Suggested Figure for Publication (if any) |                          |

|                                           |                                                                        |                        |              |
|-------------------------------------------|------------------------------------------------------------------------|------------------------|--------------|
| <b>Application Data Sheet 37 CFR 1.76</b> |                                                                        | Attorney Docket Number | IBTH 13318Aa |
|                                           |                                                                        | Application Number     |              |
| Title of Invention                        | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM) |                        |              |

**Filing By Reference:**

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

|                                                        |                          |                                            |
|--------------------------------------------------------|--------------------------|--------------------------------------------|
| Application number of the previously filed application | Filing date (YYYY-MM-DD) | Intellectual Property Authority or Country |
|                                                        |                          |                                            |

**Publication Information:**

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

**Representative Information:**

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

|                    |                                                  |                                              |                                                         |
|--------------------|--------------------------------------------------|----------------------------------------------|---------------------------------------------------------|
| Please Select One: | <input checked="" type="radio"/> Customer Number | <input type="radio"/> US Patent Practitioner | <input type="radio"/> Limited Recognition (37 CFR 11.9) |
| Customer Number    | 61650                                            |                                              |                                                         |

**Domestic Benefit/National Stage Information:**

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

When referring to the current application, please leave the "Application Number" field blank.

|                          |                 |                          |                                    |
|--------------------------|-----------------|--------------------------|------------------------------------|
| Prior Application Status | Pending         | Remove                   |                                    |
| Application Number       | Continuity Type | Prior Application Number | Filing or 371(c) Date (YYYY-MM-DD) |
|                          | Continuation of | 18219320                 | 2023-07-07                         |

|                                           |                                                                        |                        |              |
|-------------------------------------------|------------------------------------------------------------------------|------------------------|--------------|
| <b>Application Data Sheet 37 CFR 1.76</b> |                                                                        | Attorney Docket Number | IBTH 13318Aa |
|                                           |                                                                        | Application Number     |              |
| Title of Invention                        | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM) |                        |              |

|                          |                        |                          |                                    |               |                         |
|--------------------------|------------------------|--------------------------|------------------------------------|---------------|-------------------------|
| Prior Application Status | Pending                | Remove                   |                                    |               |                         |
| Application Number       | Continuity Type        | Prior Application Number | Filing or 371(c) Date (YYYY-MM-DD) |               |                         |
| 18219320                 | Continuation of        | 17560922                 | 2021-12-23                         |               |                         |
| Prior Application Status | Patented               | Remove                   |                                    |               |                         |
| Application Number       | Continuity Type        | Prior Application Number | Filing Date (YYYY-MM-DD)           | Patent Number | Issue Date (YYYY-MM-DD) |
| 17560922                 | Continuation of        | 16862598                 | 2020-04-30                         | 11233193      | 2022-01-25              |
| Prior Application Status | Patented               | Remove                   |                                    |               |                         |
| Application Number       | Continuity Type        | Prior Application Number | Filing Date (YYYY-MM-DD)           | Patent Number | Issue Date (YYYY-MM-DD) |
| 16862598                 | Continuation of        | 16443875                 | 2019-06-18                         | 10680167      | 2020-06-09              |
| Prior Application Status | Patented               | Remove                   |                                    |               |                         |
| Application Number       | Continuity Type        | Prior Application Number | Filing Date (YYYY-MM-DD)           | Patent Number | Issue Date (YYYY-MM-DD) |
| 16443875                 | Continuation of        | 15428842                 | 2017-02-09                         | 10367138      | 2019-07-30              |
| Prior Application Status | Patented               | Remove                   |                                    |               |                         |
| Application Number       | Continuity Type        | Prior Application Number | Filing Date (YYYY-MM-DD)           | Patent Number | Issue Date (YYYY-MM-DD) |
| 15428842                 | Continuation of        | 14837558                 | 2015-08-27                         | 9608198       | 2017-03-28              |
| Prior Application Status | Patented               | Remove                   |                                    |               |                         |
| Application Number       | Continuity Type        | Prior Application Number | Filing Date (YYYY-MM-DD)           | Patent Number | Issue Date (YYYY-MM-DD) |
| 14837558                 | Continuation of        | 13767290                 | 2013-02-14                         | 9123463       | 2015-09-01              |
| Prior Application Status | Patented               | Remove                   |                                    |               |                         |
| Application Number       | Continuity Type        | Prior Application Number | Filing Date (YYYY-MM-DD)           | Patent Number | Issue Date (YYYY-MM-DD) |
| 13767290                 | Continuation of        | 13400340                 | 2012-02-20                         | 8405134       | 2013-03-26              |
| Prior Application Status | Patented               | Remove                   |                                    |               |                         |
| Application Number       | Continuity Type        | Prior Application Number | Filing Date (YYYY-MM-DD)           | Patent Number | Issue Date (YYYY-MM-DD) |
| 13400340                 | Continuation of        | 12923643                 | 2010-09-30                         | 8319263       | 2012-11-27              |
| Prior Application Status | Patented               | Remove                   |                                    |               |                         |
| Application Number       | Continuity Type        | Prior Application Number | Filing Date (YYYY-MM-DD)           | Patent Number | Issue Date (YYYY-MM-DD) |
| 12923643                 | Continuation of        | 10591947                 | 2006-09-08                         | 7884403       | 2011-02-08              |
| Prior Application Status | Expired                | Remove                   |                                    |               |                         |
| Application Number       | Continuity Type        | Prior Application Number | Filing or 371(c) Date (YYYY-MM-DD) |               |                         |
| 10591947                 | a 371 of international | PCT/JP2005/004720        | 2005-03-10                         |               |                         |

WD EX1086

Western Digital v IP Bridge, IPR2024-01494

Page 48

|                                           |                                                                        |                        |              |
|-------------------------------------------|------------------------------------------------------------------------|------------------------|--------------|
| <b>Application Data Sheet 37 CFR 1.76</b> |                                                                        | Attorney Docket Number | IBTH 13318Aa |
|                                           |                                                                        | Application Number     |              |
| Title of Invention                        | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM) |                        |              |

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Add

## Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)<sup>i</sup> the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

|                                                                                                        |                      |                          |                                          |
|--------------------------------------------------------------------------------------------------------|----------------------|--------------------------|------------------------------------------|
|                                                                                                        |                      |                          | Remove                                   |
| Application Number                                                                                     | Country <sup>i</sup> | Filing Date (YYYY-MM-DD) | Access Code <sup>i</sup> (if applicable) |
| 2004-071186                                                                                            | JP                   | 2004-03-12               |                                          |
|                                                                                                        |                      |                          | Remove                                   |
| Application Number                                                                                     | Country <sup>i</sup> | Filing Date (YYYY-MM-DD) | Access Code <sup>i</sup> (if applicable) |
| 2004-313350                                                                                            | JP                   | 2004-10-28               |                                          |
| Additional Foreign Priority Data may be generated within this form by selecting the <b>Add</b> button. |                      |                          | Add                                      |

## Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

|                                    |                                                                        |              |
|------------------------------------|------------------------------------------------------------------------|--------------|
| Application Data Sheet 37 CFR 1.76 | Attorney Docket Number                                                 | IBTH 13318Aa |
|                                    | Application Number                                                     |              |
| Title of Invention                 | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM) |              |

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

**NOTE:** This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

**A. Priority Document Exchange (PDX)** - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

**B. Search Results from U.S. Application to EPO** - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

**NOTE:** Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

|                                           |                                                                        |                        |              |
|-------------------------------------------|------------------------------------------------------------------------|------------------------|--------------|
| <b>Application Data Sheet 37 CFR 1.76</b> |                                                                        | Attorney Docket Number | IBTH 13318Aa |
|                                           |                                                                        | Application Number     |              |
| Title of Invention                        | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM) |                        |              |

## Applicant Information:

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                               |                                                  |  |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|--------------------------------------------------|--|--|
| Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                               |                                                  |  |  |
| <b>Applicant</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 1                                             | <input type="button" value="Remove"/>            |  |  |
| If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section. |                                               |                                                  |  |  |
| <input type="button" value="Clear"/>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                               |                                                  |  |  |
| <input checked="" type="radio"/> Assignee                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Legal Representative under 35 U.S.C. 117      | Joint Inventor                                   |  |  |
| Person to whom the inventor is obligated to assign.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                               | Person who shows sufficient proprietary interest |  |  |
| If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                               |                                                  |  |  |
| <div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                               |                                                  |  |  |
| Name of the Deceased or Legally Incapacitated Inventor: <div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                               |                                                  |  |  |
| If the Applicant is an Organization check here. <input checked="" type="checkbox"/>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                               |                                                  |  |  |
| Organization Name                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Godo Kaisha IP Bridge 1                       |                                                  |  |  |
| <b>Mailing Address Information For Applicant:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                               |                                                  |  |  |
| Address 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | c/o Sakura Sogo Jimusho, 1-11, Kanda Jimbocho |                                                  |  |  |
| Address 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                               |                                                  |  |  |
| City                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Chiyoda-ku, Tokyo                             | State/Province                                   |  |  |
| Country                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | JP                                            | Postal Code                                      |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                               | 101-0051                                         |  |  |
| Phone Number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                               | Fax Number                                       |  |  |
| Email Address                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                               |                                                  |  |  |
| Additional Applicant Data may be generated within this form by selecting the Add button.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                               |                                                  |  |  |
| <input type="button" value="Add"/>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                               |                                                  |  |  |

## Assignee Information including Non-Applicant Assignee Information:

|                                                                                                                                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office. |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                           |                                                                        |                        |              |
|-------------------------------------------|------------------------------------------------------------------------|------------------------|--------------|
| <b>Application Data Sheet 37 CFR 1.76</b> |                                                                        | Attorney Docket Number | IBTH 13318Aa |
|                                           |                                                                        | Application Number     |              |
| Title of Invention                        | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM) |                        |              |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                               |                |          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|----------------|----------|
| Assignee                                                                                                                                                                                                                                                                                                                                                                                                                                               | 1                                             |                |          |
| Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication. |                                               |                |          |
| <div>Remove</div>                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                               |                |          |
| If the Assignee or Non-Applicant Assignee is an Organization check here. <input checked="" type="checkbox"/>                                                                                                                                                                                                                                                                                                                                           |                                               |                |          |
| Organization Name                                                                                                                                                                                                                                                                                                                                                                                                                                      | Godo Kaisha IP Bridge 1                       |                |          |
| <b>Mailing Address Information For Assignee including Non-Applicant Assignee:</b>                                                                                                                                                                                                                                                                                                                                                                      |                                               |                |          |
| Address 1                                                                                                                                                                                                                                                                                                                                                                                                                                              | c/o Sakura Sogo Jimusho, 1-11, Kanda Jimbocho |                |          |
| Address 2                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                               |                |          |
| City                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Chiyoda-ku, Tokyo                             | State/Province |          |
| Country <sup>i</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                   | JP                                            | Postal Code    | 101-0051 |
| Phone Number                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                               | Fax Number     |          |
| Email Address                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                               |                |          |
| Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.                                                                                                                                                                                                                                                                                                                                      |                                               | <div>Add</div> |          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                               |                |          |

**Signature:**

Remove

**NOTE:** This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). However, if this Application Data Sheet is submitted with the **INITIAL** filing of the application and either box A or B is **not** checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

|                                                                                     |                  |           |                   |                     |                |
|-------------------------------------------------------------------------------------|------------------|-----------|-------------------|---------------------|----------------|
| Signature                                                                           | /Brian S. Myers/ |           | Date (YYYY-MM-DD) | 2023-08-10          |                |
| First Name                                                                          | Brian            | Last Name | Myers             | Registration Number | 46947          |
| Additional Signature may be generated within this form by selecting the Add button. |                  |           |                   |                     | <div>Add</div> |

|                                           |                                                                        |                        |              |
|-------------------------------------------|------------------------------------------------------------------------|------------------------|--------------|
| <b>Application Data Sheet 37 CFR 1.76</b> |                                                                        | Attorney Docket Number | IBTH 13318Aa |
|                                           |                                                                        | Application Number     |              |
| Title of Invention                        | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM) |                        |              |

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

# Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Doc Code: OATH • Document Description: Oath or declaration filed

Continued PTOAIA/08 (00-12)

|                                                                                                                                                                                                        |  |                          |                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--------------------------|-------------------|
| <b>DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION</b><br><b>(37 CFR 1.63) – and POWER</b><br><i>[NOTE: Earliest of US or PCT application filing date must be on or after September 16, 2012]</i> |  | Docket No.               | NAGI-0005         |
|                                                                                                                                                                                                        |  | 1 <sup>st</sup> Inventor | YUASA             |
|                                                                                                                                                                                                        |  |                          | COMPLETE IF KNOWN |
|                                                                                                                                                                                                        |  | Appl. No.                | 13/767,290        |
|                                                                                                                                                                                                        |  | Filing Date              | February 14, 2013 |
|                                                                                                                                                                                                        |  | Art Unit                 | 2897              |
|                                                                                                                                                                                                        |  | Examiner                 | Chambliss, Alonzo |
| <input type="checkbox"/> Declaration Submitted with Initial Filing<br><input checked="" type="checkbox"/> Declaration Submitted after Initial Filing                                                   |  |                          |                   |

|                                                                                                                                                                                                            |                                 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b>TITLE OF INVENTION</b>                                                                                                                                                                                  | Magnetic Tunnel Junction Device |
| As the below named Inventor(s), I hereby declare that:                                                                                                                                                     |                                 |
| This declaration is directed to:                                                                                                                                                                           |                                 |
| <input type="checkbox"/> The attached application,                                                                                                                                                         |                                 |
| <input checked="" type="checkbox"/> US Application No. 13/767,290                                                                                                                                          |                                 |
| filed on February 14, 2013                                                                                                                                                                                 |                                 |
| The above-identified application was made or authorized to be made by me.                                                                                                                                  |                                 |
| I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.                                                                                         |                                 |
| I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than (5) years, or both.                             |                                 |
| Further, I have reviewed and understand the contents of the above-identified application; and I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56. |                                 |

|                                                                      |                                                                                                                                                        |
|----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>LEGAL NAME OF SOLE OR FIRST INVENTOR</b>                          |                                                                                                                                                        |
| Given Name (First and Middle (if any))                               | Shinji                                                                                                                                                 |
| FAMILY NAME or SURNAME                                               | YUASA                                                                                                                                                  |
| Full Mailing Address                                                 | c/o National Institute of Advanced Industrial Science and Technology<br>Tsukuba Central 2, 1-1, Umezono 1-chome, Tsukuba-shi, Ibaraki, 305-8568, JAPAN |
| Residence - City, State, Country (if different from mailing address) | "same as above"                                                                                                                                        |
| SIGN AND DATE HERE                                                   | Inventor's Signature                                                                                                                                   |
|                                                                      | Date 26. May 2015                                                                                                                                      |

☐ Additional inventors named on supplemental sheet provided herewith

**Stiles & Harrison PLLC • 1199 North Fairfax Street • Suite 900 • Alexandria Virginia 22314 US • (703) 739-4900 • Post A/A**

METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS  
MEMORY (MRAM)

**[0001]**CROSS-REFERENCE TO RELATED APPLICATIONS

**[0002]**The present application is a continuation of U.S. Application No. 16/862,598, filed April 30, 2020, which is a continuation of U.S. Application No. 16/443,875, filed June 18, 2019 (now U.S. Patent No. 10,680,167), which is a continuation of U.S. Application No. 15/428,842, filed February 09, 2017 (now U.S. Patent No. 10,367,138), which is a continuation of U.S. Application No. 14/837,558, filed August 27, 2015 (now U.S. Patent No. 9,608,198), which is a continuation of U.S. Application No. 13/767,290, filed February 14, 2013 (now U.S. Patent No. 9,123,463), which is a continuation of U.S. Application No. 13/400,340, filed February 20, 2012 (now U.S. Patent No. 8,405,134), which is a continuation of U.S. Application 12/923,643, filed September 30, 2010 (now U.S. Patent No. 8,319,263), which is a continuation of U.S. Application No. 10/591,947, filed September 08, 2006 (now U.S. Patent No. 7,884,403), which is a National Stage Application of PCT/JP2005/004720, filed March 10, 2005, which claims priority from Japanese Application Nos. 2004-071186 and 2004-313350, filed March 12, 2004 and October 28, 2004, respectively, the content of each is hereby incorporated by reference into this application.

**[0003]**BACKGROUND OF THE INVENTION

**[0004]**Field of the Invention

**[0005]** The present invention relates to a magnetic tunnel junction device and a method of manufacturing the same, particularly to a magnetic tunnel junction device with a high magnetoresistance and a method of manufacturing the same.

**[0006]** Description of Related Art

**[0007]** Magnetoresistive random access memories (MRAMs) refer to a large-scale integrated memory circuit that is expected to replace the currently widely used DRAM memories. Research and development of MRAM devices, which are fast and non-volatile memory devices, are being extensively carried out, and sample products of a 4Mbit MRAM have actually been delivered.

**[0008]** Figs. 8(A) and 8(B) show the structure and operation principle of a magnetic tunnel junction device (to be hereafter referred to as a “MTJ device”), which is the most important part of the MRAM. As shown in Fig. 8(A), a MTJ device comprises a tunnelling junction structure in which a tunnel barrier (to be hereafter also referred to as a “barrier layer”) made of an oxide is sandwiched between a first and a second electrode made of a ferromagnetic metal. The tunnel barrier layer comprises an amorphous Al-O layer (see Non-Patent Document 1). As shown in Fig. 8(A), in the case of parallel magnetization alignment where the directions of magnetizations of the first and second ferromagnetic electrodes are aligned parallel, the electric resistance of the device with respect to the direction normal to the interfaces of the tunneling junction structure decreases. On the other hand, in the case of antiparallel magnetization alignment where the directions of magnetizations of the first and second ferromagnetic electrodes are aligned antiparallel as shown in Fig. 8(B), the electric resistance with respect to the direction normal to the interfaces of the

tunneling junction structure increases. The resistance value does not change in a general state, so that information “1” or “0” can be stored depending on whether the resistance value is high or not. Since the parallel and antiparallel magnetization alignments can be stored in a non-volatile fashion, the device can be used as a non-volatile memory device.

**[0009]**Figs. 9(A)-(C) show an example of the basic structure of the MRAM. Fig. 9(A) shows a perspective view of the MRAM, and Fig. 9(B) schematically shows a circuit block diagram. Fig. 9(C) is a cross-section of an example of the structure of the MRAM. Referring to Fig. 9(A), in an MRAM, a word line WL and a bit line BL are disposed in an intersecting manner, with an MRAM cell disposed at each intersection. As shown in Fig. 9(B), the MRAM cell disposed at the intersection of a word line and a bit line comprises a MTJ device and a MOSFET directly connected to the MTJ device. Stored information can be read by reading the resistance value of the MTJ device that functions as a load resistance, using the MOSFET. The stored information can be rewritten by applying a magnetic field to the MTJ device, for example. As shown in Fig. 9(C), an MRAM memory cell comprises a MOSFET 100 including a source region 105 and a drain region 103 both formed inside a p-type Si substrate 101, and a gate electrode 111 formed on a channel region that is defined between the source and drain regions. The MRAM also comprises a MTJ device 117. The source region 105 is grounded, and the drain is connected to a bit line BL via the MTJ device. A word line WL is connected to the gate electrode 111 in a region that is not shown.

[0010] Thus, a single non-volatile MRAM memory cell can be formed by a single MOSFET 100 and a single MTJ device 117. The MRAMs are therefore suitable where high levels of integration are required.

[0011] Non-Patent Document 1: D. Wang, et al.: Science 294 (2001) 1488.

[0012] SUMMARY OF THE INVENTION

[0013] Although there are prospects for achieving MRAMs with capacities on the order of 64Mbits based on the current technologies, the characteristics of the MTJ device, which is the heart of MRAM, needs to be improved if higher levels of integration are to be achieved. In particular, in order to increase the output voltage of the MTJ device, the magnetoresistance must be increased and the bias voltage characteristics must be improved. Fig. 10 illustrates how the magnetoresistance in a conventional MTJ device using an amorphous Al-O as the tunnel barrier changes as a function of the bias voltage (L1). As shown, in the conventional MTJ device, the magnetoresistance is small and, notably, it tends to drastically decrease upon application of bias voltage. With such characteristics, the output voltage when operation margins are taken into consideration is too small for the device to be employed for an actual memory device. Specifically, the magnetoresistance of the current MTJ device is small at approximately 70%, and the output voltage is also small at no more than 200 mV, which is substantially half the output voltage of a DRAM. This has resulted in the problem that as the level of integration increases, signals are increasingly lost in noise and cannot be read.

**[0014]**It is an object of the invention to increase the output voltage of a MTJ device.

It is another object of the invention to provide a memory device with a high magnetoresistance for stable operation.

**[0015]**In one aspect, the invention provides a magnetoresistive device comprising a magnetic tunnel junction structure comprising: a tunnel barrier layer; a first ferromagnetic material layer of the BCC structure formed on a first side of the tunnel barrier layer; and a second ferromagnetic material layer of the BCC structure formed on a second side of the tunnel barrier layer, wherein the tunnel barrier layer is formed by a single-crystal  $\text{MgO}_x$  (001) layer or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) layer in which the (001) crystal plane is preferentially oriented.

**[0016]**The invention further provides a magnetoresistive device comprising a magnetic tunnel junction structure comprising: a tunnel barrier layer comprising  $\text{MgO}$ (001); a first ferromagnetic material layer comprising  $\text{Fe}$ (001) formed on a first side of the tunnel barrier layer; and a second ferromagnetic material layer comprising  $\text{Fe}$ (001) formed on a second side of the tunnel barrier layer, wherein the  $\text{MgO}$  layer is formed by a single-crystalline  $\text{MgO}_x$  (001) layer or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) layer in which the (001) crystal plane is preferentially oriented. In a preferred embodiment, the band discontinuity value (the height of the tunnel barrier) between the bottom of the conduction band of the  $\text{MgO}$ (001) layer and the Fermi energy of the  $\text{Fe}$ (001) layer is smaller than an ideal value of a perfect single-crystal without defect. These features increase the magnetoresistance and thereby allow the output voltage of the MTJ device to be increased. By using any of the aforementioned MTJ devices as a load for a single transistor, a non-volatile memory can be formed.

**[0017]**In another aspect, the invention provides a method of manufacturing a magnetoresistive device comprising: preparing a substrate; depositing a first Fe(001) layer on the substrate; depositing a tunnel barrier layer on the first Fe(001) layer by electron beam evaporation under high vacuum, the tunnel barrier layer comprising a single-crystalline  $\text{MgO}_x$  (001) or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) in which the (001) crystal plane is preferentially oriented; and forming a second Fe(001) layer on the tunnel barrier layer.

**[0018]**The invention furthermore provides a method of manufacturing a MTJ device comprising a first step of preparing a substrate comprising a single-crystalline  $\text{MgO}_x$ (001) or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) in which the (001) crystal plane is preferentially oriented, a second step of depositing a first Fe(001) layer on the substrate and performing an annealing process to make the surface flat, a third step of depositing a tunnel barrier layer on the first Fe(001) layer by electron beam evaporation, the tunnel barrier layer comprising a single-crystalline  $\text{MgO}_x$ (001) or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) in which the (001) crystal plane is preferentially oriented, and a fourth step of forming a second Fe(001) layer on the tunnel barrier layer. The method may further comprise the step of growing a seed layer between the first and the second steps, the seed layer comprising a single-crystalline  $\text{MgO}_x$ (001) or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) in which the (001) crystal plane is preferentially oriented. The MgO layer may be deposited using a target with the value of x in  $\text{MgO}_x$  adjusted. The value of x in  $\text{MgO}_x$  may be adjusted in the step of forming the MgO.

**[0019]**In yet another aspect, the invention provides a magnetoresistive device comprising a magnetic tunnel junction structure comprising a tunnel barrier layer comprising MgO(001), a first ferromagnetic material layer comprising an amorphous

magnetic alloy formed on a first side of the tunnel barrier layer, and a second ferromagnetic material layer comprising an amorphous magnetic alloy formed on a second side of the tunnel barrier layer, wherein the discontinuous value (the height of the tunnel barrier) between the bottom of the conduction band of the MgO(001) layer and the Fermi energy of the first or the second ferromagnetic material layer comprising the amorphous magnetic alloy is lower than an ideal value of a perfect single-crystal with no defect.

#### **[0020] BRIEF DESCRIPTION OF THE DRAWINGS**

**[0021]** Fig. 1(B) shows the structure of a MTJ device according to a first embodiment of the invention, and Fig. 1(A) shows the energy band structure of a ferromagnetic metal Fe(001), illustrating the E-E<sub>F</sub> relationship with respect to the [001] direction of the momentum space.

**[0022]** Fig. 2(A) to Fig. 2(D) schematically show the process of manufacturing a MTJ device with a Fe(001)/MgO(001)/Fe(001) structure (to be hereafter referred to as a “Fe(001)/MgO(001)/Fe(001) MTJ device”) according to an embodiment of the invention.

**[0023]** Fig. 3(A) shows a RHEED image of a Fe(001) lower electrode (a first electrode), and Fig. 3(B) shows a RHEED image of a MgO(001) barrier layer.

**[0024]** Fig. 4 shows the results of observing the quadrupole mass spectra in the deposition chamber during the MgO evaporation.

**[0025]** Fig. 5 shows the film deposition rate dependency of the oxygen partial pressure during the MgO evaporation.

**[0026]** Fig. 6 shows typical magnetoresistance curves of the Fe(001)/MgO(001)/Fe(001) MTJ device.

**[0027]** Fig. 7(A) shows the bias voltage dependency of the MR ratio at room temperature, and Fig. 7(B) shows the output voltage  $V_{\text{out}}$  of the MTJ device (=bias voltage  $\times$  (Rap-Rp)/Rap).

**[0028]** Figs. 8(A) and 8(B) show the structure of the MTJ device and its operating principle.

**[0029]** Figs. 9(A)-(C) show an example of the basic structure of an MRAM, Fig. 9(A) showing a perspective view of the MRAM, Fig. 9(B) showing a schematic circuit diagram, and Fig. 9(C) showing a cross-sectional view of an example of its structure.

**[0030]** Fig. 10 shows how the magnetoresistance of a conventional MTJ device using an amorphous Al-O as the tunnel barrier changes depending on the bias voltage.

**[0031]** Fig. 11 shows the structure of a MTJ device according to a variation of the invention, corresponding to Fig. 1(B).

## **[0032]** DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0033]** In the context of the present specification, because MgO has a cubic crystal structure (NaCl structure), the (001) plane, the (100) plane, and the (010) plane are all equivalent. The direction perpendicular to the film surface is herein considered to be the z-axis so that the film plane can be uniformly described as (001). Also in the context of the present specification, BCC structure, which the crystalline structure of ferromagnetic electrode layer, means body-centered cubic lattice structure. More

specifically, BCC structure includes the BCC structure with no chemical ordering so-called A2-type structure, the BCC structure with chemical ordering such as B2-type structure and L2<sub>1</sub>-type structure, and also the aforementioned structures with slight lattice distortion.

**[0034]** The term “ideal value” with regard to a perfect single-crystal without defect herein refers to a value that has been estimated from ultraviolet photoemission spectroscopy experiments (see W. Wulfhekel, et al.: Appl. Phys. Lett. 78 (2001) 509.). The term “ideal value” is used herein because the aforementioned state can be considered to be an upper limit value of the potential barrier height of the tunnel barrier of an ideal single-crystal MgO with hardly any oxygen vacancy defect or lattice defect.

**[0035]** Before describing the preferred embodiments of the invention, an analysis conducted by the inventors is discussed. The magnetoresistance (MR) ratio of a MTJ device can be expressed by the following equation:

$$\mathbf{[0036]}\Delta R/R_p = (R_{ap} - R_p)/R_p$$

**[0037]** where  $R_p$  and  $R_{ap}$  indicate the tunnel junction resistance in the cases of parallel and antiparallel magnetization alignments, respectively, of two electrodes. According to the Julliere's formula, the MR ratio at low bias voltage can be expressed by:

$$\mathbf{[0038]}\text{MR ratio} = (R_{ap} - R_p)/R_p = 2P_1P_2/(1 - P_1P_2), \text{ and}$$

$$\mathbf{[0039]}P\alpha = (D\alpha \uparrow (E_F) - D\alpha \downarrow (E_F))/(D\alpha \uparrow (E_F) + D\alpha \downarrow (E_F)),$$

[0040] where  $\alpha = 1, 2$

(1)

[0041] In the above equations,  $P\alpha$  is the spin polarization of an electrode, and  $D\alpha \uparrow (E_F)$  and  $D\alpha \downarrow (E_F)$  are the density of state (DOS) at the Fermi energy ( $E_F$ ) of the majority-spin band and the minority-spin band, respectively. Since the spin polarization of ferromagnetic transition metals and alloys is approximately 0.5 or smaller, the Jullire's formula predicts a highest estimated MR ratio of about 70%.

[0042] Although the MR ratio of approximately 70% has been obtained at room temperature when a MTJ device was made using an amorphous Al-O tunnel barrier and polycrystalline electrodes, it has been difficult to obtain the output voltage of 200 mV, which is comparable to the output voltages of DRAMs, thereby preventing the realization of MRAM as mentioned above.

[0043] The inventors tried an approach to deposit a MTJ device in which the tunnel barrier comprises a single-crystal (001) of magnesium oxide (MgO) or a polycrystalline MgO in which the (001) crystal plane is preferentially oriented. It is the inventors' theory that, because magnesium oxide is a crystal (where the atoms are arranged in an orderly fashion), as opposed to the conventional amorphous Al-O barrier, the electrons are not scattered and the coherent states of electrons are conserved during the tunneling process. Fig. 1(B) shows the MTJ device structure according to an embodiment of the invention. Fig. 1(A) shows the energy band structure of the ferromagnetic Fe(001), that is, the  $E-E_F$  relationship with respect to the [001] direction of the momentum space. As shown in Fig. 1(B), the MTJ device structure of the present embodiment comprises a first Fe (001) layer 1, a second Fe (001) layer 5, and a single-crystalline  $MgO_x$  (001) layer 3 or a poly-crystalline  $MgO_x$

( $0 < x < 1$ ) layer 3 sandwiched therebetween, the polycrystalline layer having the (001) crystal plane preferentially oriented therein. According to the aforementioned Jullire's model, assuming that the momentum of the conduction electrons is preserved in the tunneling process, the tunneling current that passes through MgO would be dominated by those electrons with wave vector  $k_z$  in the direction perpendicular to the tunnel barrier (normal to the junction interfaces). In accordance with the energy band diagram shown in Fig. 1(A) of Fe in the [001] ( $\Gamma$ -H) direction, the density of state (DOS) at the Fermi energy  $E_F$  does not exhibit a very high spin polarization due to the fact that the sub-bands of the majority-spin and the minority-spin have states at the Fermi energy  $E_F$ . However, in case the coherent states of electrons are conserved in the tunneling process, only those conduction electrons that have totally symmetrical wave functions with respect to the axis perpendicular to the barrier would be coupled with the states in the barrier region and come to have a finite tunneling probability. The  $\Delta_1$  band in the Fe(001) electrode has such totally symmetric wave functions. As shown in Fig. 1(A), the majority spin  $\Delta_1$  band (solid line) has states at the Fermi energy  $E_F$ , whereas the minority spin  $\Delta_1$  band (broken line) does not have state at the Fermi energy  $E_F$ . Because of such half-metallic characteristics of the Fe  $\Delta_1$  band, there is the possibility that a very high MR ratio can be obtained in a coherent spin polarized tunneling. Since in an epitaxial (single-crystal, or (001) oriented polycrystal) MTJ device the scattering of electrons is suppressed during the tunneling process, an epitaxial MTJ device is thought to be ideal for realizing the aforementioned coherent tunneling.

**[0044]**In the following, a MTJ device according to a first embodiment of the invention and a method of manufacturing the same will be described with reference to the

drawings. Figs. 2(A) to 2(D) schematically show the method of manufacturing the MTJ device having the Fe (001)/MgO(001)/Fe(001) structure according to the embodiment (to be hereafter referred to as a “Fe(001)/MgO(001)/Fe(001) MTJ device”). Fe(001) refers to a ferromagnetic material with the BCC structure. First, a single-crystal MgO(001) substrate 11 was prepared. In order to improve the morphology of the surface of the single-crystal MgO(001) substrate 11, a MgO(001) seed layer 15 was grown by the molecular beam epitaxy (MBE) method. This was subsequently followed by the growth of an epitaxial Fe(001) lower electrode (first electrode) 17 with the thickness of 50 nm on the MgO(001) seed layer 15 at room temperature, as shown in Fig. 1(B), and then annealing was performed at 350°C under ultrahigh vacuum ( $2 \times 10^{-8}$  Pa). Electron-beam evaporation conditions included an acceleration voltage of 8 kV, a growth rate of 0.02 nm/sec, and the growth temperature of room temperature (about 293K). The source material of the electron-beam evaporation was MgO of the stoichiometric composition (the ratio of Mg to O being 1:1), the distance between the source and the substrate was 40 cm, the base vacuum pressure was  $1 \times 10^{-8}$  Pa, and the O<sub>2</sub> partial pressure was  $1 \times 10^{-6}$  Pa. Alternatively, a source with oxygen vacancy defects may be used instead of the MgO of the stoichiometric composition (the ratio of Mg to O is 1:1).

**[0045]** Fig. 3(A) shows a RHEED image of the Fe(001) lower electrode (a first electrode). The image shows that the Fe(001) lower electrode (first electrode) 17 possesses a good crystallinity and flatness. Thereafter, a MgO(001) barrier layer 21 with the thickness of 2 nm was epitaxially grown on the Fe(001) lower electrode (first electrode) at room temperature, also using the MgO electron-beam evaporation method. Fig. 3(B) shows a RHEED image of the MgO(001) barrier layer 21. The

image shows that the MgO(001) barrier layer 21 also possesses a good crystallinity and flatness.

**[0046]** As shown in Fig. 2(D), a Fe(001) upper electrode (a second electrode) 23 with the thickness of 10 nm was formed on the MgO(001) barrier layer 21 at room temperature. This was successively followed by the deposition of a Co layer 25 with the thickness of 10 nm on the Fe(001) upper electrode (second electrode) 23. The Co layer 25 is provided to increase the coercive force of the upper electrode 23 so as to realize the antiparallel magnetization alignment. The thus prepared sample was then processed by microfabrication techniques to obtain the Fe(001)/MgO(001)/Fe(001) MTJ device.

**[0047]** The aforementioned MgO evaporation using an electron beam involved the formation of a film under ultrahigh vacuum of  $10^{-9}$  Torr. It can be seen that in this method, the film, even when formed on a glass substrate to the thickness of 300 nm, was colorless and transparent, showing that a good crystal film was formed. Fig. 4 shows the results of observing the quadrupole mass spectra in the deposition chamber during the MgO growth. The results show that the partial pressures regarding the spectrum P1 of O and the spectrum P2 of O<sub>2</sub> are high. Fig. 5 shows the film deposition rate dependency of the oxygen partial pressure during MgO evaporation. It will be seen from the figure that the oxygen partial pressure itself is high, and that the oxygen partial pressure increases as the deposition rate increases. These results indicate the separation of oxygen from MgO during the deposition of MgO. Since the separated oxygen is pumped out of the deposition chamber using vacuum pumps, there is the possibility that there are oxygen vacancy defects such as MgO<sub>x</sub> ( $0.9 < x < 1$ ). When there are oxygen vacancy defects, the potential barrier height of the MgO

tunnel barrier is thought to decrease (such as in the range of 0.10 to 0.85 eV; more specifically, 0.2 to 0.5 eV), which is thought to result in an increase in the tunneling current. In the case of a typical Al-O tunnel barrier, the height of the tunnel barrier with respect to Fe(001) electrodes is considered to be 0.7 to 2.5 eV. An ideal tunnel barrier height of a MgO crystal is 3.6 eV, and experimental values of 0.9 to 3.7 eV have been obtained. Using the method according to the present embodiment of the invention, a tunnel barrier height of approximately 0.3 eV is expected, indicating that the resistance of the tunnel barrier can be lowered. However, it should be noted that other factors, such as the influence of the aforementioned coherent tunneling, might also be involved. The value of  $x$  in  $\text{MgO}_x$  due to oxygen vacancy defects is such that  $0.98 < x < 1$ , and more preferably  $0.99 < x < 1$ . These are the ranges such that the sole presence of Mg is excluded and the characteristics of MgO can be basically maintained.

**[0048]** The aforementioned tunnel barrier height  $\phi$  was determined by fitting the electric conductance characteristics of the MTJ device (the relationship between tunnel current density  $J$  and bias voltage  $V$ ) onto the Simmons' formula (Equation (20) in a non-patent document by J. G. Simmons: J. Appl. Phys. 34, pp. 1793-1803 (1963)) based on the WKB approximation, using the least squares method. The fitting was performed using the free electron mass ( $m = 9.11 \times 10^{-31}$  kg) as the electron's effective mass. When a bias voltage  $V$  (which is normally on the order of 500 mV to 1000 mV) is applied until non-linearity appears in the  $J$ - $V$  characteristics, the height  $\phi$  of the tunnel barrier and the effective thickness  $\Delta s$  of the tunnel barrier can be simultaneously determined by fitting the  $J$ - $V$  characteristics using the Simmons' formula.

**[0049]** The effective thickness  $\Delta s$  of the tunnel barrier was determined to be smaller than the thickness of the actual MgO(001) tunnel barrier layer ( $t_{\text{MgO}}$ ) determined from a cross-sectional transmission electron microscope image of the MTJ device by approximately 0.5 nm. This is the result of the effective thickness  $\Delta s$  of the tunnel barrier having been reduced from the actual MgO(001) layer thickness by the effect of the image potential produced at the interface between the MgO(001) layer and the alloy layer consisting mainly of Fe and Co.

**[0050]** It is noted that, in the event that  $t_{\text{MgO}}$  can be accurately determined using the cross-sectional transmission electron microscope (TEM) image, the height  $\phi$  of the tunnel barrier can be more simply determined by the following technique. Namely, when the bias voltage  $V$  applied to the MTJ device is small (normally 100 mV or smaller), the tunnel current density  $J$  is proportional to the bias voltage  $V$ , such that the J-V characteristics become linear. In such a low-bias voltage region, the Simmons' formula can be described as follows:

$$\mathbf{[0051]} J = [(2m\phi)^{1/2}/\Delta s](e/h)^2 \times \exp[-(4\pi\Delta s/h) \times (2m\phi)^{1/2}] \times V \quad (2)$$

**[0052]** where  $m$  is the mass of the free electron ( $9.11 \times 10^{-31}$  kg),  $e$  is the elementary electric charge ( $1.60 \times 10^{-19}$  C), and  $h$  is the Planck's constant ( $6.63 \times 10^{-34}$  J·s). The effective thickness of the tunnel barrier  $\Delta s$  is approximately  $t_{\text{MgO}} - 0.5$  nm. By fitting the J-V characteristics of the MTJ device in the low-bias voltage region onto Equation (2), the height  $\phi$  of the tunnel barrier can be simply and yet accurately estimated.

**[0053]** Fig. 6 shows a typical magnetoresistance curve of the Fe(001)/MgO(001)/Fe(001) MTJ device produced by the above-described method. The MR ratio is 146% at the measurement temperature of 20K and 88% at the

measurement temperature of 293K. These values represent the highest MR ratios that have so far been obtained at room temperature. Such high MR ratios cannot be explained by the spin polarization of the Fe(001) electrode and is thought rather to be related to a coherent spin-polarized tunneling. When 160 prototype MTJ devices were made, the variations regarding the MR ratio and tunneling resistance value were not more than 20%. The yield of the MTJ devices was 90% or more at the laboratory stage. These high values suggest the effectiveness of the approach of the invention. The resistance-area (RA) product of the MTJ device was on the order of a few  $\text{k}\Omega\mu\text{m}^2$ , which is suitable for MRAM.

**[0054]** Fig. 7(a) shows the bias voltage dependency of the MR ratio at room temperature. It will be seen that the bias voltage dependency of the MR ratio is fairly small. Although the characteristics are asymmetric, the voltage  $V_{\text{half}}$  at which the MR ratio is reduced in half of the zero-bias value is 1250 mV, which is a very high value. In this connection, it is noted that the voltage  $V_{\text{half}}$  at which the MR ratio is reduced in half of the zero-bias value in the conventional MTJs with Al-O tunnel barrier is 300 to 600 mV. Fig. 7(b) shows the output voltage  $V_{\text{out}}$  of the MTJ device ( $=\text{bias voltage} \times (\text{Rap} - \text{Rp})/\text{Rap}$ ). The maximum value of the output voltage  $V_{\text{out}}$  is 380 mV with a positive bias. This value is about twice as large as that (a little less than 200 mV) in the case of the Al-O barrier. These high values in terms of both MR ratio and output voltage suggest the effectiveness of the technique according to the present embodiment.

**[0055]** Although in the above-described embodiment Fe(001) of BCC was employed, an Fe alloy of BCC, such as an Fe-Co alloy, Fe-Ni alloy, or Fe-Pt alloy, may be used instead. Alternatively, a layer of Co or Ni with the thickness of one or several

monoatomic layers may be inserted between the electrode layer and the MgO(001) layer.

**[0056]** Hereafter, a MTJ device according to a second embodiment of the invention and a method of manufacturing the same will be described. In the method of manufacturing a Fe(001)/MgO(001)/Fe(001) MTJ device according to the present embodiment, MgO(001) is initially deposited in a poly-crystalline or amorphous state by sputtering or the like, and then an annealing process is performed such that a poly-crystal in which the (001) crystal plane is preferentially oriented or a single-crystal is obtained. The sputtering conditions were such that, for example, the temperature was room temperature (293K), a 2-inch  $\phi$  MgO was used as a target, and sputtering was conducted in an Ar atmosphere. The acceleration power was 200 W and the growth rate was 0.008 nm/s. Because MgO that is deposited under these conditions is in an amorphous state, a crystallized MgO was obtained by increasing the temperature to 300°C from room temperature and maintaining that temperature for a certain duration of time.

**[0057]** Oxygen vacancy defects may be introduced by a method whereby oxygen vacancy defects is produced during growth, a method whereby oxygen vacancy defects is introduced subsequently, or a method whereby a state with oxygen vacancy defects is subjected to an oxygen plasma process or natural oxidation so as to achieve a certain oxygen deficit level.

**[0058]** As described above, in accordance with the MTJ device technology of the present embodiment, an annealing process is carried out for crystallization after an

amorphous MgO has been deposited by sputtering, thereby eliminating the need for large-sized equipment.

**[0059]** Hereafter, a MTJ device according to a variation of the embodiments of the invention will be described with reference to the drawings. Fig. 11 shows the structure of the MTJ device according to the variation, which corresponds to Fig. 1(B). As shown in Fig. 11, the MTJ device of the variation is characterized in that, as in the MTJ device of the above-described embodiments, the electrodes disposed on either side of a single-crystal  $\text{MgO}_x(001)$  layer 503 or an oxygen-deficit poly-crystal  $\text{MgO}_x$  ( $0 < x < 1$ ) in which the (001) crystal plane is preferentially oriented comprises an amorphous ferromagnetic alloy, such as CoFeB layers 501 and 505. The amorphous ferromagnetic alloy can be formed by evaporation or sputtering, for example. The resultant characteristics are substantially identical to those of the first embodiment.

**[0060]** As the amorphous magnetic alloy, FeCoB, FeCoBSi, FeCoBP, FeZr, and CoZr may be used, for example. Although an anneal process after the preparation of the MTJ device might cause the amorphous magnetic alloy in the electrode layers to be partially or entirely crystallized, this would not lead to a significant deterioration of the MR ratio. Thus, such a crystallized amorphous magnetic alloy may be used in the electrode layers.

**[0061]** While the MTJ device according to various embodiments of the invention has been described, it should be apparent to those skilled in the art that the invention is not limited to those specific embodiments and various other modifications, improvements and combinations are possible. For example, the height of the tunnel

barrier may be adjusted by doping Ca or Sr, instead of introducing an oxygen vacancy defects to the MgO layer. Further, while the MgO layer has been described to be deposited by electron-beam evaporation or sputtering, it should be obvious that other deposition methods are also possible. The term “high vacuum” refers to values on the order of no more than  $10^{-6}$  Pa in the case where oxygen is not introduced, for example. In the case where oxygen is introduced, the term refers to values on the order of  $10^{-4}$  Pa.

**[0062]**In accordance with the invention, a larger magnetoresistance than in the conventional MTJ device can be obtained, and the output voltage of the MTJ device can be increased. At the same time, the resistance value of the MTJ device can be reduced so that it is optimized for MRAM. The invention thus enables the level of integration of MRAM using the MTJ device to be readily increased. In accordance with the invention, the output voltage value of the MRAM roughly doubles over prior art, making the MTJ device of the invention suitable for very large scale integrated MRAMs of gigabit class.

What is claimed is:

1. A magnetoresistive device comprising a magnetic tunnel junction structure comprising:

a tunnel barrier layer;

a first ferromagnetic material layer of the BCC structure formed on a first side of said tunnel barrier layer; and

a second ferromagnetic material layer of the BCC structure formed on a second side of said tunnel barrier layer,

wherein said tunnel barrier layer is formed by a single-crystalline  $\text{MgO}_x$  (001) layer or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) layer in which the (001) crystal plane is preferentially oriented.

2. A memory device comprising:

a transistor; and

the magnetoresistive device according to claim 1, wherein said magnetoresistive device is used as a load for said transistor.

## Abstract of the Disclosure

The output voltage of an MRAM is increased by means of an Fe(001)/MgO(001)/Fe(001) MTJ device, which is formed by microfabrication of a sample prepared as follows: A single-crystalline MgO (001) substrate is prepared. An epitaxial Fe(001) lower electrode (a first electrode) is grown on a MgO(001) seed layer at room temperature, followed by annealing under ultrahigh vacuum. A MgO(001) barrier layer is epitaxially formed on the Fe(001) lower electrode (the first electrode) at room temperature, using a MgO electron-beam evaporation. A Fe(001) upper electrode (a second electrode) is then formed on the MgO(001) barrier layer at room temperature. This is successively followed by the deposition of a Co layer on the Fe(001) upper electrode (the second electrode). The Co layer is provided so as to increase the coercive force of the upper electrode in order to realize an antiparallel magnetization alignment.

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Inventor: Shinji YUASA

Serial No.: TBD

Filing Date: Filed Concurrently Herewith

For: METHOD OF MANUFACTURING A  
MAGNETORESISTIVE RANDOM  
ACCESS MEMORY (MRAM)

Examiner: TBD

Art Unit: TBD

Confirmation No.: TBD

Attorney Docket No.: IBTH 13318Aa

August 10, 2023

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**Preliminary Amendment**

Sir/Madam:

Prior to determining claim fees and examination on the merits, please amend the above identified application as outlined herein.

Amendments to the **Specification** begin on page 2 of this paper;

Amendments to the **Claims** begin on page 6 of this paper; and

**Remarks** begin on page 9 of this paper.

### **Amendments to the Specification**

Please replace the paragraph [0002] as follows:

[0002] The present application is a continuation of U.S. Application No. 18/219,320, filed July 7, 2023 (now pending), which is a continuation of U.S. Application No. 17/560,922, filed December 23, 2021 (now pending), which is a continuation of U.S. Application No. 16/862,598, filed April 30, 2020 (now U.S. Patent No. 11,233,193), which is a continuation of U.S. Application No. 16/443,875, filed June 18, 2019 (now U.S. Patent No. 10,680,167), which is a continuation of U.S. Application No. 15/428,842, filed February 09, 2017 (now U.S. Patent No. 10,367,138), which is a continuation of U.S. Application No. 14/837,558, filed August 27, 2015 (now U.S. Patent No. 9,608,198), which is a continuation of U.S. Application No. 13/767,290, filed February 14, 2013 (now U.S. Patent No. 9,123,463), which is a continuation of U.S. Application No. 13/400,340, filed February 20, 2012 (now U.S. Patent No. 8,405,134), which is a continuation of U.S. Application 12/923,643, filed September 30, 2010 (now U.S. Patent No. 8,319,263), which is a continuation of U.S. Application No. 10/591,947, filed September 08, 2006 (now U.S. Patent No. 7,884,403), which is a National Stage Application of PCT/JP2005/004720, filed March 10, 2005, which claims priority from Japanese Application Nos. 2004-071186 and 2004-313350, filed March 12, 2004 and October 28, 2004, respectively, the content of each is hereby incorporated by reference into this application.

Please replace the paragraph [0013] as follows:

[0013] Although there are prospects for achieving MRAMs with capacities on the order of 64Mbits based on the current technologies, the characteristics of the MTJ device, which is the heart of MRAM, needs to be improved if higher levels of integration are to be achieved. In particular, in order to increase the output voltage of the MTJ device, the magnetoresistance must be increased and the bias voltage characteristics must be improved. Fig. 10 illustrates how the magnetoresistance in a ~~relatedconventional~~ MTJ device using an amorphous Al-O as the tunnel barrier changes as a function of the bias voltage (L1). As shown, in the ~~relatedconventional~~ MTJ device, the magnetoresistance is small and, notably, it tends to drastically decrease upon application of bias voltage. With

such characteristics, the output voltage when operation margins are taken into consideration is too small for the device to be employed for an actual memory device. Specifically, the magnetoresistance of the current MTJ device is small at approximately 70%, and the output voltage is also small at no more than 200 mV, which is substantially half the output voltage of a DRAM. This has resulted in the problem that as the level of integration increases, signals are increasingly lost in noise and cannot be read.

Please replace the paragraph [0030] as follows:

[0030] Fig. 10 shows how the magnetoresistance of a ~~relatedconventional~~ MTJ device using an amorphous Al-O as the tunnel barrier changes depending on the bias voltage.

Please replace the paragraph [0043] as follows:

[0043] The inventors tried an approach to deposit a MTJ device in which the tunnel barrier comprises a single-crystal (001) of magnesium oxide (MgO) or a polycrystalline MgO in which the (001) crystal plane is preferentially oriented. It is the inventors' theory that, because magnesium oxide is a crystal (where the atoms are arranged in an orderly fashion), as opposed to the ~~relatedconventional~~ amorphous Al-O barrier, the electrons are not scattered and the coherent states of electrons are conserved during the tunneling process. Fig. 1(B) shows the MTJ device structure according to an embodiment of the invention. Fig. 1(A) shows the energy band structure of the ferromagnetic Fe(001), that is, the E-E<sub>F</sub> relationship with respect to the [001] direction of the momentum space. As shown in Fig. 1(B), the MTJ device structure of the present embodiment comprises a first Fe (001) layer 1, a second Fe (001) layer 5, and a single-crystalline MgO<sub>x</sub> (001) layer 3 or a poly-crystalline MgO<sub>x</sub> (0 < x < 1) layer 3 sandwiched therebetween, the polycrystalline layer having the (001) crystal plane preferentially oriented therein. According to the aforementioned Jullire' s model, assuming that the momentum of the conduction electrons is preserved in the tunneling process, the tunneling current that passes through MgO would be dominated by those electrons with wave vector k<sub>z</sub> in the direction perpendicular to the tunnel barrier (normal to the junction interfaces). In accordance with the energy band diagram shown in Fig. 1(A) of Fe in the [001] (Γ-H) direction, the density of state (DOS) at the Fermi energy E<sub>F</sub> does not exhibit a very high spin polarization due

to the fact that the sub-bands of the majority-spin and the minority-spin have states at the Fermi energy  $E_F$ . However, in case the coherent states of electrons are conserved in the tunneling process, only those conduction electrons that have totally symmetrical wave functions with respect to the axis perpendicular to the barrier would be coupled with the states in the barrier region and come to have a finite tunneling probability. The  $\Delta 1$  band in the Fe(001) electrode has such totally symmetric wave functions. As shown in Fig. 1(A), the majority spin  $\Delta 1$  band (solid line) has states at the Fermi energy  $E_F$ , whereas the minority spin  $\Delta 1$  band (broken line) does not have state at the Fermi energy  $E_F$ . Because of such half-metallic characteristics of the Fe  $\Delta 1$  band, there is the possibility that a very high MR ratio can be obtained in a coherent spin polarized tunneling. Since in an epitaxial (single-crystal, or (001) oriented polycrystal) MTJ device the scattering of electrons is suppressed during the tunneling process, an epitaxial MTJ device is thought to be ideal for realizing the aforementioned coherent tunneling.

Please replace the paragraph [0054] as follows:

[0054] Fig. 7(a) shows the bias voltage dependency of the MR ratio at room temperature. It will be seen that the bias voltage dependency of the MR ratio is fairly small. Although the characteristics are asymmetric, the voltage  $V_{\text{half}}$  at which the MR ratio is reduced in half of the zero-bias value is 1250 mV, which is a very high value. In this connection, it is noted that the voltage  $V_{\text{half}}$  at which the MR ratio is reduced in half of the zero-bias value in the ~~relatedconventional~~ MTJ s with Al-O tunnel barrier is 300 to 600 mV. Fig. 7(b) shows the output voltage  $V_{\text{out}}$  of the MTJ device (=bias voltage x  $(R_{\text{ap}} - R_{\text{p}})/R_{\text{ap}}$ ). The maximum value of the output voltage  $V_{\text{out}}$  is 380 mV with a positive bias. This value is about twice as large as that (a little less than 200 mV) in the case of the Al-O barrier. These high values in terms of both MR ratio and output voltage suggest the effectiveness of the technique according to the present embodiment.

Please replace the paragraph [0062] as follows:

[0062] In accordance with the invention, a larger magnetoresistance than in the ~~relatedconventional~~ MTJ device can be obtained, and the output voltage of the MTJ device can be increased. At the same time, the resistance value of the MTJ device can

be reduced so that it is optimized for MRAM. The invention thus enables the level of integration of MRAM using the MTJ device to be readily increased. In accordance with the invention, the output voltage value of the MRAM roughly doubles over ~~related prior art~~, making the MTJ device of the invention suitable for very large scale integrated MRAMs of gigabit class.

**Amendments to the Claims**

This listing of claims will replace all prior versions of claims:

1-2. (Canceled)

3. (New) A magnetoresistive device comprising a magnetic tunnel junction structure comprising:

a first ferromagnetic material layer;  
a second ferromagnetic material layer; and  
a tunnel barrier layer between the first ferromagnetic material layer and the second ferromagnetic material layer,  
wherein said tunnel barrier layer comprises crystalline  $\text{MgO}_x$  (001) with oxygen vacancy defects and ( $0 < x < 1$ ).

4. (New) The magnetoresistive device of claim 3, wherein  $0.9 < x < 1$ .

5. (New) The magnetoresistive device of claim 4, wherein  $0.98 < x < 1$ .

6. (New) The magnetoresistive device of claim 5, wherein  $0.99 < x < 1$ .

7. (New) The magnetoresistive device of claim 3, wherein a barrier height of the tunnel barrier layer is in a range of 0.1 eV to 0.85 eV.

8. (New) The magnetoresistive device of claim 7, wherein the barrier height of the tunnel barrier layer is in a range of 0.2 eV to 0.5 eV.

9. (New) The magnetoresistive device of claim 3, wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer comprises Boron.

10. (New) The magnetoresistive device of claim 3, wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer is partially or entirely crystallized.

11. (New) A magnetoresistive device comprising a magnetic tunnel junction structure comprising:

- a first ferromagnetic material layer;
- a second ferromagnetic material layer; and
- a tunnel barrier layer between the first ferromagnetic material layer and the second ferromagnetic material layer,

wherein said tunnel barrier layer comprises magnesium oxide and has a barrier height in a range of 0.1 eV to 0.85 eV.

12. (New) The magnetoresistive device of claim 11, wherein the tunnel barrier layer comprises partially or fully crystalline magnesium oxide.

13. (New) The magnetoresistive device of claim 12, wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer is partially or entirely crystallized.

14. (New) The magnetoresistive device of claim 13, wherein the barrier height is in a range of 0.2 eV to 0.5 eV.

15. (New) The magnetoresistive device of claim 13, wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer exhibits a body-centered cubic (BCC) structure.

16. (New) The magnetoresistive device of claim 13, wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer comprises Cobalt and Iron.

17. (New) A magnetoresistive device comprising:

- a first ferromagnetic material layer;
- a tunnel barrier layer disposed on the first ferromagnetic material layer, wherein said tunnel barrier layer comprises magnesium oxide and has a barrier height in a range of 0.2 eV to 0.5 eV; and
- a second ferromagnetic material layer disposed on the tunnel barrier layer.

18. (New) The magnetoresistive device of claim 17, wherein the tunnel barrier layer comprises partially or fully crystalline magnesium oxide.

19. (New) The magnetoresistive device of claim 18, wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer is partially or entirely crystallized.

20. (New) The magnetoresistive device of claim 19, wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer exhibits a body-centered cubic (BCC) structure.

21. (New) The magnetoresistive device of claim 19, wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer comprises Cobalt and Iron.

22. (New) The magnetoresistive device of claim 17, wherein the tunnel barrier layer has a thickness less than 10 nm.

**Remarks**

In the Specification, the above-identified paragraphs are amended for clarification.

Claims 3-22 are pending. Claims 3-22 are newly added; and claims 1-2 are canceled without prejudice. No new matter has been added. Claims 3, 11 and 17 are independent.

Any fee due with this paper, not already paid through an EFS-Web filing, may be charged to Deposit Account No. 50-3894. Any overpayment may be credited to Deposit Account No. 50-3894.

Respectfully submitted,  
MYERS WOLIN, LLC

/Akihiro Matsuya/  
Akihiro Matsuya  
Reg. No. 76,573

/Brian S. Myers/  
Brian S. Myers  
Reg. No. 46,947

**CUSTOMER NUMBER 61650**  
PHONE: (973) 828-1284  
FAX: (866) 864-3947

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Re: Application of: Shinji YUASA

Examiner: TBD

Serial No.: TBD

Art Unit: TBD

Filing Date: August 10, 2023

Confirmation No.: TBD

Title: METHOD OF MANUFACTURING A  
MAGNETORESISTIVE RANDOM ACCESS  
MEMORY (MRAM)

Attorney Docket No.: IBTH 13318Aa

Commissioner for Patents  
P. O. Box 1450  
Alexandria, VA 22313-1450

**AUTHORIZATION PURSUANT TO 37 CFR §1.136 (a) (3)**  
**AND AUTHORIZATION TO CHARGE DEPOSIT ACCOUNT**

Sir:

The Commissioner is hereby requested and authorized to treat any concurrent or future reply in this application requiring a petition for extension of time for its timely submission, as incorporating a petition for extension of time for the appropriate length of time.

Please also charge any additional fees which may now or in the future be required in this application, including extension of time fees, but excluding the issue fee unless explicitly requested to do so, and credit any overpayment, to Deposit Account No. 50-3894.

Respectfully submitted,

MYERS WOLIN, LLC

/Brian S. Myers/

Brian S. Myers

Reg. No. 46,947

**CUSTOMER NUMBER 61650**

PHONE: (973) 828-1284

FAX: (866) 864-3947

Doc Code: ECOMM.AUTH/ECOMM.WTDW

Doc Description: Internet Communications Authorization/Internet Communications Authorization Withdrawal

PTO/SB/439 (11-15)

**AUTHORIZATION FOR INTERNET  
COMMUNICATIONS IN A PATENT  
APPLICATION OR REQUEST TO  
WITHDRAW AUTHORIZATION FOR  
INTERNET COMMUNICATIONS**

|                         |                 |
|-------------------------|-----------------|
| Application No.         |                 |
| Filing Date             | August 10, 2023 |
| First Named Inventor    | Shinji YUASA    |
| Art Unit                |                 |
| Examiner Name           |                 |
| Practitioner Docket No. | IBTH 13318Aa    |

To: Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**I. To authorize permission for Internet Communications.**

☒ Recognizing that Internet communications are not secure, I hereby authorize the USPTO to communicate with the undersigned and practitioners in accordance with 37 CFR 1.33 and 37 CFR 1.34 concerning any subject matter of this application via video conferencing, instant messaging, or electronic mail. I understand that a copy of these communications will be made of record in the application file. (MPEP 502.03)

**II. To withdraw authorization for Internet Communications.**

☐ The authorization given on \_\_\_\_\_, to the USPTO to communicate with the undersigned and any practitioner in accordance with 37 CFR 1.33 and 37 CFR 1.34 concerning any subject matter of this application via Internet communications such as video conferencing, instant messaging, or electronic mail is hereby withdrawn. I understand that the withdrawal is effective when approved rather than when received.

I am the

☐ applicant.

☒ attorney or agent of record. Registration number 46947.

☐ attorney or agent acting under 37 CFR 1.34. Registration number \_\_\_\_\_.

/Brian S. Myers/

Signature

August 10, 2023

Date

Brian S. Myers

Typed or printed name

973-828-1325

Telephone Number

**NOTE:** This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Juristic entities must be represented by a patent practitioner (see 37 CFR 1.31, which is applicable to any paper filed on or after September 16, 2012, that is presented on behalf of a juristic entity, regardless of application filing date). Submit multiple forms if more than one signature is required, see below\*.

☐ \* Total of \_\_\_\_\_ forms are submitted.

## Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

## POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number

Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)



I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above:

61650

OR



I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:



The address associated with the above-mentioned Customer Number

OR



The address associated with Customer Number:

OR



Firm or  
Individual Name

Address

City

State

Zip

Country

Telephone

Email

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

Godo Kaisha IP Bridge 1



Inventor or Joint Inventor (title not required below)



Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)



Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)



Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

### SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature

Date (Optional)

Name

FUJIKI, Minoru

Title

Executive Manager

**NOTE:** Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.



Total of

forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

| APPLICATION<br>NUMBER | FILING or<br>371(c) DATE | GRP ART<br>UNIT | FIL FEE REC'D | ATTY. DOCKET NO | TOT CLAIMS | IND CLAIMS |
|-----------------------|--------------------------|-----------------|---------------|-----------------|------------|------------|
| 18/232,576            | 08/10/2023               |                 | 1820          | IBTH 13318Aa    | 20         | 3          |

CONFIRMATION NO. 1021

## FILING RECEIPT



0000000060847806

61650  
MYERS WOLIN, LLC  
100 SOUTH JEFFERSON ROAD  
SUITE 202  
WHIPPANY, NJ 07981-1009

Date Mailed: 08/22/2023

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

**Please verify the accuracy of the data presented on this receipt.** If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

### Inventor(s)

Shinji YUASA, Ibaraki, JAPAN;

### Applicant(s)

Godo Kaisha IP Bridge 1, Tokyo, JAPAN;

### Assignment For Published Patent Application

Godo Kaisha IP Bridge 1, Chiyoda-ku, Tokyo, JAPAN

**Power of Attorney:** The patent practitioners associated with Customer Number 61650

### Domestic Priority data as claimed by applicant

This application is a CON of 18/219,320 07/07/2023  
which is a CON of 17/560,922 12/23/2021 PAT 11,737,372  
which is a CON of 16/862,598 04/30/2020 PAT 11,233,193  
which is a CON of 16/443,875 06/18/2019 PAT 10,680,167  
which is a CON of 15/428,842 02/09/2017 PAT 10,367,138  
which is a CON of 14/837,558 08/27/2015 PAT 9,608,198  
which is a CON of 13/767,290 02/14/2013 PAT 9,123,463  
which is a CON of 13/400,340 02/20/2012 PAT 8,405,134  
which is a CON of 12/923,643 09/30/2010 PAT 8,319,263  
which is a CON of 10/591,947 09/08/2006 PAT 7,884,403  
which is a 371 of PCT/JP2005/004720 03/10/2005

**Foreign Applications** (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.)

JAPAN 2004-071186 03/12/2004 No Access Code Provided  
JAPAN 2004-313350 10/28/2004 No Access Code Provided

**Permission to Access Application via Priority Document Exchange:** Yes

**Permission to Access Search Results:** Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

**If Required, Foreign Filing License Granted:** 08/21/2023

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 18/232,576**

**Projected Publication Date:** To Be Determined - pending completion of Corrected Papers.

**Non-Publication Request:** No

**Early Publication Request:** No

**Title**

METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM)

**Preliminary Class**

**Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications:** No

## **PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES**

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign

page 2 of 4

patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

## **LICENSE FOR FOREIGN FILING UNDER**

### **Title 35, United States Code, Section 184**

### **Title 37, Code of Federal Regulations, 5.11 & 5.15**

#### **GRANTED**

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

#### **NOT GRANTED**

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

## ***SelectUSA***

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit <http://www.SelectUSA.gov> or call +1-202-482-6800.

# PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number  
18/232,576

## APPLICATION AS FILED - PART I

| (Column 1)                                                                |                                                                                                                                                                                                                               | (Column 2)   | SMALL ENTITY |         | OR | OTHER THAN SMALL ENTITY |         |
|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------|---------|----|-------------------------|---------|
| FOR                                                                       | NUMBER FILED                                                                                                                                                                                                                  | NUMBER EXTRA | RATE(\$)     | FEE(\$) |    | RATE(\$)                | FEE(\$) |
| BASIC FEE<br>(37 CFR 1.16(a), (b), or (c))                                | N/A                                                                                                                                                                                                                           | N/A          | N/A          |         |    | N/A                     | 320     |
| SEARCH FEE<br>(37 CFR 1.16(k), (l), or (m))                               | N/A                                                                                                                                                                                                                           | N/A          | N/A          |         |    | N/A                     | 700     |
| EXAMINATION FEE<br>(37 CFR 1.16(o), (p), or (q))                          | N/A                                                                                                                                                                                                                           | N/A          | N/A          |         |    | N/A                     | 800     |
| TOTAL CLAIMS<br>(37 CFR 1.16(i))                                          | 20 minus 20 =                                                                                                                                                                                                                 | *            |              |         | OR | x =                     | 0       |
| INDEPENDENT CLAIMS<br>(37 CFR 1.16(h))                                    | 3 minus 3 =                                                                                                                                                                                                                   | *            |              |         |    | x =                     | 0       |
| APPLICATION SIZE FEE<br>(37 CFR 1.16(s))                                  | If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s). |              |              |         |    |                         | 0       |
| MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))                         |                                                                                                                                                                                                                               |              |              |         |    |                         | 0       |
| * If the difference in column 1 is less than zero, enter "0" in column 2. |                                                                                                                                                                                                                               |              | TOTAL        |         |    | TOTAL                   | 1820    |

## APPLICATION AS AMENDED - PART II

| (Column 1)                                                      |                                  | (Column 2)                         | (Column 3)    | SMALL ENTITY |                    | OR | OTHER THAN SMALL ENTITY |                    |
|-----------------------------------------------------------------|----------------------------------|------------------------------------|---------------|--------------|--------------------|----|-------------------------|--------------------|
| AMENDMENT A                                                     | CLAIMS REMAINING AFTER AMENDMENT | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA | RATE(\$)     | ADDITIONAL FEE(\$) |    | RATE(\$)                | ADDITIONAL FEE(\$) |
| Total<br>(37 CFR 1.16(i))                                       | *                                | Minus **                           | =             | x =          |                    | OR | x =                     |                    |
| Independent<br>(37 CFR 1.16(h))                                 | *                                | Minus ***                          | =             | x =          |                    | OR | x =                     |                    |
| Application Size Fee (37 CFR 1.16(s))                           |                                  |                                    |               |              |                    | OR |                         |                    |
| FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) |                                  |                                    |               |              |                    | OR |                         |                    |
| TOTAL ADD'L FEE                                                 |                                  |                                    |               |              |                    | OR | TOTAL ADD'L FEE         |                    |

| (Column 1)                                                      |                                  | (Column 2)                         | (Column 3)    | SMALL ENTITY |                    | OR | OTHER THAN SMALL ENTITY |                    |
|-----------------------------------------------------------------|----------------------------------|------------------------------------|---------------|--------------|--------------------|----|-------------------------|--------------------|
| AMENDMENT B                                                     | CLAIMS REMAINING AFTER AMENDMENT | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA | RATE(\$)     | ADDITIONAL FEE(\$) |    | RATE(\$)                | ADDITIONAL FEE(\$) |
| Total<br>(37 CFR 1.16(i))                                       | *                                | Minus **                           | =             | x =          |                    | OR | x =                     |                    |
| Independent<br>(37 CFR 1.16(h))                                 | *                                | Minus ***                          | =             | x =          |                    | OR | x =                     |                    |
| Application Size Fee (37 CFR 1.16(s))                           |                                  |                                    |               |              |                    | OR |                         |                    |
| FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) |                                  |                                    |               |              |                    | OR |                         |                    |
| TOTAL ADD'L FEE                                                 |                                  |                                    |               |              |                    | OR | TOTAL ADD'L FEE         |                    |

\* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

\*\* If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

\*\*\* If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

| APPLICATION NUMBER | FILING OR 371(C) DATE | FIRST NAMED APPLICANT | ATTY. DOCKET NO./TITLE |
|--------------------|-----------------------|-----------------------|------------------------|
| 18/232,576         | 08/10/2023            | Shinji YUASA          | IBTH 13318Aa           |

CONFIRMATION NO. 1021

61650  
MYERS WOLIN, LLC  
100 SOUTH JEFFERSON ROAD  
SUITE 202  
WHIPPANY, NJ 07981-1009

## FORMALITIES LETTER



\*OC000000060847808\*

Date Mailed: 08/22/2023

## NOTICE TO FILE CORRECTED APPLICATION PAPERS

### Filing Date Granted

An application number and filing date have been accorded to the above-identified nonprovisional application. The application is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- A substitute specification excluding claims in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125 is required. The substitute specification must be submitted with markings and be accompanied by a clean version (without markings) as set forth in 37 CFR 1.125(c) and a statement that the substitute specification contains no new matter (see 37 CFR 1.125(b)). Since a preliminary amendment was present on the filing date of the application and such amendment is part of the original disclosure of the application, the substitute specification must include all of the desired changes made in the preliminary amendment. See 37 CFR 1.115 and 1.215.

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be addressed to:

Mail Stop Missing Parts  
Commissioner for Patents  
P.O. Box 1450  
Alexandria VA 22313-1450

### REPLY VIA ELECTRONIC FILING

A reply may be submitted via electronic filing only by registered users of the appropriate USPTO patent electronic filing system and must include:

- A separate document having the document description, "**Applicant response to Pre-Exam Formalities Notice**"; and
- the item(s) for which a reply period is set forth above.

For more information about electronic filing, contact the Patent Electronic Business Center (EBC) 1-866-217-9197 or visit <https://www.uspto.gov/ebc>

NOTE: If the reply is not being submitted electronically, a copy of this notice must be included.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000 or (571) 272-4200 or 1-888-786-0101**.

/hkquach/

---

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Inventor: Shinji YUASA

Serial No.: 18/232,576

Filing Date: August 10, 2023

For: METHOD OF MANUFACTURING A  
MAGNETORESISTIVE RANDOM  
ACCESS MEMORY (MRAM)

Examiner: TBD

Art Unit: TBD

Confirmation No.: 1021

Attorney Docket No.: IBTH 13318Aa

September 7, 2023

Mail Stop: **Missing Parts**  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**Response to Notice to File Corrected Application Papers**

Sir/Madam:

In the Notice to File Corrected Application Papers mailed on August 22, 2023, the Office indicates that a substitute specification excluding claims in compliance with 37 CFR 1.52, 1.121 (b)(3), and 1.125 is required.

Applicant respectfully submits the response to Pre-Exam Formalities Notice and a substitute specification (marked-up version and clean version).

The substitute specification contains no new matter.

A substitute Specification (marked-up and clean) is attached.

Respectfully submitted,  
MYERS WOLIN, LLC

/Akihiro Matsuya/  
Akihiro Matsuya  
Reg. No. 76,573

/Brian S. Myers/  
Brian S. Myers  
Reg. No. 46,947

**CUSTOMER NUMBER 61650**

PHONE: (973) 828-1284

FAX: (866) 864-3947

METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS  
MEMORY (MRAM)

**[0001]**CROSS-REFERENCE TO RELATED APPLICATIONS

**[0002]**The present application is a continuation of U.S. Application No. 18/219,320, filed July 7, 2023 (now pending), which is a continuation of U.S. Application No. 17/560,922, filed December 23, 2021 (now pending), which is a continuation of U.S. Application No. 16/862,598, filed April 30, 2020 (now U.S. Patent No. 11,233,193), which is a continuation of U.S. Application 16/443,875, filed June 18, 2019 now U.S. Patent No. 10,680,167), which is a continuation of U.S. Application No. 15/428,842, filed February 09, 2017 (now U.S. Patent No. 10,367,138), which is a continuation of U.S. Application No. 14/837,558, filed August 27, 2015 (now U.S. Patent No. 9,608,198), which is a continuation of U.S. Application No. 13/767,290, filed February 14, 2013 (now U.S. Patent No. 9,123,463), which is a continuation of U.S. Application No. 13/400,340, filed February 20, 2012 (now U.S. Patent No. 8,405,134), which is a continuation of U.S. Application 12/923,643, filed September 30, 2010 (now U.S. Patent No. 8,319,263), which is a continuation of U.S. Application No. 10/591,947, filed September 08, 2006 (now U.S. Patent No. 7,884,403), which is a National Stage Application of PCT/JP2005/004720, filed March 10, 2005, which claims priority from Japanese Application Nos. 2004-071186 and 2004-313350, filed March 12, 2004 and October 28, 2004, respectively, the content of each is hereby incorporated by reference into this application.

**[0003]**BACKGROUND OF THE INVENTION

**[0004]**Field of the Invention

**[0005]** The present invention relates to a magnetic tunnel junction device and a method of manufacturing the same, particularly to a magnetic tunnel junction device with a high magnetoresistance and a method of manufacturing the same.

**[0006]** Description of Related Art

**[0007]** Magnetoresistive random access memories (MRAMs) refer to a large-scale integrated memory circuit that is expected to replace the currently widely used DRAM memories. Research and development of MRAM devices, which are fast and non-volatile memory devices, are being extensively carried out, and sample products of a 4Mbit MRAM have actually been delivered.

**[0008]** Figs. 8(A) and 8(B) show the structure and operation principle of a magnetic tunnel junction device (to be hereafter referred to as a “MTJ device”), which is the most important part of the MRAM. As shown in Fig. 8(A), a MTJ device comprises a tunnelling junction structure in which a tunnel barrier (to be hereafter also referred to as a “barrier layer”) made of an oxide is sandwiched between a first and a second electrode made of a ferromagnetic metal. The tunnel barrier layer comprises an amorphous Al-O layer (see Non-Patent Document 1). As shown in Fig. 8(A), in the case of parallel magnetization alignment where the directions of magnetizations of the first and second ferromagnetic electrodes are aligned parallel, the electric resistance of the device with respect to the direction normal to the interfaces of the tunneling junction structure decreases. On the other hand, in the case of antiparallel magnetization alignment where the directions of magnetizations of the first and second ferromagnetic electrodes are aligned antiparallel as shown in Fig. 8(B), the electric resistance with respect to the direction normal to the interfaces of the tunneling junction structure increases. The resistance value does not change in a

general state, so that information “1” or “0” can be stored depending on whether the resistance value is high or not. Since the parallel and antiparallel magnetization alignments can be stored in a non-volatile fashion, the device can be used as a non-volatile memory device.

**[0009]**Figs. 9(A)-(C) show an example of the basic structure of the MRAM. Fig. 9(A) shows a perspective view of the MRAM, and Fig. 9(B) schematically shows a circuit block diagram. Fig. 9(C) is a cross-section of an example of the structure of the MRAM. Referring to Fig. 9(A), in an MRAM, a word line WL and a bit line BL are disposed in an intersecting manner, with an MRAM cell disposed at each intersection. As shown in Fig. 9(B), the MRAM cell disposed at the intersection of a word line and a bit line comprises a MTJ device and a MOSFET directly connected to the MTJ device. Stored information can be read by reading the resistance value of the MTJ device that functions as a load resistance, using the MOSFET. The stored information can be rewritten by applying a magnetic field to the MTJ device, for example. As shown in Fig. 9(C), an MRAM memory cell comprises a MOSFET 100 including a source region 105 and a drain region 103 both formed inside a p-type Si substrate 101, and a gate electrode 111 formed on a channel region that is defined between the source and drain regions. The MRAM also comprises a MTJ device 117. The source region 105 is grounded, and the drain is connected to a bit line BL via the MTJ device. A word line WL is connected to the gate electrode 111 in a region that is not shown.

**[0010]**Thus, a single non-volatile MRAM memory cell can be formed by a single MOSFET 100 and a single MTJ device 117. The MRAMs are therefore suitable where high levels of integration are required.

[0011]Non-Patent Document 1: D. Wang, et al.: Science 294 (2001) 1488.

[0012]SUMMARY OF THE INVENTION

[0013]Although there are prospects for achieving MRAMs with capacities on the order of 64Mbits based on the current technologies, the characteristics of the MTJ device, which is the heart of MRAM, needs to be improved if higher levels of integration are to be achieved. In particular, in order to increase the output voltage of the MTJ device, the magnetoresistance must be increased and the bias voltage characteristics must be improved. Fig. 10 illustrates how the magnetoresistance in a related MTJ device using an amorphous Al-O as the tunnel barrier changes as a function of the bias voltage (L1). As shown, in the related MTJ device, the magnetoresistance is small and, notably, it tends to drastically decrease upon application of bias voltage. With such characteristics, the output voltage when operation margins are taken into consideration is too small for the device to be employed for an actual memory device. Specifically, the magnetoresistance of the current MTJ device is small at approximately 70%, and the output voltage is also small at no more than 200 mV, which is substantially half the output voltage of a DRAM. This has resulted in the problem that as the level of integration increases, signals are increasingly lost in noise and cannot be read.

[0014]It is an object of the invention to increase the output voltage of a MTJ device. It is another object of the invention to provide a memory device with a high magnetoresistance for stable operation.

**[0015]**In one aspect, the invention provides a magnetoresistive device comprising a magnetic tunnel junction structure comprising: a tunnel barrier layer; a first ferromagnetic material layer of the BCC structure formed on a first side of the tunnel barrier layer; and a second ferromagnetic material layer of the BCC structure formed on a second side of the tunnel barrier layer, wherein the tunnel barrier layer is formed by a single-crystal  $\text{MgO}_x$  (001) layer or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) layer in which the (001) crystal plane is preferentially oriented.

**[0016]**The invention further provides a magnetoresistive device comprising a magnetic tunnel junction structure comprising: a tunnel barrier layer comprising  $\text{MgO}$ (001); a first ferromagnetic material layer comprising  $\text{Fe}$ (001) formed on a first side of the tunnel barrier layer; and a second ferromagnetic material layer comprising  $\text{Fe}$ (001) formed on a second side of the tunnel barrier layer, wherein the  $\text{MgO}$  layer is formed by a single-crystalline  $\text{MgO}_x$  (001) layer or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) layer in which the (001) crystal plane is preferentially oriented. In a preferred embodiment, the band discontinuity value (the height of the tunnel barrier) between the bottom of the conduction band of the  $\text{MgO}$ (001) layer and the Fermi energy of the  $\text{Fe}$ (001) layer is smaller than an ideal value of a perfect single-crystal without defect. These features increase the magnetoresistance and thereby allow the output voltage of the MTJ device to be increased. By using any of the aforementioned MTJ devices as a load for a single transistor, a non-volatile memory can be formed.

**[0017]**In another aspect, the invention provides a method of manufacturing a magnetoresistive device comprising: preparing a substrate; depositing a first  $\text{Fe}$ (001) layer on the substrate; depositing a tunnel barrier layer on the first  $\text{Fe}$ (001) layer by electron beam evaporation under high vacuum, the tunnel barrier layer comprising a

single-crystalline  $\text{MgO}_x$  (001) or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) in which the (001) crystal plane is preferentially oriented; and forming a second Fe(001) layer on the tunnel barrier layer.

**[0018]** The invention furthermore provides a method of manufacturing a MTJ device comprising a first step of preparing a substrate comprising a single-crystalline  $\text{MgO}_x$ (001) or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) in which the (001) crystal plane is preferentially oriented, a second step of depositing a first Fe(001) layer on the substrate and performing an annealing process to make the surface flat, a third step of depositing a tunnel barrier layer on the first Fe(001) layer by electron beam evaporation, the tunnel barrier layer comprising a single-crystalline  $\text{MgO}_x$ (001) or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) in which the (001) crystal plane is preferentially oriented, and a fourth step of forming a second Fe(001) layer on the tunnel barrier layer. The method may further comprise the step of growing a seed layer between the first and the second steps, the seed layer comprising a single-crystalline  $\text{MgO}_x$ (001) or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) in which the (001) crystal plane is preferentially oriented. The MgO layer may be deposited using a target with the value of  $x$  in  $\text{MgO}_x$  adjusted. The value of  $x$  in  $\text{MgO}_x$  may be adjusted in the step of forming the MgO.

**[0019]** In yet another aspect, the invention provides a magnetoresistive device comprising a magnetic tunnel junction structure comprising a tunnel barrier layer comprising MgO(001), a first ferromagnetic material layer comprising an amorphous magnetic alloy formed on a first side of the tunnel barrier layer, and a second ferromagnetic material layer comprising an amorphous magnetic alloy formed on a second side of the tunnel barrier layer, wherein the discontinuous value (the height of the tunnel barrier) between the bottom of the conduction band of the MgO(001) layer

and the Fermi energy of the first or the second ferromagnetic material layer comprising the amorphous magnetic alloy is lower than an ideal value of a perfect single-crystal with no defect.

## **[0020] BRIEF DESCRIPTION OF THE DRAWINGS**

**[0021]** Fig. 1(B) shows the structure of a MTJ device according to a first embodiment of the invention, and Fig. 1(A) shows the energy band structure of a ferromagnetic metal Fe(001), illustrating the E-E<sub>F</sub> relationship with respect to the [001] direction of the momentum space.

**[0022]** Fig. 2(A) to Fig. 2(D) schematically show the process of manufacturing a MTJ device with a Fe(001)/MgO(001)/Fe(001) structure (to be hereafter referred to as a “Fe(001)/MgO(001)/Fe(001) MTJ device”) according to an embodiment of the invention.

**[0023]** Fig. 3(A) shows a RHEED image of a Fe(001) lower electrode (a first electrode), and Fig. 3(B) shows a RHEED image of a MgO(001) barrier layer.

**[0024]** Fig. 4 shows the results of observing the quadrupole mass spectra in the deposition chamber during the MgO evaporation.

**[0025]** Fig. 5 shows the film deposition rate dependency of the oxygen partial pressure during the MgO evaporation.

**[0026]** Fig. 6 shows typical magnetoresistance curves of the Fe(001)/MgO(001)/Fe(001) MTJ device.

**[0027]**Fig. 7(A) shows the bias voltage dependency of the MR ratio at room temperature, and Fig. 7(B) shows the output voltage  $V_{out}$  of the MTJ device (=bias voltage  $\times$  (Rap-Rp)/Rap).

**[0028]**Figs. 8(A) and 8(B) show the structure of the MTJ device and its operating principle.

**[0029]**Figs. 9(A)-(C) show an example of the basic structure of an MRAM, Fig. 9(A) showing a perspective view of the MRAM, Fig. 9(B) showing a schematic circuit diagram, and Fig. 9(C) showing a cross-sectional view of an example of its structure.

**[0030]**Fig. 10 shows how the magnetoresistance of a related MTJ device using an amorphous Al-O as the tunnel barrier changes depending on the bias voltage.

**[0031]**Fig. 11 shows the structure of a MTJ device according to a variation of the invention, corresponding to Fig. 1(B).

## **[0032]**DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0033]**In the context of the present specification, because MgO has a cubic crystal structure (NaCl structure), the (001) plane, the (100) plane, and the (010) plane are all equivalent. The direction perpendicular to the film surface is herein considered to be the z-axis so that the film plane can be uniformly described as (001). Also in the context of the present specification, BCC structure, which the crystalline structure of ferromagnetic electrode layer, means body-centered cubic lattice structure. More specifically, BCC structure includes the BCC structure with no chemical ordering so-called A2-type structure, the BCC structure with chemical ordering such as B2-type

structre and L2<sub>1</sub>-type structure, and also the aforementioned structures with slight lattice distortion.

**[0034]** The term “ideal value” with regard to a perfect single-crystal without defect herein refers to a value that has been estimated from ultraviolet photoemission spectroscopy experiments (see W. Wulfhekel, et al.: Appl. Phys. Lett. 78 (2001) 509.). The term “ideal value” is used herein because the aforementioned state can be considered to be an upper limit value of the potential barrier height of the tunnel barrier of an ideal single-crystal MgO with hardly any oxygen vacancy defect or lattice defect.

**[0035]** Before describing the preferred embodiments of the invention, an analysis conducted by the inventors is discussed. The magnetoresistance (MR) ratio of a MTJ device can be expressed by the following equation:

**[0036]** 
$$\Delta R/R_p = (R_{ap} - R_p)/R_p$$

**[0037]** where  $R_p$  and  $R_{ap}$  indicate the tunnel junction resistance in the cases of parallel and antiparallel magnetization alignments, respectively, of two electrodes. According to the Jullire’s formula, the MR ratio at low bias voltage can be expressed by:

**[0038]** 
$$\text{MR ratio} = (R_{ap} - R_p)/R_p = 2P_1P_2/(1-P_1P_2), \text{ and}$$

**[0039]** 
$$P_\alpha = (D_\alpha \uparrow (E_F) - D_\alpha \downarrow (E_F))/(D_\alpha \uparrow (E_F) + D_\alpha \downarrow (E_F)),$$

**[0040]** where  $\alpha = 1, 2$  (1)

**[0041]** In the above equations,  $P\alpha$  is the spin polarization of an electrode, and  $D\alpha \uparrow (E_F)$  and  $D\alpha \downarrow (E_F)$  are the density of state (DOS) at the Fermi energy ( $E_F$ ) of the majority-spin band and the minority-spin band, respectively. Since the spin polarization of ferromagnetic transition metals and alloys is approximately 0.5 or smaller, the Jullire's formula predicts a highest estimated MR ratio of about 70%.

**[0042]** Although the MR ratio of approximately 70% has been obtained at room temperature when a MTJ device was made using an amorphous Al-O tunnel barrier and polycrystalline electrodes, it has been difficult to obtain the output voltage of 200 mV, which is comparable to the output voltages of DRAMs, thereby preventing the realization of MRAM as mentioned above.

**[0043]** The inventors tried an approach to deposit a MTJ device in which the tunnel barrier comprises a single-crystal (001) of magnesium oxide (MgO) or a polycrystalline MgO in which the (001) crystal plane is preferentially oriented. It is the inventors' theory that, because magnesium oxide is a crystal (where the atoms are arranged in an orderly fashion), as opposed to the related amorphous Al-O barrier, the electrons are not scattered and the coherent states of electrons are conserved during the tunneling process. Fig. 1(B) shows the MTJ device structure according to an embodiment of the invention. Fig. 1(A) shows the energy band structure of the ferromagnetic Fe(001), that is, the  $E-E_F$  relationship with respect to the [001] direction of the momentum space. As shown in Fig. 1(B), the MTJ device structure of the present embodiment comprises a first Fe (001) layer 1, a second Fe (001) layer 5, and a single-crystalline  $MgO_x$  (001) layer 3 or a poly-crystalline  $MgO_x$  ( $0 < x < 1$ ) layer 3 sandwiched therebetween, the polycrystalline layer having the (001) crystal plane preferentially oriented therein. According to the aforementioned Jullire's

model, assuming that the momentum of the conduction electrons is preserved in the tunneling process, the tunneling current that passes through MgO would be dominated by those electrons with wave vector  $k_z$  in the direction perpendicular to the tunnel barrier (normal to the junction interfaces). In accordance with the energy band diagram shown in Fig. 1(A) of Fe in the [001] ( $\Gamma$ -H) direction, the density of state (DOS) at the Fermi energy  $E_F$  does not exhibit a very high spin polarization due to the fact that the sub-bands of the majority-spin and the minority-spin have states at the Fermi energy  $E_F$ . However, in case the coherent states of electrons are conserved in the tunneling process, only those conduction electrons that have totally symmetrical wave functions with respect to the axis perpendicular to the barrier would be coupled with the states in the barrier region and come to have a finite tunneling probability. The  $\Delta_1$  band in the Fe(001) electrode has such totally symmetric wave functions. As shown in Fig. 1(A), the majority spin  $\Delta_1$  band (solid line) has states at the Fermi energy  $E_F$ , whereas the minority spin  $\Delta_1$  band (broken line) does not have state at the Fermi energy  $E_F$ . Because of such half-metallic characteristics of the Fe  $\Delta_1$  band, there is the possibility that a very high MR ratio can be obtained in a coherent spin polarized tunneling. Since in an epitaxial (single-crystal, or (001) oriented polycrystal) MTJ device the scattering of electrons is suppressed during the tunneling process, an epitaxial MTJ device is thought to be ideal for realizing the aforementioned coherent tunneling.

**[0044]**In the following, a MTJ device according to a first embodiment of the invention and a method of manufacturing the same will be described with reference to the drawings. Figs. 2(A) to 2(D) schematically show the method of manufacturing the MTJ device having the Fe (001)/MgO(001)/Fe(001) structure according to the embodiment (to be hereafter referred to as a “Fe(001)/MgO(001)/Fe(001) MTJ

device”). Fe(001) refers to a ferromagnetic material with the BCC structure. First, a single-crystal MgO(001) substrate 11 was prepared. In order to improve the morphology of the surface of the single-crystal MgO(001) substrate 11, a MgO(001) seed layer 15 was grown by the molecular beam epitaxy (MBE) method. This was subsequently followed by the growth of an epitaxial Fe(001) lower electrode (first electrode) 17 with the thickness of 50 nm on the MgO(001) seed layer 15 at room temperature, as shown in Fig. 1(B), and then annealing was performed at 350°C under ultrahigh vacuum ( $2 \times 10^{-8}$  Pa). Electron-beam evaporation conditions included an acceleration voltage of 8 kV, a growth rate of 0.02 nm/sec, and the growth temperature of room temperature (about 293K). The source material of the electron-beam evaporation was MgO of the stoichiometric composition (the ratio of Mg to O being 1:1), the distance between the source and the substrate was 40 cm, the base vacuum pressure was  $1 \times 10^{-8}$  Pa, and the O<sub>2</sub> partial pressure was  $1 \times 10^{-6}$  Pa. Alternatively, a source with oxygen vacancy defects may be used instead of the MgO of the stoichiometric composition (the ratio of Mg to O is 1:1).

**[0045]** Fig. 3(A) shows a RHEED image of the Fe(001) lower electrode (a first electrode). The image shows that the Fe(001) lower electrode (first electrode) 17 possesses a good crystallinity and flatness. Thereafter, a MgO(001) barrier layer 21 with the thickness of 2 nm was epitaxially grown on the Fe(001) lower electrode (first electrode) at room temperature, also using the MgO electron-beam evaporation method. Fig. 3(B) shows a RHEED image of the MgO(001) barrier layer 21. The image shows that the MgO(001) barrier layer 21 also possesses a good crystallinity and flatness.

[0046] As shown in Fig. 2(D), a Fe(001) upper electrode (a second electrode) 23 with the thickness of 10 nm was formed on the MgO(001) barrier layer 21 at room temperature. This was successively followed by the deposition of a Co layer 25 with the thickness of 10 nm on the Fe(001) upper electrode (second electrode) 23. The Co layer 25 is provided to increase the coercive force of the upper electrode 23 so as to realize the antiparallel magnetization alignment. The thus prepared sample was then processed by microfabrication techniques to obtain the Fe(001)/MgO(001)/Fe(001) MTJ device.

[0047] The aforementioned MgO evaporation using an electron beam involved the formation of a film under ultrahigh vacuum of  $10^{-9}$  Torr. It can be seen that in this method, the film, even when formed on a glass substrate to the thickness of 300 nm, was colorless and transparent, showing that a good crystal film was formed. Fig. 4 shows the results of observing the quadrupole mass spectra in the deposition chamber during the MgO growth. The results show that the partial pressures regarding the spectrum P1 of O and the spectrum P2 of O<sub>2</sub> are high. Fig. 5 shows the film deposition rate dependency of the oxygen partial pressure during MgO evaporation. It will be seen from the figure that the oxygen partial pressure itself is high, and that the oxygen partial pressure increases as the deposition rate increases. These results indicate the separation of oxygen from MgO during the deposition of MgO. Since the separated oxygen is pumped out of the deposition chamber using vacuum pumps, there is the possibility that there are oxygen vacancy defects such as MgO<sub>x</sub> ( $0.9 < x < 1$ ). When there are oxygen vacancy defects, the potential barrier height of the MgO tunnel barrier is thought to decrease (such as in the range of 0.10 to 0.85 eV; more specifically, 0.2 to 0.5 eV), which is thought to result in an increase in the tunneling current. In the case of a typical Al-O tunnel barrier, the height of the tunnel barrier

with respect to Fe(001) electrodes is considered to be 0.7 to 2.5 eV. An ideal tunnel barrier height of a MgO crystal is 3.6 eV, and experimental values of 0.9 to 3.7 eV have been obtained. Using the method according to the present embodiment of the invention, a tunnel barrier height of approximately 0.3 eV is expected, indicating that the resistance of the tunnel barrier can be lowered. However, it should be noted that other factors, such as the influence of the aforementioned coherent tunneling, might also be involved. The value of  $x$  in  $\text{MgO}_x$  due to oxygen vacancy defects is such that  $0.98 < x < 1$ , and more preferably  $0.99 < x < 1$ . These are the ranges such that the sole presence of Mg is excluded and the characteristics of MgO can be basically maintained.

**[0048]** The aforementioned tunnel barrier height  $\phi$  was determined by fitting the electric conductance characteristics of the MTJ device (the relationship between tunnel current density  $J$  and bias voltage  $V$ ) onto the Simmons' formula (Equation (20) in a non-patent document by J. G. Simmons: J. Appl. Phys. 34, pp. 1793-1803 (1963)) based on the WKB approximation, using the least squares method. The fitting was performed using the free electron mass ( $m = 9.11 \times 10^{-31}$  kg) as the electron's effective mass. When a bias voltage  $V$  (which is normally on the order of 500 mV to 1000 mV) is applied until non-linearity appears in the  $J$ - $V$  characteristics, the height  $\phi$  of the tunnel barrier and the effective thickness  $\Delta s$  of the tunnel barrier can be simultaneously determined by fitting the  $J$ - $V$  characteristics using the Simmons' formula.

**[0049]** The effective thickness  $\Delta s$  of the tunnel barrier was determined to be smaller than the thickness of the actual MgO(001) tunnel barrier layer ( $t_{\text{MgO}}$ ) determined from a cross-sectional transmission electron microscope image of the MTJ device by

approximately 0.5 nm. This is the result of the effective thickness  $\Delta s$  of the tunnel barrier having been reduced from the actual MgO(001) layer thickness by the effect of the image potential produced at the interface between the MgO(001) layer and the alloy layer consisting mainly of Fe and Co.

**[0050]** It is noted that, in the event that  $t_{\text{MgO}}$  can be accurately determined using the cross-sectional transmission electron microscope (TEM) image, the height  $\phi$  of the tunnel barrier can be more simply determined by the following technique. Namely, when the bias voltage  $V$  applied to the MTJ device is small (normally 100 mV or smaller), the tunnel current density  $J$  is proportional to the bias voltage  $V$ , such that the J-V characteristics become linear. In such a low-bias voltage region, the Simmons' formula can be described as follows:

$$\mathbf{[0051]} J = [(2m\phi)^{1/2}/\Delta s](e/h)^2 \times \exp[-(4\pi\Delta s/h) \times (2m\phi)^{1/2}] \times V \quad (2)$$

**[0052]** where  $m$  is the mass of the free electron ( $9.11 \times 10^{-31}$  kg),  $e$  is the elementary electric charge ( $1.60 \times 10^{-19}$  C), and  $h$  is the Planck's constant ( $6.63 \times 10^{-34}$  J·s). The effective thickness of the tunnel barrier  $\Delta s$  is approximately  $t_{\text{MgO}} - 0.5$  nm. By fitting the J-V characteristics of the MTJ device in the low-bias voltage region onto Equation (2), the height  $\phi$  of the tunnel barrier can be simply and yet accurately estimated.

**[0053]** Fig. 6 shows a typical magnetoresistance curve of the Fe(001)/MgO(001)/Fe(001) MTJ device produced by the above-described method. The MR ratio is 146% at the measurement temperature of 20K and 88% at the measurement temperature of 293K. These values represent the highest MR ratios that have so far been obtained at room temperature. Such high MR ratios cannot be explained by the spin polarization of the Fe(001) electrode and is thought rather to be

related to a coherent spin-polarized tunneling. When 160 prototype MTJ devices were made, the variations regarding the MR ratio and tunneling resistance value were not more than 20%. The yield of the MTJ devices was 90% or more at the laboratory stage. These high values suggest the effectiveness of the approach of the invention. The resistance-area (RA) product of the MTJ device was on the order of a few  $\text{k}\Omega\mu\text{m}^2$ , which is suitable for MRAM.

**[0054]** Fig. 7(a) shows the bias voltage dependency of the MR ratio at room temperature. It will be seen that the bias voltage dependency of the MR ratio is fairly small. Although the characteristics are asymmetric, the voltage  $V_{\text{half}}$  at which the MR ratio is reduced in half of the zero-bias value is 1250 mV, which is a very high value. In this connection, it is noted that the voltage  $V_{\text{half}}$  at which the MR ratio is reduced in half of the zero-bias value in the related MTJs with Al-O tunnel barrier is 300 to 600 mV. Fig. 7(b) shows the output voltage  $V_{\text{out}}$  of the MTJ device ( $=\text{bias voltage} \times (\text{Rap} - \text{Rp})/\text{Rap}$ ). The maximum value of the output voltage  $V_{\text{out}}$  is 380 mV with a positive bias. This value is about twice as large as that (a little less than 200 mV) in the case of the Al-O barrier. These high values in terms of both MR ratio and output voltage suggest the effectiveness of the technique according to the present embodiment.

**[0055]** Although in the above-described embodiment Fe(001) of BCC was employed, an Fe alloy of BCC, such as an Fe-Co alloy, Fe-Ni alloy, or Fe-Pt alloy, may be used instead. Alternatively, a layer of Co or Ni with the thickness of one or several monoatomic layers may be inserted between the electrode layer and the MgO(001) layer.

**[0056]** Hereafter, a MTJ device according to a second embodiment of the invention and a method of manufacturing the same will be described. In the method of

manufacturing a Fe(001)/MgO(001)/Fe(001) MTJ device according to the present embodiment, MgO(001) is initially deposited in a poly-crystalline or amorphous state by sputtering or the like, and then an annealing process is performed such that a poly-crystal in which the (001) crystal plane is preferentially oriented or a single-crystal is obtained. The sputtering conditions were such that, for example, the temperature was room temperature (293K), a 2-inch  $\phi$  MgO was used as a target, and sputtering was conducted in an Ar atmosphere. The acceleration power was 200 W and the growth rate was 0.008 nm/s. Because MgO that is deposited under these conditions is in an amorphous state, a crystallized MgO was obtained by increasing the temperature to 300°C from room temperature and maintaining that temperature for a certain duration of time.

**[0057]** Oxygen vacancy defects may be introduced by a method whereby oxygen vacancy defects is produced during growth, a method whereby oxygen vacancy defects is introduced subsequently, or a method whereby a state with oxygen vacancy defects is subjected to an oxygen plasma process or natural oxidation so as to achieve a certain oxygen deficit level.

**[0058]** As described above, in accordance with the MTJ device technology of the present embodiment, an annealing process is carried out for crystallization after an amorphous MgO has been deposited by sputtering, thereby eliminating the need for large-sized equipment.

**[0059]** Hereafter, a MTJ device according to a variation of the embodiments of the invention will be described with reference to the drawings. Fig. 11 shows the structure of the MTJ device according to the variation, which corresponds to Fig. 1(B). As shown in Fig. 11, the MTJ device of the variation is characterized in that, as

in the MTJ device of the above-described embodiments, the electrodes disposed on either side of a single-crystal  $\text{MgO}_x(001)$  layer 503 or an oxygen-deficit poly-crystal  $\text{MgO}_x$  ( $0 < x < 1$ ) in which the (001) crystal plane is preferentially oriented comprises an amorphous ferromagnetic alloy, such as CoFeB layers 501 and 505. The amorphous ferromagnetic alloy can be formed by evaporation or sputtering, for example. The resultant characteristics are substantially identical to those of the first embodiment.

**[0060]** As the amorphous magnetic alloy, FeCoB, FeCoBSi, FeCoBP, FeZr, and CoZr may be used, for example. Although an anneal process after the preparation of the MTJ device might cause the amorphous magnetic alloy in the electrode layers to be partially or entirely crystallized, this would not lead to a significant deterioration of the MR ratio. Thus, such a crystallized amorphous magnetic alloy may be used in the electrode layers.

**[0061]** While the MTJ device according to various embodiments of the invention has been described, it should be apparent to those skilled in the art that the invention is not limited to those specific embodiments and various other modifications, improvements and combinations are possible. For example, the height of the tunnel barrier may be adjusted by doping Ca or Sr, instead of introducing an oxygen vacancy defects to the MgO layer. Further, while the MgO layer has been described to be deposited by electron-beam evaporation or sputtering, it should be obvious that other deposition methods are also possible. The term “high vacuum” refers to values on the order of no more than  $10^{-6}$  Pa in the case where oxygen is not introduced, for example. In the case where oxygen is introduced, the term refers to values on the order of  $10^{-4}$  Pa.

**[0062]**In accordance with the invention, a larger magnetoresistance than in the related MTJ device can be obtained, and the output voltage of the MTJ device can be increased. At the same time, the resistance value of the MTJ device can be reduced so that it is optimized for MRAM. The invention thus enables the level of integration of MRAM using the MTJ device to be readily increased. In accordance with the invention, the output voltage value of the MRAM roughly doubles over related art, making the MTJ device of the invention suitable for very large scale integrated MRAMs of gigabit class.

## Abstract of the Disclosure

The output voltage of an MRAM is increased by means of an Fe(001)/MgO(001)/Fe(001) MTJ device, which is formed by microfabrication of a sample prepared as follows: A single-crystalline MgO (001) substrate is prepared. An epitaxial Fe(001) lower electrode (a first electrode) is grown on a MgO(001) seed layer at room temperature, followed by annealing under ultrahigh vacuum. A MgO(001) barrier layer is epitaxially formed on the Fe(001) lower electrode (the first electrode) at room temperature, using a MgO electron-beam evaporation. A Fe(001) upper electrode (a second electrode) is then formed on the MgO(001) barrier layer at room temperature. This is successively followed by the deposition of a Co layer on the Fe(001) upper electrode (the second electrode). The Co layer is provided so as to increase the coercive force of the upper electrode in order to realize an antiparallel magnetization alignment.

METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS  
MEMORY (MRAM)

**[0001]CROSS-REFERENCE TO RELATED APPLICATIONS**

**[0002]**The present application is a continuation of U.S. Application No. 18/219,320, filed July 7, 2023 (now pending), which is a continuation of U.S. Application No. 17/560,922, filed December 23, 2021 (now pending), which is a continuation of U.S. Application No. 16/862,598, filed April 30, 2020 (now U.S. Patent No. 11,233,193), which is a continuation of U.S. Application 16/443,875, filed June 18, 2019 now U.S. Patent No. 10,680,167), which is a continuation of U.S. Application No. 15/428,842, filed February 09, 2017 (now U.S. Patent No. 10,367,138), which is a continuation of U.S. Application No. 14/837,558, filed August 27, 2015 (now U.S. Patent No. 9,608,198), which is a continuation of U.S. Application No. 13/767,290, filed February 14, 2013 (now U.S. Patent No. 9,123,463), which is a continuation of U.S. Application No. 13/400,340, filed February 20, 2012 (now U.S. Patent No. 8,405,134), which is a continuation of U.S. Application 12/923,643, filed September 30, 2010 (now U.S. Patent No. 8,319,263), which is a continuation of U.S. Application No. 10/591,947, filed September 08, 2006 (now U.S. Patent No. 7,884,403), which is a National Stage Application of PCT/JP2005/004720, filed March 10, 2005, which claims priority from Japanese Application Nos. 2004-071186 and 2004-313350, filed March 12, 2004 and October 28, 2004, respectively, the content of each is hereby incorporated by reference into this application.

**[0003]BACKGROUND OF THE INVENTION**

**[0004]Field of the Invention**

**[0005]** The present invention relates to a magnetic tunnel junction device and a method of manufacturing the same, particularly to a magnetic tunnel junction device with a high magnetoresistance and a method of manufacturing the same.

**[0006]** Description of Related Art

**[0007]** Magnetoresistive random access memories (MRAMs) refer to a large-scale integrated memory circuit that is expected to replace the currently widely used DRAM memories. Research and development of MRAM devices, which are fast and non-volatile memory devices, are being extensively carried out, and sample products of a 4Mbit MRAM have actually been delivered.

**[0008]** Figs. 8(A) and 8(B) show the structure and operation principle of a magnetic tunnel junction device (to be hereafter referred to as a “MTJ device”), which is the most important part of the MRAM. As shown in Fig. 8(A), a MTJ device comprises a tunnelling junction structure in which a tunnel barrier (to be hereafter also referred to as a “barrier layer”) made of an oxide is sandwiched between a first and a second electrode made of a ferromagnetic metal. The tunnel barrier layer comprises an amorphous Al-O layer (see Non-Patent Document 1). As shown in Fig. 8(A), in the case of parallel magnetization alignment where the directions of magnetizations of the first and second ferromagnetic electrodes are aligned parallel, the electric resistance of the device with respect to the direction normal to the interfaces of the tunneling junction structure decreases. On the other hand, in the case of antiparallel magnetization alignment where the directions of magnetizations of the first and second ferromagnetic electrodes are aligned antiparallel as shown in Fig. 8(B), the electric resistance with respect to the direction normal to the interfaces of the tunneling junction structure increases. The resistance value does not change in a

general state, so that information “1” or “0” can be stored depending on whether the resistance value is high or not. Since the parallel and antiparallel magnetization alignments can be stored in a non-volatile fashion, the device can be used as a non-volatile memory device.

**[0009]**Figs. 9(A)-(C) show an example of the basic structure of the MRAM. Fig. 9(A) shows a perspective view of the MRAM, and Fig. 9(B) schematically shows a circuit block diagram. Fig. 9(C) is a cross-section of an example of the structure of the MRAM. Referring to Fig. 9(A), in an MRAM, a word line WL and a bit line BL are disposed in an intersecting manner, with an MRAM cell disposed at each intersection. As shown in Fig. 9(B), the MRAM cell disposed at the intersection of a word line and a bit line comprises a MTJ device and a MOSFET directly connected to the MTJ device. Stored information can be read by reading the resistance value of the MTJ device that functions as a load resistance, using the MOSFET. The stored information can be rewritten by applying a magnetic field to the MTJ device, for example. As shown in Fig. 9(C), an MRAM memory cell comprises a MOSFET 100 including a source region 105 and a drain region 103 both formed inside a p-type Si substrate 101, and a gate electrode 111 formed on a channel region that is defined between the source and drain regions. The MRAM also comprises a MTJ device 117. The source region 105 is grounded, and the drain is connected to a bit line BL via the MTJ device. A word line WL is connected to the gate electrode 111 in a region that is not shown.

**[0010]**Thus, a single non-volatile MRAM memory cell can be formed by a single MOSFET 100 and a single MTJ device 117. The MRAMs are therefore suitable where high levels of integration are required.

[0011]Non-Patent Document 1: D. Wang, et al.: Science 294 (2001) 1488.

[0012]SUMMARY OF THE INVENTION

[0013]Although there are prospects for achieving MRAMs with capacities on the order of 64Mbits based on the current technologies, the characteristics of the MTJ device, which is the heart of MRAM, needs to be improved if higher levels of integration are to be achieved. In particular, in order to increase the output voltage of the MTJ device, the magnetoresistance must be increased and the bias voltage characteristics must be improved. Fig. 10 illustrates how the magnetoresistance in a ~~relatedconventional~~ MTJ device using an amorphous Al-O as the tunnel barrier changes as a function of the bias voltage (L1). As shown, in the ~~relatedconventional~~ MTJ device, the magnetoresistance is small and, notably, it tends to drastically decrease upon application of bias voltage. With such characteristics, the output voltage when operation margins are taken into consideration is too small for the device to be employed for an actual memory device. Specifically, the magnetoresistance of the current MTJ device is small at approximately 70%, and the output voltage is also small at no more than 200 mV, which is substantially half the output voltage of a DRAM. This has resulted in the problem that as the level of integration increases, signals are increasingly lost in noise and cannot be read.

[0014]It is an object of the invention to increase the output voltage of a MTJ device. It is another object of the invention to provide a memory device with a high magnetoresistance for stable operation.

**[0015]**In one aspect, the invention provides a magnetoresistive device comprising a magnetic tunnel junction structure comprising: a tunnel barrier layer; a first ferromagnetic material layer of the BCC structure formed on a first side of the tunnel barrier layer; and a second ferromagnetic material layer of the BCC structure formed on a second side of the tunnel barrier layer, wherein the tunnel barrier layer is formed by a single-crystal  $\text{MgO}_x$  (001) layer or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) layer in which the (001) crystal plane is preferentially oriented.

**[0016]**The invention further provides a magnetoresistive device comprising a magnetic tunnel junction structure comprising: a tunnel barrier layer comprising  $\text{MgO}$ (001); a first ferromagnetic material layer comprising  $\text{Fe}$ (001) formed on a first side of the tunnel barrier layer; and a second ferromagnetic material layer comprising  $\text{Fe}$ (001) formed on a second side of the tunnel barrier layer, wherein the  $\text{MgO}$  layer is formed by a single-crystalline  $\text{MgO}_x$  (001) layer or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) layer in which the (001) crystal plane is preferentially oriented. In a preferred embodiment, the band discontinuity value (the height of the tunnel barrier) between the bottom of the conduction band of the  $\text{MgO}$ (001) layer and the Fermi energy of the  $\text{Fe}$ (001) layer is smaller than an ideal value of a perfect single-crystal without defect. These features increase the magnetoresistance and thereby allow the output voltage of the MTJ device to be increased. By using any of the aforementioned MTJ devices as a load for a single transistor, a non-volatile memory can be formed.

**[0017]**In another aspect, the invention provides a method of manufacturing a magnetoresistive device comprising: preparing a substrate; depositing a first  $\text{Fe}$ (001) layer on the substrate; depositing a tunnel barrier layer on the first  $\text{Fe}$ (001) layer by electron beam evaporation under high vacuum, the tunnel barrier layer comprising a

single-crystalline  $\text{MgO}_x$  (001) or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) in which the (001) crystal plane is preferentially oriented; and forming a second Fe(001) layer on the tunnel barrier layer.

**[0018]** The invention furthermore provides a method of manufacturing a MTJ device comprising a first step of preparing a substrate comprising a single-crystalline  $\text{MgO}_x$ (001) or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) in which the (001) crystal plane is preferentially oriented, a second step of depositing a first Fe(001) layer on the substrate and performing an annealing process to make the surface flat, a third step of depositing a tunnel barrier layer on the first Fe(001) layer by electron beam evaporation, the tunnel barrier layer comprising a single-crystalline  $\text{MgO}_x$ (001) or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) in which the (001) crystal plane is preferentially oriented, and a fourth step of forming a second Fe(001) layer on the tunnel barrier layer. The method may further comprise the step of growing a seed layer between the first and the second steps, the seed layer comprising a single-crystalline  $\text{MgO}_x$ (001) or a poly-crystalline  $\text{MgO}_x$  ( $0 < x < 1$ ) in which the (001) crystal plane is preferentially oriented. The MgO layer may be deposited using a target with the value of x in  $\text{MgO}_x$  adjusted. The value of x in  $\text{MgO}_x$  may be adjusted in the step of forming the MgO.

**[0019]** In yet another aspect, the invention provides a magnetoresistive device comprising a magnetic tunnel junction structure comprising a tunnel barrier layer comprising MgO(001), a first ferromagnetic material layer comprising an amorphous magnetic alloy formed on a first side of the tunnel barrier layer, and a second ferromagnetic material layer comprising an amorphous magnetic alloy formed on a second side of the tunnel barrier layer, wherein the discontinuous value (the height of the tunnel barrier) between the bottom of the conduction band of the MgO(001) layer

and the Fermi energy of the first or the second ferromagnetic material layer comprising the amorphous magnetic alloy is lower than an ideal value of a perfect single-crystal with no defect.

## **[0020] BRIEF DESCRIPTION OF THE DRAWINGS**

**[0021]** Fig. 1(B) shows the structure of a MTJ device according to a first embodiment of the invention, and Fig. 1(A) shows the energy band structure of a ferromagnetic metal Fe(001), illustrating the  $E-E_F$  relationship with respect to the [001] direction of the momentum space.

**[0022]** Fig. 2(A) to Fig. 2(D) schematically show the process of manufacturing a MTJ device with a Fe(001)/MgO(001)/Fe(001) structure (to be hereafter referred to as a “Fe(001)/MgO(001)/Fe(001) MTJ device”) according to an embodiment of the invention.

**[0023]** Fig. 3(A) shows a RHEED image of a Fe(001) lower electrode (a first electrode), and Fig. 3(B) shows a RHEED image of a MgO(001) barrier layer.

**[0024]** Fig. 4 shows the results of observing the quadrupole mass spectra in the deposition chamber during the MgO evaporation.

**[0025]** Fig. 5 shows the film deposition rate dependency of the oxygen partial pressure during the MgO evaporation.

**[0026]** Fig. 6 shows typical magnetoresistance curves of the Fe(001)/MgO(001)/Fe(001) MTJ device.

[0027]Fig. 7(A) shows the bias voltage dependency of the MR ratio at room temperature, and Fig. 7(B) shows the output voltage  $V_{out}$  of the MTJ device (=bias voltage  $\times$  (Rap-Rp)/Rap).

[0028]Figs. 8(A) and 8(B) show the structure of the MTJ device and its operating principle.

[0029]Figs. 9(A)-(C) show an example of the basic structure of an MRAM, Fig. 9(A) showing a perspective view of the MRAM, Fig. 9(B) showing a schematic circuit diagram, and Fig. 9(C) showing a cross-sectional view of an example of its structure.

[0030]Fig. 10 shows how the magnetoresistance of a ~~related conventional~~ MTJ device using an amorphous Al-O as the tunnel barrier changes depending on the bias voltage.

[0031]Fig. 11 shows the structure of a MTJ device according to a variation of the invention, corresponding to Fig. 1(B).

#### [0032]DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0033]In the context of the present specification, because MgO has a cubic crystal structure (NaCl structure), the (001) plane, the (100) plane, and the (010) plane are all equivalent. The direction perpendicular to the film surface is herein considered to be the z-axis so that the film plane can be uniformly described as (001). Also in the context of the present specification, BCC structure, which the crystalline structure of ferromagnetic electrode layer, means body-centered cubic lattice structure. More specifically, BCC structure includes the BCC structure with no chemical ordering so-called A2-type structure, the BCC structure with chemical ordering such as B2-type

structre and L2<sub>1</sub>-type structure, and also the aforementioned structures with slight lattice distortion.

**[0034]** The term “ideal value” with regard to a perfect single-crystal without defect herein refers to a value that has been estimated from ultraviolet photoemission spectroscopy experiments (see W. Wulfhekel, et al.: Appl. Phys. Lett. 78 (2001) 509.). The term “ideal value” is used herein because the aforementioned state can be considered to be an upper limit value of the potential barrier height of the tunnel barrier of an ideal single-crystal MgO with hardly any oxygen vacancy defect or lattice defect.

**[0035]** Before describing the preferred embodiments of the invention, an analysis conducted by the inventors is discussed. The magnetoresistance (MR) ratio of a MTJ device can be expressed by the following equation:

**[0036]** 
$$\Delta R/R_p = (R_{ap} - R_p)/R_p$$

**[0037]** where  $R_p$  and  $R_{ap}$  indicate the tunnel junction resistance in the cases of parallel and antiparallel magnetization alignments, respectively, of two electrodes. According to the Jullire’s formula, the MR ratio at low bias voltage can be expressed by:

**[0038]** 
$$\text{MR ratio} = (R_{ap} - R_p)/R_p = 2P_1P_2/(1-P_1P_2), \text{ and}$$

**[0039]** 
$$P_\alpha = (D_\alpha \uparrow (E_F) - D_\alpha \downarrow (E_F))/(D_\alpha \uparrow (E_F) + D_\alpha \downarrow (E_F)),$$

**[0040]** where  $\alpha = 1, 2$  (1)

**[0041]** In the above equations,  $P\alpha$  is the spin polarization of an electrode, and  $D\alpha \uparrow (E_F)$  and  $D\alpha \downarrow (E_F)$  are the density of state (DOS) at the Fermi energy ( $E_F$ ) of the majority-spin band and the minority-spin band, respectively. Since the spin polarization of ferromagnetic transition metals and alloys is approximately 0.5 or smaller, the Jullire's formula predicts a highest estimated MR ratio of about 70%.

**[0042]** Although the MR ratio of approximately 70% has been obtained at room temperature when a MTJ device was made using an amorphous Al-O tunnel barrier and polycrystalline electrodes, it has been difficult to obtain the output voltage of 200 mV, which is comparable to the output voltages of DRAMs, thereby preventing the realization of MRAM as mentioned above.

**[0043]** The inventors tried an approach to deposit a MTJ device in which the tunnel barrier comprises a single-crystal (001) of magnesium oxide (MgO) or a polycrystalline MgO in which the (001) crystal plane is preferentially oriented. It is the inventors' theory that, because magnesium oxide is a crystal (where the atoms are arranged in an orderly fashion), as opposed to the ~~related conventional~~ amorphous Al-O barrier, the electrons are not scattered and the coherent states of electrons are conserved during the tunneling process. Fig. 1(B) shows the MTJ device structure according to an embodiment of the invention. Fig. 1(A) shows the energy band structure of the ferromagnetic Fe(001), that is, the  $E-E_F$  relationship with respect to the [001] direction of the momentum space. As shown in Fig. 1(B), the MTJ device structure of the present embodiment comprises a first Fe (001) layer 1, a second Fe (001) layer 5, and a single-crystalline  $MgO_x$  (001) layer 3 or a polycrystalline  $MgO_x$  ( $0 < x < 1$ ) layer 3 sandwiched therebetween, the polycrystalline layer having the (001) crystal plane preferentially oriented therein. According to the aforementioned

Jullire's model, assuming that the momentum of the conduction electrons is preserved in the tunneling process, the tunneling current that passes through MgO would be dominated by those electrons with wave vector  $k_z$  in the direction perpendicular to the tunnel barrier (normal to the junction interfaces). In accordance with the energy band diagram shown in Fig. 1(A) of Fe in the [001] ( $\Gamma$ -H) direction, the density of state (DOS) at the Fermi energy  $E_F$  does not exhibit a very high spin polarization due to the fact that the sub-bands of the majority-spin and the minority-spin have states at the Fermi energy  $E_F$ . However, in case the coherent states of electrons are conserved in the tunneling process, only those conduction electrons that have totally symmetrical wave functions with respect to the axis perpendicular to the barrier would be coupled with the states in the barrier region and come to have a finite tunneling probability. The  $\Delta_1$  band in the Fe(001) electrode has such totally symmetric wave functions. As shown in Fig. 1(A), the majority spin  $\Delta_1$  band (solid line) has states at the Fermi energy  $E_F$ , whereas the minority spin  $\Delta_1$  band (broken line) does not have state at the Fermi energy  $E_F$ . Because of such half-metallic characteristics of the Fe  $\Delta_1$  band, there is the possibility that a very high MR ratio can be obtained in a coherent spin polarized tunneling. Since in an epitaxial (single-crystal, or (001) oriented polycrystal) MTJ device the scattering of electrons is suppressed during the tunneling process, an epitaxial MTJ device is thought to be ideal for realizing the aforementioned coherent tunneling.

**[0044]**In the following, a MTJ device according to a first embodiment of the invention and a method of manufacturing the same will be described with reference to the drawings. Figs. 2(A) to 2(D) schematically show the method of manufacturing the MTJ device having the Fe (001)/MgO(001)/Fe(001) structure according to the embodiment (to be hereafter referred to as a "Fe(001)/MgO(001)/Fe(001) MTJ

device”). Fe(001) refers to a ferromagnetic material with the BCC structure. First, a single-crystal MgO(001) substrate 11 was prepared. In order to improve the morphology of the surface of the single-crystal MgO(001) substrate 11, a MgO(001) seed layer 15 was grown by the molecular beam epitaxy (MBE) method. This was subsequently followed by the growth of an epitaxial Fe(001) lower electrode (first electrode) 17 with the thickness of 50 nm on the MgO(001) seed layer 15 at room temperature, as shown in Fig. 1(B), and then annealing was performed at 350°C under ultrahigh vacuum ( $2 \times 10^{-8}$  Pa). Electron-beam evaporation conditions included an acceleration voltage of 8 kV, a growth rate of 0.02 nm/sec, and the growth temperature of room temperature (about 293K). The source material of the electron-beam evaporation was MgO of the stoichiometric composition (the ratio of Mg to O being 1:1), the distance between the source and the substrate was 40 cm, the base vacuum pressure was  $1 \times 10^{-8}$  Pa, and the O<sub>2</sub> partial pressure was  $1 \times 10^{-6}$  Pa. Alternatively, a source with oxygen vacancy defects may be used instead of the MgO of the stoichiometric composition (the ratio of Mg to O is 1:1).

**[0045]** Fig. 3(A) shows a RHEED image of the Fe(001) lower electrode (a first electrode). The image shows that the Fe(001) lower electrode (first electrode) 17 possesses a good crystallinity and flatness. Thereafter, a MgO(001) barrier layer 21 with the thickness of 2 nm was epitaxially grown on the Fe(001) lower electrode (first electrode) at room temperature, also using the MgO electron-beam evaporation method. Fig. 3(B) shows a RHEED image of the MgO(001) barrier layer 21. The image shows that the MgO(001) barrier layer 21 also possesses a good crystallinity and flatness.

[0046] As shown in Fig. 2(D), a Fe(001) upper electrode (a second electrode) 23 with the thickness of 10 nm was formed on the MgO(001) barrier layer 21 at room temperature. This was successively followed by the deposition of a Co layer 25 with the thickness of 10 nm on the Fe(001) upper electrode (second electrode) 23. The Co layer 25 is provided to increase the coercive force of the upper electrode 23 so as to realize the antiparallel magnetization alignment. The thus prepared sample was then processed by microfabrication techniques to obtain the Fe(001)/MgO(001)/Fe(001) MTJ device.

[0047] The aforementioned MgO evaporation using an electron beam involved the formation of a film under ultrahigh vacuum of  $10^{-9}$  Torr. It can be seen that in this method, the film, even when formed on a glass substrate to the thickness of 300 nm, was colorless and transparent, showing that a good crystal film was formed. Fig. 4 shows the results of observing the quadrupole mass spectra in the deposition chamber during the MgO growth. The results show that the partial pressures regarding the spectrum P1 of O and the spectrum P2 of O<sub>2</sub> are high. Fig. 5 shows the film deposition rate dependency of the oxygen partial pressure during MgO evaporation. It will be seen from the figure that the oxygen partial pressure itself is high, and that the oxygen partial pressure increases as the deposition rate increases. These results indicate the separation of oxygen from MgO during the deposition of MgO. Since the separated oxygen is pumped out of the deposition chamber using vacuum pumps, there is the possibility that there are oxygen vacancy defects such as MgO<sub>x</sub> ( $0.9 < x < 1$ ). When there are oxygen vacancy defects, the potential barrier height of the MgO tunnel barrier is thought to decrease (such as in the range of 0.10 to 0.85 eV; more specifically, 0.2 to 0.5 eV), which is thought to result in an increase in the tunneling current. In the case of a typical Al-O tunnel barrier, the height of the tunnel barrier

with respect to Fe(001) electrodes is considered to be 0.7 to 2.5 eV. An ideal tunnel barrier height of a MgO crystal is 3.6 eV, and experimental values of 0.9 to 3.7 eV have been obtained. Using the method according to the present embodiment of the invention, a tunnel barrier height of approximately 0.3 eV is expected, indicating that the resistance of the tunnel barrier can be lowered. However, it should be noted that other factors, such as the influence of the aforementioned coherent tunneling, might also be involved. The value of  $x$  in  $\text{MgO}_x$  due to oxygen vacancy defects is such that  $0.98 < x < 1$ , and more preferably  $0.99 < x < 1$ . These are the ranges such that the sole presence of Mg is excluded and the characteristics of MgO can be basically maintained.

**[0048]** The aforementioned tunnel barrier height  $\phi$  was determined by fitting the electric conductance characteristics of the MTJ device (the relationship between tunnel current density  $J$  and bias voltage  $V$ ) onto the Simmons' formula (Equation (20) in a non-patent document by J. G. Simmons: J. Appl. Phys. 34, pp. 1793-1803 (1963)) based on the WKB approximation, using the least squares method. The fitting was performed using the free electron mass ( $m = 9.11 \times 10^{-31}$  kg) as the electron's effective mass. When a bias voltage  $V$  (which is normally on the order of 500 mV to 1000 mV) is applied until non-linearity appears in the  $J$ - $V$  characteristics, the height  $\phi$  of the tunnel barrier and the effective thickness  $\Delta s$  of the tunnel barrier can be simultaneously determined by fitting the  $J$ - $V$  characteristics using the Simmons' formula.

**[0049]** The effective thickness  $\Delta s$  of the tunnel barrier was determined to be smaller than the thickness of the actual MgO(001) tunnel barrier layer ( $t_{\text{MgO}}$ ) determined from a cross-sectional transmission electron microscope image of the MTJ device by

approximately 0.5 nm. This is the result of the effective thickness  $\Delta s$  of the tunnel barrier having been reduced from the actual MgO(001) layer thickness by the effect of the image potential produced at the interface between the MgO(001) layer and the alloy layer consisting mainly of Fe and Co.

**[0050]** It is noted that, in the event that  $t_{\text{MgO}}$  can be accurately determined using the cross-sectional transmission electron microscope (TEM) image, the height  $\phi$  of the tunnel barrier can be more simply determined by the following technique. Namely, when the bias voltage  $V$  applied to the MTJ device is small (normally 100 mV or smaller), the tunnel current density  $J$  is proportional to the bias voltage  $V$ , such that the J-V characteristics become linear. In such a low-bias voltage region, the Simmons' formula can be described as follows:

$$\mathbf{[0051]} J = [(2m\phi)^{1/2}/\Delta s](e/h)^2 \times \exp[-(4\pi\Delta s/h) \times (2m\phi)^{1/2}] \times V \quad (2)$$

**[0052]** where  $m$  is the mass of the free electron ( $9.11 \times 10^{-31}$  kg),  $e$  is the elementary electric charge ( $1.60 \times 10^{-19}$  C), and  $h$  is the Planck's constant ( $6.63 \times 10^{-34}$  J·s). The effective thickness of the tunnel barrier  $\Delta s$  is approximately  $t_{\text{MgO}} - 0.5$  nm. By fitting the J-V characteristics of the MTJ device in the low-bias voltage region onto Equation (2), the height  $\phi$  of the tunnel barrier can be simply and yet accurately estimated.

**[0053]** Fig. 6 shows a typical magnetoresistance curve of the Fe(001)/MgO(001)/Fe(001) MTJ device produced by the above-described method. The MR ratio is 146% at the measurement temperature of 20K and 88% at the measurement temperature of 293K. These values represent the highest MR ratios that have so far been obtained at room temperature. Such high MR ratios cannot be explained by the spin polarization of the Fe(001) electrode and is thought rather to be

related to a coherent spin-polarized tunneling. When 160 prototype MTJ devices were made, the variations regarding the MR ratio and tunneling resistance value were not more than 20%. The yield of the MTJ devices was 90% or more at the laboratory stage. These high values suggest the effectiveness of the approach of the invention. The resistance-area (RA) product of the MTJ device was on the order of a few  $\text{k}\Omega\mu\text{m}^2$ , which is suitable for MRAM.

[0054] Fig. 7(a) shows the bias voltage dependency of the MR ratio at room temperature. It will be seen that the bias voltage dependency of the MR ratio is fairly small. Although the characteristics are asymmetric, the voltage  $V_{\text{half}}$  at which the MR ratio is reduced in half of the zero-bias value is 1250 mV, which is a very high value. In this connection, it is noted that the voltage  $V_{\text{half}}$  at which the MR ratio is reduced in half of the zero-bias value in the ~~related conventional~~ MTJs with Al-O tunnel barrier is 300 to 600 mV. Fig. 7(b) shows the output voltage  $V_{\text{out}}$  of the MTJ device (=bias voltage  $\times$  (Rap – Rp)/Rap). The maximum value of the output voltage  $V_{\text{out}}$  is 380 mV with a positive bias. This value is about twice as large as that (a little less than 200 mV) in the case of the Al-O barrier. These high values in terms of both MR ratio and output voltage suggest the effectiveness of the technique according to the present embodiment.

[0055] Although in the above-described embodiment Fe(001) of BCC was employed, an Fe alloy of BCC, such as an Fe-Co alloy, Fe-Ni alloy, or Fe-Pt alloy, may be used instead. Alternatively, a layer of Co or Ni with the thickness of one or several monoatomic layers may be inserted between the electrode layer and the MgO(001) layer.

**[0056]** Hereafter, a MTJ device according to a second embodiment of the invention and a method of manufacturing the same will be described. In the method of manufacturing a Fe(001)/MgO(001)/Fe(001) MTJ device according to the present embodiment, MgO(001) is initially deposited in a poly-crystalline or amorphous state by sputtering or the like, and then an annealing process is performed such that a poly-crystal in which the (001) crystal plane is preferentially oriented or a single-crystal is obtained. The sputtering conditions were such that, for example, the temperature was room temperature (293K), a 2-inch  $\phi$  MgO was used as a target, and sputtering was conducted in an Ar atmosphere. The acceleration power was 200 W and the growth rate was 0.008 nm/s. Because MgO that is deposited under these conditions is in an amorphous state, a crystallized MgO was obtained by increasing the temperature to 300°C from room temperature and maintaining that temperature for a certain duration of time.

**[0057]** Oxygen vacancy defects may be introduced by a method whereby oxygen vacancy defects is produced during growth, a method whereby oxygen vacancy defects is introduced subsequently, or a method whereby a state with oxygen vacancy defects is subjected to an oxygen plasma process or natural oxidation so as to achieve a certain oxygen deficit level.

**[0058]** As described above, in accordance with the MTJ device technology of the present embodiment, an annealing process is carried out for crystallization after an amorphous MgO has been deposited by sputtering, thereby eliminating the need for large-sized equipment.

**[0059]** Hereafter, a MTJ device according to a variation of the embodiments of the invention will be described with reference to the drawings. Fig. 11 shows the

structure of the MTJ device according to the variation, which corresponds to Fig. 1(B). As shown in Fig. 11, the MTJ device of the variation is characterized in that, as in the MTJ device of the above-described embodiments, the electrodes disposed on either side of a single-crystal  $\text{MgO}_x(001)$  layer 503 or an oxygen-deficit poly-crystal  $\text{MgO}_x$  ( $0 < x < 1$ ) in which the (001) crystal plane is preferentially oriented comprises an amorphous ferromagnetic alloy, such as CoFeB layers 501 and 505. The amorphous ferromagnetic alloy can be formed by evaporation or sputtering, for example. The resultant characteristics are substantially identical to those of the first embodiment.

**[0060]** As the amorphous magnetic alloy, FeCoB, FeCoBSi, FeCoBP, FeZr, and CoZr may be used, for example. Although an anneal process after the preparation of the MTJ device might cause the amorphous magnetic alloy in the electrode layers to be partially or entirely crystallized, this would not lead to a significant deterioration of the MR ratio. Thus, such a crystallized amorphous magnetic alloy may be used in the electrode layers.

**[0061]** While the MTJ device according to various embodiments of the invention has been described, it should be apparent to those skilled in the art that the invention is not limited to those specific embodiments and various other modifications, improvements and combinations are possible. For example, the height of the tunnel barrier may be adjusted by doping Ca or Sr, instead of introducing an oxygen vacancy defects to the MgO layer. Further, while the MgO layer has been described to be deposited by electron-beam evaporation or sputtering, it should be obvious that other deposition methods are also possible. The term “high vacuum” refers to values on the order of no more than  $10^{-6}$  Pa in the case where oxygen is not introduced, for

example. In the case where oxygen is introduced, the term refers to values on the order of  $10^{-4}$  Pa.

[0062] In accordance with the invention, a larger magnetoresistance than in the ~~related conventional~~ MTJ device can be obtained, and the output voltage of the MTJ device can be increased. At the same time, the resistance value of the MTJ device can be reduced so that it is optimized for MRAM. The invention thus enables the level of integration of MRAM using the MTJ device to be readily increased. In accordance with the invention, the output voltage value of the MRAM roughly doubles over ~~related prior~~ art, making the MTJ device of the invention suitable for very large scale integrated MRAMs of gigabit class.

## Abstract of the Disclosure

The output voltage of an MRAM is increased by means of an Fe(001)/MgO(001)/Fe(001) MTJ device, which is formed by microfabrication of a sample prepared as follows: A single-crystalline MgO (001) substrate is prepared. An epitaxial Fe(001) lower electrode (a first electrode) is grown on a MgO(001) seed layer at room temperature, followed by annealing under ultrahigh vacuum. A MgO(001) barrier layer is epitaxially formed on the Fe(001) lower electrode (the first electrode) at room temperature, using a MgO electron-beam evaporation. A Fe(001) upper electrode (a second electrode) is then formed on the MgO(001) barrier layer at room temperature. This is successively followed by the deposition of a Co layer on the Fe(001) upper electrode (the second electrode). The Co layer is provided so as to increase the coercive force of the upper electrode in order to realize an antiparallel magnetization alignment.

| Electronic Acknowledgement Receipt   |                                                                        |
|--------------------------------------|------------------------------------------------------------------------|
| EFS ID:                              | 48550970                                                               |
| Application Number:                  | 18232576                                                               |
| International Application Number:    |                                                                        |
| Confirmation Number:                 | 1021                                                                   |
| Title of Invention:                  | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM) |
| First Named Inventor/Applicant Name: | Shinji YUASA                                                           |
| Customer Number:                     | 61650                                                                  |
| Filer:                               | Brian S. Myers/Oleksandra Onishchuk                                    |
| Filer Authorized By:                 | Brian S. Myers                                                         |
| Attorney Docket Number:              | IBTH 13318Aa                                                           |
| Receipt Date:                        | 07-SEP-2023                                                            |
| Filing Date:                         | 10-AUG-2023                                                            |
| Time Stamp:                          | 11:53:07                                                               |
| Application Type:                    | Utility under 35 USC 111(a)                                            |

| Payment information:   |                                                   |                                            |                                          |                  |                  |
|------------------------|---------------------------------------------------|--------------------------------------------|------------------------------------------|------------------|------------------|
| Submitted with Payment |                                                   |                                            | no                                       |                  |                  |
| File Listing:          |                                                   |                                            |                                          |                  |                  |
| Document Number        | Document Description                              | File Name                                  | File Size(Bytes)/ Message Digest         | Multi Part /.zip | Pages (if appl.) |
| 1                      | Applicant Response to Pre-Exam Formalities Notice | ibth_13318Aa_20230822_ntc_corr_resp_r1.pdf | 102714                                   | no               | 2                |
|                        |                                                   |                                            | 7a8cc97619807019ea593ead55a2757104c819dc |                  |                  |
| Warnings:              |                                                   |                                            |                                          |                  |                  |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |                                                              |                                          |    |    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------------------------------------------------------|------------------------------------------|----|----|
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                                                              |                                          |    |    |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Specification | ibtn_13318Aa_20230822_ntc_corr_substitute_spec_clean.pdf     | 130518                                   | no | 20 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |                                                              | e133e44c6785d5b9536bfb77b160c5a1831e36c4 |    |    |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                                                              |                                          |    |    |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                                                              |                                          |    |    |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Specification | ibtn_13318Aa_20230822_ntc_corr_substitute_spec_marked_r1.pdf | 134291                                   | no | 20 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |                                                              | a91c017906787eb575298fbedfd9c49a71ac8d45 |    |    |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                                                              |                                          |    |    |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                                                              |                                          |    |    |
| <b>Total Files Size (in bytes):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                                                              | 367523                                   |    |    |
| <p><b>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</b></p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b><br/> <b>If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</b></p> <p><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b><br/> <b>If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</b></p> <p><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b><br/> <b>If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</b></p> |               |                                                              |                                          |    |    |



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

| APPLICATION<br>NUMBER | FILING or<br>371(c) DATE | GRP ART<br>UNIT | FIL FEE REC'D | ATTY. DOCKET NO | TOT CLAIMS | IND CLAIMS |
|-----------------------|--------------------------|-----------------|---------------|-----------------|------------|------------|
| 18/232,576            | 08/10/2023               |                 | 1820          | IBTH 13318Aa    | 20         | 3          |

61650  
MYERS WOLIN, LLC  
100 SOUTH JEFFERSON ROAD  
SUITE 202  
WHIPPANY, NJ 07981-1009

**CONFIRMATION NO. 1021**  
**UPDATED FILING RECEIPT**



0000000061754988

Date Mailed: 09/12/2023

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

**Please verify the accuracy of the data presented on this receipt.** If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

**Inventor(s)**

Shinji YUASA, Ibaraki, JAPAN;

**Applicant(s)**

Godo Kaisha IP Bridge 1, Tokyo, JAPAN;

**Assignment For Published Patent Application**

Godo Kaisha IP Bridge 1, Chiyoda-ku, Tokyo, JAPAN

**Power of Attorney:** The patent practitioners associated with Customer Number 61650

**Domestic Priority data as claimed by applicant**

This application is a CON of 18/219,320 07/07/2023  
which is a CON of 17/560,922 12/23/2021 PAT 11,737,372  
which is a CON of 16/862,598 04/30/2020 PAT 11,233,193  
which is a CON of 16/443,875 06/18/2019 PAT 10,680,167  
which is a CON of 15/428,842 02/09/2017 PAT 10,367,138  
which is a CON of 14/837,558 08/27/2015 PAT 9,608,198  
which is a CON of 13/767,290 02/14/2013 PAT 9,123,463  
which is a CON of 13/400,340 02/20/2012 PAT 8,405,134  
which is a CON of 12/923,643 09/30/2010 PAT 8,319,263  
which is a CON of 10/591,947 09/08/2006 PAT 7,884,403  
which is a 371 of PCT/JP2005/004720 03/10/2005

Foreign Applications (You may be eligible to benefit from the Patent Prosecution Highway program at the USPTO. Please see <http://www.uspto.gov> for more information.)

JAPAN 2004-071186 03/12/2004 No Access Code Provided  
JAPAN 2004-313350 10/28/2004 No Access Code Provided

**Permission to Access Application via Priority Document Exchange:** Yes

**Permission to Access Search Results:** Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

**If Required, Foreign Filing License Granted:** 08/21/2023

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 18/232,576**

**Projected Publication Date:** 12/21/2023

**Non-Publication Request:** No

**Early Publication Request:** No

**Title**

METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM)

**Preliminary Class**

**Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications:** No

## **PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES**

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign

page 2 of 4

patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

## **LICENSE FOR FOREIGN FILING UNDER**

### **Title 35, United States Code, Section 184**

### **Title 37, Code of Federal Regulations, 5.11 & 5.15**

#### **GRANTED**

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

#### **NOT GRANTED**

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

## ***SelectUSA***

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit <http://www.SelectUSA.gov> or call +1-202-482-6800.

# PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number  
18/232,576

## APPLICATION AS FILED - PART I

| (Column 1)                                                                |                                                                                                                                                                                                                               | (Column 2)   | SMALL ENTITY |         | OR | OTHER THAN SMALL ENTITY |         |
|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------|---------|----|-------------------------|---------|
| FOR                                                                       | NUMBER FILED                                                                                                                                                                                                                  | NUMBER EXTRA | RATE(\$)     | FEE(\$) |    | RATE(\$)                | FEE(\$) |
| BASIC FEE<br>(37 CFR 1.16(a), (b), or (c))                                | N/A                                                                                                                                                                                                                           | N/A          | N/A          |         |    | N/A                     | 320     |
| SEARCH FEE<br>(37 CFR 1.16(k), (l), or (m))                               | N/A                                                                                                                                                                                                                           | N/A          | N/A          |         |    | N/A                     | 700     |
| EXAMINATION FEE<br>(37 CFR 1.16(o), (p), or (q))                          | N/A                                                                                                                                                                                                                           | N/A          | N/A          |         |    | N/A                     | 800     |
| TOTAL CLAIMS<br>(37 CFR 1.16(i))                                          | 20 minus 20 =                                                                                                                                                                                                                 | *            |              |         | OR | x =                     | 0       |
| INDEPENDENT CLAIMS<br>(37 CFR 1.16(h))                                    | 3 minus 3 =                                                                                                                                                                                                                   | *            |              |         |    | x =                     | 0       |
| APPLICATION SIZE FEE<br>(37 CFR 1.16(s))                                  | If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s). |              |              |         |    |                         | 0       |
| MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))                         |                                                                                                                                                                                                                               |              |              |         |    |                         | 0       |
| * If the difference in column 1 is less than zero, enter "0" in column 2. |                                                                                                                                                                                                                               |              | TOTAL        |         |    | TOTAL                   | 1820    |

## APPLICATION AS AMENDED - PART II

|             | (Column 1)                                                      |                                  | (Column 2) | (Column 3)                         | SMALL ENTITY       |          | OR | OTHER THAN SMALL ENTITY |          |                    |
|-------------|-----------------------------------------------------------------|----------------------------------|------------|------------------------------------|--------------------|----------|----|-------------------------|----------|--------------------|
|             |                                                                 | CLAIMS REMAINING AFTER AMENDMENT |            | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA      | RATE(\$) |    | ADDITIONAL FEE(\$)      | RATE(\$) | ADDITIONAL FEE(\$) |
| AMENDMENT A | Total<br>(37 CFR 1.16(i))                                       | *                                | Minus      | **                                 | =                  | x =      |    | OR                      | x =      |                    |
|             | Independent<br>(37 CFR 1.16(h))                                 | *                                | Minus      | ***                                | =                  | x =      |    | OR                      | x =      |                    |
|             | Application Size Fee (37 CFR 1.16(s))                           |                                  |            |                                    |                    |          |    | OR                      |          |                    |
|             | FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) |                                  |            |                                    |                    |          |    | OR                      |          |                    |
|             |                                                                 |                                  |            |                                    | TOTAL<br>ADD'L FEE |          | OR | TOTAL<br>ADD'L FEE      |          |                    |
| AMENDMENT B | Total<br>(37 CFR 1.16(i))                                       | *                                | Minus      | **                                 | =                  | x =      |    | OR                      | x =      |                    |
|             | Independent<br>(37 CFR 1.16(h))                                 | *                                | Minus      | ***                                | =                  | x =      |    | OR                      | x =      |                    |
|             | Application Size Fee (37 CFR 1.16(s))                           |                                  |            |                                    |                    |          |    | OR                      |          |                    |
|             | FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) |                                  |            |                                    |                    |          |    | OR                      |          |                    |
|             |                                                                 |                                  |            |                                    | TOTAL<br>ADD'L FEE |          | OR | TOTAL<br>ADD'L FEE      |          |                    |

\* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

\*\* If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

\*\*\* If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
**United States Patent and Trademark Office**  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

| APPLICATION NO.          | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|--------------------------|-------------|----------------------|---------------------|------------------|
| 18/232,576               | 08/10/2023  | Shinji YUASA         | IBTH 13318Aa        | 1021             |
| 61650                    | 7590        | 09/19/2023           | EXAMINER            |                  |
| MYERS WOLIN, LLC         |             |                      | CENTRAL, DOCKET     |                  |
| 100 SOUTH JEFFERSON ROAD |             |                      |                     |                  |
| SUITE 202                |             |                      |                     |                  |
| WHIPPANY, NJ 07981-1009  |             |                      |                     |                  |
|                          |             |                      | ART UNIT            | PAPER NUMBER     |
|                          |             |                      | 2897                |                  |
|                          |             |                      | NOTIFICATION DATE   | DELIVERY MODE    |
|                          |             |                      | 09/19/2023          | ELECTRONIC       |

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patent@myerswoln.com

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                      |                                      |                                |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|--------------------------------------|--------------------------------|
| <b><i>Decision Granting Request for Prioritized Examination (Track I)</i></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Application No.</b><br>18/232,576 | <b>Applicant(s)</b><br>YUASA, Shinji |                                |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Examiner</b><br>JoAnne L Burke    | <b>Art Unit</b><br>OPET              | <b>AIA (FITF) Status</b><br>No |
| <p>1. THE REQUEST FILED <u>10 August 2023</u> IS <b>GRANTED</b> .</p> <p>The above-identified application has met the requirements for prioritized examination</p> <p>A. <input checked="" type="checkbox"/> for an original nonprovisional application (Track I).</p> <p>B. <input type="checkbox"/> for an application undergoing continued examination (RCE).</p> <p>2. <b>The above-identified application will undergo prioritized examination.</b> The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:</p> <p>A. filing a <b><u>petition for extension of time</u></b> to extend the time period for filing a reply;</p> <p>B. filing an <b><u>amendment to amend the application to contain more than four independent claims, more than thirty total claims</u></b>, or a multiple dependent claim;</p> <p>C. filing a <b><u>request for continued examination</u></b> ;</p> <p>D. filing a notice of appeal;</p> <p>E. filing a request for suspension of action;</p> <p>F. mailing of a notice of allowance;</p> <p>G. mailing of a final Office action;</p> <p>H. completion of examination as defined in 37 CFR 41.102; or</p> <p>I. abandonment of the application.</p> <p>Telephone inquiries with regard to this decision should be directed to JoAnne Burke at (571)272-4584. In his/her absence, calls may be directed to Petition Help Desk at (571) 272-3282.</p> |                                      |                                      |                                |
| /JOANNE L BURKE/<br>Lead Paralegal Specialist, OPET                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                      |                                      |                                |

|                                                                                                                    |                                              |                                                                 |
|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------------------------|
| <b><i>Index of Claims</i></b><br> | <b>Application/Control No.</b><br>18/232,576 | <b>Applicant(s)/Patent Under Reexamination</b><br>YUASA, Shinji |
|                                                                                                                    | <b>Examiner</b><br>ALONZO CHAMBLISS          | <b>Art Unit</b><br>2897                                         |

|   |                 |   |                   |   |                     |   |                 |
|---|-----------------|---|-------------------|---|---------------------|---|-----------------|
| ✓ | <b>Rejected</b> | - | <b>Cancelled</b>  | N | <b>Non-Elected</b>  | A | <b>Appeal</b>   |
| = | <b>Allowed</b>  | ÷ | <b>Restricted</b> | I | <b>Interference</b> | O | <b>Objected</b> |

| CLAIMS                                                                                                                                                                            |          |            |  |  |  |  |  |  |  |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------------|--|--|--|--|--|--|--|--|
| <input type="checkbox"/> Claims renumbered in the same order as presented by applicant <input type="checkbox"/> CPA <input type="checkbox"/> T.D. <input type="checkbox"/> R.1.47 |          |            |  |  |  |  |  |  |  |  |
| CLAIM                                                                                                                                                                             |          | DATE       |  |  |  |  |  |  |  |  |
| Final                                                                                                                                                                             | Original | 10/01/2023 |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 1        | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 2        | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 3        | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 4        | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 5        | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 6        | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 7        | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 8        | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 9        | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 10       | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 11       | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 12       | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 13       | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 14       | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 15       | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 16       | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 17       | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 18       | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 19       | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 20       | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 21       | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   | 22       | ✓          |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   |          |            |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   |          |            |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   |          |            |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                   |          |            |  |  |  |  |  |  |  |  |

|                                                                                                                 |                                              |                                                                 |
|-----------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------------------------|
| <b><i>Search Notes</i></b><br> | <b>Application/Control No.</b><br>18/232,576 | <b>Applicant(s)/Patent Under Reexamination</b><br>YUASA, Shinji |
|                                                                                                                 | <b>Examiner</b><br>ALONZO CHAMBLISS          | <b>Art Unit</b><br>2897                                         |

|                                                                                                                               |             |                 |
|-------------------------------------------------------------------------------------------------------------------------------|-------------|-----------------|
| <b>CPC - Searched*</b>                                                                                                        |             |                 |
| <b>Symbol</b>                                                                                                                 | <b>Date</b> | <b>Examiner</b> |
| H10B61/00, 53/30, 61/22; H01F10/132, 10/3254; G11C11/15, 11/16, 11/161; H10N 50/85, 50/01, 50/80, 50/10; H01L28/55; B82Y25/00 | 10/01/2023  | AC              |

|                                         |             |                 |
|-----------------------------------------|-------------|-----------------|
| <b>CPC Combination Sets - Searched*</b> |             |                 |
| <b>Symbol</b>                           | <b>Date</b> | <b>Examiner</b> |
|                                         |             |                 |

|                                      |                 |             |                 |
|--------------------------------------|-----------------|-------------|-----------------|
| <b>US Classification - Searched*</b> |                 |             |                 |
| <b>Class</b>                         | <b>Subclass</b> | <b>Date</b> | <b>Examiner</b> |
|                                      |                 |             |                 |

\* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

|                                                 |             |                 |
|-------------------------------------------------|-------------|-----------------|
| <b>Search Notes</b>                             |             |                 |
| <b>Search Notes</b>                             | <b>Date</b> | <b>Examiner</b> |
| East text search only - see attached printout   | 10/01/2023  | AC              |
| Ip.com text search only - see attached printout | 10/01/2023  | AC              |

|                            |                              |             |                 |
|----------------------------|------------------------------|-------------|-----------------|
| <b>Interference Search</b> |                              |             |                 |
| <b>US Class/CPC Symbol</b> | <b>US Subclass/CPC Group</b> | <b>Date</b> | <b>Examiner</b> |
|                            |                              |             |                 |

|  |  |
|--|--|
|  |  |
|--|--|

Bibliographic Data

Application No: 18/232,576

Foreign Priority claimed: ☒ Yes ☐ No

35 USC 119 (a-d) conditions met: ☒ Yes ☐ No ☐ Met After Allowance

Verified and Acknowledged: 

/ALONZO CHAMBLISS/

Examiner's Signature

Initials

Title: 

METHOD OF MANUFACTURING A MAGNETORESISTIVE  
RANDOM ACCESS MEMORY (MRAM)

| FILING or 371(c) DATE | CLASS | GROUP ART UNIT | ATTORNEY DOCKET NO. |
|-----------------------|-------|----------------|---------------------|
| 08/10/2023            | 257   | 2897           | IBTH 13318Aa        |
| RULE                  |       |                |                     |

APPLICANTS

Godo Kaisha IP Bridge 1,

INVENTORS

Shinji YUASA, Ibaraki, JAPAN

CONTINUING DATA

This application is a CON of 18219320 07/07/2023  
18219320 is a CON of 17560922 12/23/2021 PAT 11737372  
17560922 is a CON of 16862598 04/30/2020 PAT 11233193  
16862598 is a CON of 16443875 06/18/2019 PAT 10680167  
16443875 is a CON of 15428842 02/09/2017 PAT 10367138  
15428842 is a CON of 14837558 08/27/2015 PAT 9608198  
14837558 is a CON of 13767290 02/14/2013 PAT 9123463  
13767290 is a CON of 13400340 02/20/2012 PAT 8405134  
13400340 is a CON of 12923643 09/30/2010 PAT 8319263  
12923643 is a CON of 10591947 09/08/2006 PAT 7884403  
10591947 is a 371 of PCT/JP2005/004720 03/10/2005

FOREIGN APPLICATIONS

JAPAN JP2004-071186 03/12/2004  
JAPAN JP2004-313350 10/28/2004

IF REQUIRED, FOREIGN LICENSE GRANTED\*\*

08/21/2023

STATE OR COUNTRY

JAPAN

**ADDRESS**

MYERS WOLIN, LLC  
100 SOUTH JEFFERSON ROAD  
SUITE 202  
WHIPPANY, NJ 07981-1009  
UNITED STATES

**FILING FEE RECEIVED**

\$0

# PE2E SEARCH - Search History (Prior Art)

| Ref # | Hits | Search Query                                                                                                                                                                                                        | DBs                                                                                                                                                                                                                                                            | Default Operator | Plurals | British Equivalents | Time Stamp             |
|-------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------|---------------------|------------------------|
| L1    | 9    | ("11737372"<br>"11233193" "10680167"<br>"10367138" "9608198"<br>"9123463" "8405134"<br>"8319263"<br>"7884403").pn.                                                                                                  | (US-PGPUB; USPAT)                                                                                                                                                                                                                                              | OR               | ON      | ON                  | 2023/10/01<br>01:53 PM |
| L2    | 1    | ("20040109347").pn.                                                                                                                                                                                                 | (US-PGPUB; USPAT)                                                                                                                                                                                                                                              | OR               | ON      | ON                  | 2023/10/01<br>07:22 PM |
| L3    | 1    | ("11737372").pn.                                                                                                                                                                                                    | (US-PGPUB; USPAT)                                                                                                                                                                                                                                              | OR               | ON      | ON                  | 2023/10/01<br>07:23 PM |
| L4    | 1    | godo.as. AND (bottom<br>first) adj2 ferromagnetic<br>adj2 (layer film) AND<br>(second top) adj2<br>ferromagnetic adj2<br>(layer film) AND (MgO<br>magnesium adj2 oxide)<br>WITH barrier adj2 (layer<br>film)        | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB) | OR               | ON      | ON                  | 2023/10/01<br>10:12 PM |
| L5    | 75   | yuasa.in. AND (bottom<br>first) adj2 ferromagnetic<br>adj2 (layer film) AND<br>(second top) adj2<br>ferromagnetic adj2<br>(layer film) AND (MgO<br>magnesium adj2 oxide)<br>WITH barrier adj2 (layer<br>film)       | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB) | OR               | ON      | ON                  | 2023/10/01<br>10:14 PM |
| L6    | 454  | 257/\$.ccls. AND<br>(bottom first) adj2<br>ferromagnetic adj2<br>(layer film) AND<br>(second top) adj2<br>ferromagnetic adj2<br>(layer film) AND (MgO<br>magnesium adj2 oxide)<br>WITH barrier adj2 (layer<br>film) | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB) | OR               | ON      | ON                  | 2023/10/01<br>10:19 PM |
| L7    | 166  | 438/\$.ccls. AND<br>(bottom first) adj2<br>ferromagnetic adj2<br>(layer film) AND<br>(second top) adj2<br>ferromagnetic adj2<br>(layer film) AND (MgO<br>magnesium adj2 oxide)                                      | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,                                                                 | OR               | ON      | ON                  | 2023/10/01<br>10:19 PM |

|     |     |                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                |    |    |    |                     |
|-----|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|---------------------|
| L8  | 0   | WITH barrier adj2 (layer film)<br><br>361/\$.ccls. AND (bottom first) adj2 ferromagnetic adj2 (layer film) AND (second top) adj2 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) WITH barrier adj2 (layer film) | MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)<br><br>(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2023/10/01 10:19 PM |
| L9  | 481 | L6 L7                                                                                                                                                                                                                          | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                               | OR | ON | ON | 2023/10/01 10:20 PM |
| L10 | 469 | L9 AND ( (H10N50/10 OR H10N50/01 OR H10N50/85 OR H10N50/80 OR G11C11/161 OR G11C11/16 OR G11C11/15 OR B82Y25/00 OR H10B53/30 OR H10B61/22 OR H10B61/00 OR H01F10/3254 OR H01F10/132 OR H01L28/55).cpc.)                        | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                               | OR | ON | ON | 2023/10/01 10:29 PM |

## PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.



# Search History

## 18232576

Report Run Date: 2023-10-02 UTC

Searches: 1

Markers: 0

| Search # | Timestamp                            | Results    | Page |
|----------|--------------------------------------|------------|------|
| 1        | <a href="#">2023-10-02 02:30 UTC</a> | 11,016,626 | 3    |



## Content: Patent Publications (169)

US Patents | US Designs | US Applications | EPO Patents | EPO Applications | China Patents | China Applications | Japan Patents | Japan Applications | Korea Patents | Korea Applications | WIPO Applications | Argentina Patents | Argentina Applications | Brazil Patents | Brazil Applications | Canada Patents | Canada Applications | Chile Patents | Chile Applications | Colombia Applications | Costa Rica Applications | Cuba Patents | Cuba Applications | Dominican Republic Applications | Ecuador Patents | Ecuador Applications | El Salvador Applications | Guatemala Applications | Honduras Applications | Mexico Patents | Mexico Applications | Nicaragua Patents | Panama Applications | Peru Applications | Trinidad & Tobago Patents | Uruguay Applications | Austria Patents | Austria Applications | Belarus Patents | Belgium Patents | Belgium Applications | Bosnia & Herzegovina Patents | Bosnia & Herzegovina Applications | Bulgaria Patents | Bulgaria Applications | Croatia Patents | Croatia Applications | Czech Republic Patents | Czech Republic Applications | Czechoslovakia Patents | Czechoslovakia Applications | Denmark Patents | Denmark Applications | Estonia Patents | Estonia Applications | EUIPO Patents | Finland Patents | Finland Applications | France Patents | France Applications | Germany Patents | Germany Applications | Great Britain Patents | Great Britain Applications | Greece Patents | Greece Applications | Hungary Patents | Hungary Applications | Iceland Patents | Iceland Applications | Ireland Patents | Ireland Applications | Italy Patents | Italy Applications | Latvia Patents | Latvia Applications | Lithuania Patents | Lithuania Applications | Luxembourg Patents | Luxembourg Applications | Malta Patents | Monaco Patents | Montenegro Patents | Montenegro Applications | Netherlands Patents | Netherlands Applications | Norway Patents | Norway Applications | Poland Patents | Poland Applications | Portugal Patents | Portugal Applications | Republic of Moldova Patents | Republic of Moldova Applications | Romania Patents | Romania Applications | San Marino Patents | San Marino Applications | Serbia Patents | Serbia Applications | Slovakia Patents | Slovakia Applications | Slovenia Patents | Spain Patents | Spain Applications | Sweden Patents | Sweden Applications | Switzerland Patents | Switzerland Applications | Ukraine Patents | Yugoslavia/Serbia and Montenegro Patents | Yugoslavia/Serbia and Montenegro Applications | Armenia Patents | Australia Patents | Australia Applications | Cyprus Patents | Gulf Cooperation Council Patents | Hong Kong Patents | India Patents | India Applications | Indonesia Patents | Indonesia Applications | Israel Patents | Israel Applications | Jordan Patents | Jordan Applications | Kyrgyzstan Patents | Macao Applications | Malaysia Patents | Mongolia Patents | New Zealand Patents | Philippines Patents | Philippines Applications | Saudi Arabia Patents | Saudi Arabia Applications | Singapore Patents | Singapore Applications | Taiwan Patents | Taiwan Applications | Tajikistan Patents | Tajikistan Applications | Thailand Patents | Thailand Applications | Uzbekistan Patents | Vietnam Patents | Algeria Patents | ARIPO Patents | ARIPO Applications | Egypt Patents | Kenya Patents | Malawi Patents | Morocco Patents | Morocco Applications | OAPI Patents | South Africa Patents | Tunisia Applications | Zambia Patents | Zimbabwe Patents | EAPO Patents | EAPO Applications | Georgia Patents | Georgia Applications | Kazakhstan Patents | Kazakhstan Applications | Russia Patents | Russia Applications | Turkey Patents | Turkey Applications

1 2023-10-02 02:30 UTC | 11,016,626 results from

**De-Dup:** None | **Relevance Cut-off:** None | **Sort:** Relevance

**Main Concept:** Text

(bottom first) adj2 ferromagnetic adj2 (layer film) AND (second top) adj2 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) WITH barrier adj2 (layer film)

**Concept Modifiers:** None

**Filters:** None

Application Number: TBD  
Attorney Docket No. IBTH 13318Aa  
Information Disclosure Statement

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

**Applicant:** Shinji YUASA

**Serial No.:** TBD

**Filing Date:** August 10, 2023

**Title:** METHOD OF MANUFACTURING A MAGNETORESISTIVE  
RANDOM ACCESS MEMORY (MRAM)

**Examiner:** TBD

**Art Unit:** TBD

**Confirmation No.:** TBD

**Attorney Docket No.:** IBTH 13318Aa

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**INFORMATION DISCLOSURE STATEMENT**

Sir:

To comply with rules 37 CFR §§1.97 and 1.98, attached hereto is a copy of Form PTO-1449 with documents listed thereon. These documents contain information which the Examiner may consider to be important in deciding whether to issue a patent in the instant application.

As all foreign patent documents and non-patent literature cited herein were submitted in the parent application **18/219,320** filed **July 7, 2023**, now pending, and in the grandparent case **17/560,922** filed **December 23, 2021**, now pending, copies of such documents are not being provided herewith.

The present Information Disclosure Statement is being submitted in compliance with 37 CFR §1.56, as an Examiner might consider any cited document important in deciding whether to allow the application to issue as a patent, but the citation of each document is not to be construed as an admission that such document is necessarily relevant or prior art. No representation is intended that the cited documents represent the results of a complete search, and it is anticipated that the Examiner, in the normal course of examination, will make an independent search and will determine the best prior art consistent with 37 CFR §§1.104 (a) and 1.106 (b), and in the course of such search will review for relevance every document cited on the attached form even if not initialed.

Any fee due with this paper not already paid through an EFS-Web filing may be charged to Deposit Account No. 50-3894. Any overpayment may be credited to Deposit Account No. 50-3894.

Respectfully submitted,  
MYERS WOLIN, LLC

/Brian S. Myers/  
Brian S. Myers  
Reg. No. 46,947

**CUSTOMER NUMBER 61650**  
PHONE: (973) 828-1284  
FAX: (866) 864-3948

|                                                                                                     |                        |              |            |  |
|-----------------------------------------------------------------------------------------------------|------------------------|--------------|------------|--|
| <b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br>( Not for submission under 37 CFR 1.99) | Application Number     |              |            |  |
|                                                                                                     | Filing Date            |              | 2023-08-10 |  |
|                                                                                                     | First Named Inventor   | Shinji YUASA |            |  |
|                                                                                                     | Art Unit               |              |            |  |
|                                                                                                     | Examiner Name          |              |            |  |
|                                                                                                     | Attorney Docket Number | IBTH 13318Aa |            |  |

| U.S.PATENTS       |         |               |                        |            |                                                 |                                                                        |
|-------------------|---------|---------------|------------------------|------------|-------------------------------------------------|------------------------------------------------------------------------|
| Examiner Initial* | Cite No | Patent Number | Kind Code <sup>1</sup> | Issue Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear |
|                   | 1       | 11233193      | B2                     | 2022-01-25 | Shinji YUASA                                    |                                                                        |

If you wish to add additional U.S. Patent citation information please click the Add button.

| U.S.PATENT APPLICATION PUBLICATIONS |         |                    |                        |                  |                                                 |                                                                        |
|-------------------------------------|---------|--------------------|------------------------|------------------|-------------------------------------------------|------------------------------------------------------------------------|
| Examiner Initial*                   | Cite No | Publication Number | Kind Code <sup>1</sup> | Publication Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear |
|                                     | 1       | 20040109347        | A1                     | 2004-06-10       | DEBROSSE et al.                                 |                                                                        |

If you wish to add additional U.S. Published Application citation information please click the Add button.

| FOREIGN PATENT DOCUMENTS |         |                                      |                           |                        |                  |                                                 |                                                                        |                          |
|--------------------------|---------|--------------------------------------|---------------------------|------------------------|------------------|-------------------------------------------------|------------------------------------------------------------------------|--------------------------|
| Examiner Initial*        | Cite No | Foreign Document Number <sup>3</sup> | Country Code <sup>2</sup> | Kind Code <sup>4</sup> | Publication Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear | T <sup>5</sup>           |
|                          | 1       |                                      |                           |                        |                  |                                                 |                                                                        | <input type="checkbox"/> |

If you wish to add additional Foreign Patent Document citation information please click the Add button

| NON-PATENT LITERATURE DOCUMENTS |         |                                                                                                                                                                                                                                                                 |                |
|---------------------------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Examiner Initials*              | Cite No | Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published. | T <sup>5</sup> |
|                                 |         |                                                                                                                                                                                                                                                                 |                |

INFORMATION DISCLOSURE  
STATEMENT BY APPLICANT  
( Not for submission under 37 CFR 1.99)

|                        |              |            |
|------------------------|--------------|------------|
| Application Number     |              |            |
| Filing Date            |              | 2023-08-10 |
| First Named Inventor   | Shinji YUASA |            |
| Art Unit               |              |            |
| Examiner Name          |              |            |
| Attorney Docket Number | IBTH 13318Aa |            |

|   |                                                                                                                                                                            |                          |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| 1 | Non-Final Office Action issued by the United States Patent and Trademark Office for U.S. Patent Application No. 17/560,922, electronically delivered on November 17, 2022. | <input type="checkbox"/> |
| 2 | Notice of Allowance issued by the United States Patent and Trademark Office for U.S. Patent Application No. 17/560,922, electronically delivered on March 22, 2023.        | <input type="checkbox"/> |

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

|                    |                    |                 |            |
|--------------------|--------------------|-----------------|------------|
| Examiner Signature | /ALONZO CHAMBLISS/ | Date Considered | 10/01/2023 |
|--------------------|--------------------|-----------------|------------|

\*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

<sup>1</sup> See Kind Codes of USPTO Patent Documents at [www.USPTO.GOV](http://www.USPTO.GOV) or MPEP 901.04. <sup>2</sup> Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). <sup>3</sup> For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. <sup>4</sup> Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. <sup>5</sup> Applicant is to place a check mark here if English language translation is attached.

**INFORMATION DISCLOSURE  
STATEMENT BY APPLICANT**  
( Not for submission under 37 CFR 1.99)

|                        |              |
|------------------------|--------------|
| Application Number     |              |
| Filing Date            | 2023-08-10   |
| First Named Inventor   | Shinji YUASA |
| Art Unit               |              |
| Examiner Name          |              |
| Attorney Docket Number | IBTH 13318Aa |

**CERTIFICATION STATEMENT**

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

**OR**

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

**SIGNATURE**

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

|            |                  |                     |            |
|------------|------------------|---------------------|------------|
| Signature  | /Brian S. Myers/ | Date (YYYY-MM-DD)   | 2023-08-10 |
| Name/Print | Brian S. Myers   | Registration Number | 46947      |

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

## Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)

Approved for use through 11/30/2020. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

**INFORMATION DISCLOSURE  
STATEMENT BY APPLICANT**  
( Not for submission under 37 CFR 1.99)

Application Number

Filing Date

First Named Inventor

Shinji YUASA

Art Unit

Examiner Name

Attorney Docket Number

IBTH 13318Aa

**U.S.PATENTS**

| Examiner Initial* | Cite No | Patent Number | Kind Code <sup>1</sup> | Issue Date | Name of Patentee or Applicant of cited Document | Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear |
|-------------------|---------|---------------|------------------------|------------|-------------------------------------------------|--------------------------------------------------------------------------|
|                   | 1       | 10680167      | B2                     | 2020-06-09 | Yuasa                                           |                                                                          |
|                   | 2       | 6621730       | B1                     | 2003-09-16 | Lage                                            |                                                                          |

If you wish to add additional U.S. Patent citation information please click the Add button.

**U.S.PATENT APPLICATION PUBLICATIONS**

| Examiner Initial* | Cite No | Publication Number | Kind Code <sup>1</sup> | Publication Date | Name of Patentee or Applicant of cited Document | Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear |
|-------------------|---------|--------------------|------------------------|------------------|-------------------------------------------------|--------------------------------------------------------------------------|
|                   | 1       |                    |                        |                  |                                                 |                                                                          |

If you wish to add additional U.S. Published Application citation information please click the Add button.

**FOREIGN PATENT DOCUMENTS**

| Examiner Initial* | Cite No | Foreign Document Number <sup>3</sup> | Country Code <sup>2</sup> | Kind Code <sup>4</sup> | Publication Date | Name of Patentee or Applicant of cited Document | Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear | T <sup>5</sup>           |
|-------------------|---------|--------------------------------------|---------------------------|------------------------|------------------|-------------------------------------------------|--------------------------------------------------------------------------|--------------------------|
|                   | 1       |                                      |                           |                        |                  |                                                 |                                                                          | <input type="checkbox"/> |

If you wish to add additional Foreign Patent Document citation information please click the Add button

**NON-PATENT LITERATURE DOCUMENTS**

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)

Approved for use through 11/30/2020. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

**INFORMATION DISCLOSURE  
STATEMENT BY APPLICANT**  
( Not for submission under 37 CFR 1.99)

|                        |              |  |
|------------------------|--------------|--|
| Application Number     |              |  |
| Filing Date            |              |  |
| First Named Inventor   | Shinji YUASA |  |
| Art Unit               |              |  |
| Examiner Name          |              |  |
| Attorney Docket Number | IBTH 13318Aa |  |

**U.S.PATENTS**

| Examiner Initial* | Cite No | Patent Number | Kind Code <sup>1</sup> | Issue Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear |
|-------------------|---------|---------------|------------------------|------------|-------------------------------------------------|------------------------------------------------------------------------|
|                   | 1       | 10367138      | B2                     | 2019-07-30 | Yuasa                                           |                                                                        |

If you wish to add additional U.S. Patent citation information please click the Add button.

**U.S.PATENT APPLICATION PUBLICATIONS**

| Examiner Initial* | Cite No | Publication Number | Kind Code <sup>1</sup> | Publication Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear |
|-------------------|---------|--------------------|------------------------|------------------|-------------------------------------------------|------------------------------------------------------------------------|
|                   | 1       |                    |                        |                  |                                                 |                                                                        |

If you wish to add additional U.S. Published Application citation information please click the Add button.

**FOREIGN PATENT DOCUMENTS**

| Examiner Initial* | Cite No | Foreign Document Number <sup>3</sup> | Country Code <sup>2</sup> | Kind Code <sup>4</sup> | Publication Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear | T <sup>5</sup>           |
|-------------------|---------|--------------------------------------|---------------------------|------------------------|------------------|-------------------------------------------------|------------------------------------------------------------------------|--------------------------|
|                   | 1       |                                      |                           |                        |                  |                                                 |                                                                        | <input type="checkbox"/> |

If you wish to add additional Foreign Patent Document citation information please click the Add button

**NON-PATENT LITERATURE DOCUMENTS**

| Examiner Initials* | Cite No | Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published. | T <sup>5</sup> |
|--------------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
|                    |         |                                                                                                                                                                                                                                                                 |                |

**INFORMATION DISCLOSURE  
STATEMENT BY APPLICANT**  
( Not for submission under 37 CFR 1.99)

|                        |              |
|------------------------|--------------|
| Application Number     |              |
| Filing Date            |              |
| First Named Inventor   | Shinji YUASA |
| Art Unit               |              |
| Examiner Name          |              |
| Attorney Docket Number | IBTH 13318Aa |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | YUASA, S. et al., "Giant tunnel magnetoresistance in magnetic tunnel junctions with a crystalline MgO(001) barrier", Journal of Physics D: Applied Physics, 40, (2007), R337-R354, which is Evidence Otsu 29 (Evidence submitted by the Defendant 29) for 2014(wa)25200 Case of Claiming Damages in Japan, already submitted as IDS on August 12, 2019                                                             |
| 2 | TSUNODA, M. et al., "Orientational Control of Barrier Layer with Interfacial Modification and Its Effect on Tunnel Magnetoresistance in CoFeB/MgO/CoFeB Magnetic Tunnel Junctions", Journal of Vacuum Society of Japan, Vol.51, No.9, (2008), pp.583-588, which is Evidence Otsu 38 (Evidence submitted by the Defendant 38) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation |
| 3 | YUASA, S. et al., "High Tunnel Magnetoresistance at Room Temperature in Fully Epitaxial Fe/MgO/Fe Tunnel Junctions due to Coherent Spin-Polarized Tunneling", Japanese Journal of Applied Physics, Vol. 43, No. 4B, (2004), pp. L588-L590, which is Evidence Otsu 48 (Evidence submitted by the Defendant 48) for 2014(wa)25200 Case of Claiming Damages in Japan, already submitted as IDS on August 12, 2019     |
| 4 | Defendant Technical briefing Documents Page 42 - Page 67, which is Evidence Otsu 55 (Evidence submitted by the Defendant 55) for 2014(wa)25200 Case of Claiming Damages in Japan, with English translation                                                                                                                                                                                                         |
| 5 | YUASA, S. et al., "Tunneling Magnetoresistance and Interface Structure of Magnetic Tunnel Junctions with a MgO (001) Barrier", Surface Science Vol. 28, No. 1, pp.15-21, 2007, which is Evidence Otsu 56 (Evidence submitted by the Defendant 56) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                            |
| 6 | "Part VI Chapter 1 Section 1" of "Examination Guidelines for Patent and Utility Model in Japan" of September 2015, which is Evidence Otsu 60 (Evidence submitted by the Defendant 60) for 2014(wa)25200 Case of Claiming Damages in Japan, with English translation                                                                                                                                                |
| 7 | MACHIDA, K. et al., "Spatial Light Modulator with Tunnel Magnetoresistance Driven by Spin Transfer Switching - Toward the Development of a 3D Television System with Low Power Consumption-", NHK STRL R&D, No.138, (2013), pp.51-60, which is Evidence Otsu 65 (Evidence submitted by the Defendant 65) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                     |
| 8 | MACHIDA, K. et al., "Magnetic tunnel junctions using Co/Pt multilayered free layers with perpendicular magnetic anisotropy", Journal of Physics: Conference Series, 303, (2011), 012100, which is an original paper of MACHIDA, K. et al., NHK STRL R&D, No.138, (2013), pp.51-60                                                                                                                                  |

If you wish to add additional non-patent literature document citation information please click the Add button **EXAMINER SIGNATURE**

|                    |                    |                 |            |
|--------------------|--------------------|-----------------|------------|
| Examiner Signature | /ALONZO CHAMBLISS/ | Date Considered | 10/01/2023 |
|--------------------|--------------------|-----------------|------------|

\*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

<sup>1</sup> See Kind Codes of USPTO Patent Documents at [www.USPTO.GOV](http://www.USPTO.GOV) or MPEP 901.04. <sup>2</sup> Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). <sup>3</sup> For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. <sup>4</sup> Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. <sup>5</sup> Applicant is to place a check mark here if English language translation is attached.

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)

Approved for use through 11/30/2020. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

# **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** ( Not for submission under 37 CFR 1.99)

Application Number

Filing Date

First Named Inventor

Shinji YUASA

Art Unit

Examiner Name

Attorney Docket Number

IBTH 13318A<sub>a</sub>

## **U.S.PATENTS**

Remove

| Examiner Initial* | Cite No | Patent Number | Kind Code <sup>1</sup> | Issue Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear                                         |
|-------------------|---------|---------------|------------------------|------------|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
|                   | 1       | 8294228       | B2                     | 2012-10-23 | PENG et al.                                     | Evidence Kou 16 (Evidence submitted by the Plaintiffs 16) for 2014(wa) 25200 Case of Claiming Damages in Japan |
|                   | 2       | 8091209       | B2                     | 2012-01-10 | GAO et al.                                      | Evidence Kou 29 (Evidence submitted by the Plaintiffs 29) for 2014(wa) 25200 Case of Claiming Damages in Japan |

If you wish to add additional U.S. Patent citation information please click the Add button.

Add

## **U.S.PATENT APPLICATION PUBLICATIONS**

Remove

| Examiner Initial* | Cite No | Publication Number | Kind Code <sup>1</sup> | Publication Date | Name of Patentee or Applicant of cited Document | Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear                                                                                           |
|-------------------|---------|--------------------|------------------------|------------------|-------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                   | 1       | 20040144995        | A1                     | 2004-07-29       | NAGAHAMA et al.                                 | Corresponds to JP2003-318465, which is Evidence Otsu 34 (Evidence submitted by the Defendant 34) for 2014(wa) 25200 Case of Claiming Damages in Japan, already + |
|                   | 2       | 20020064069        | A1                     | 2002-05-30       | GOEBEL et al.                                   | Corresponds to JP2002-540594, which is Evidence Otsu 35 (Evidence submitted by the Defendant 35) for 2014(wa) 25200 Case of Claiming Damages in Japan            |
|                   | 3       | 20030203189        | A1                     | 2003-10-30       | FUTAMOTO et al.                                 | Corresponds to JP2001-023140, which is Evidence Otsu 49 (Evidence submitted by the Defendant 49) for 2014(wa) 25200 Case of Claiming Damages in Japan, already + |
|                   | 4       | 20030080363        | A1                     | 2003-05-01       | MARUYAMA et al.                                 | Corresponds to JP2003-133531, which is Evidence Otsu 52 (Evidence submitted by the Defendant 52) for 2014(wa) 25200 Case of Claiming Damages in Japan            |

If you wish to add additional U.S. Published Application citation information please click the Add button.

Add

## **FOREIGN PATENT DOCUMENTS**

Remove

# INFORMATION DISCLOSURE STATEMENT BY APPLICANT

( Not for submission under 37 CFR 1.99)

|                        |              |  |
|------------------------|--------------|--|
| Application Number     |              |  |
| Filing Date            |              |  |
| First Named Inventor   | Shinji YUASA |  |
| Art Unit               |              |  |
| Examiner Name          |              |  |
| Attorney Docket Number | IBTH 13318Aa |  |

| Examiner Initial* | Cite No | Foreign Document Number <sup>3</sup> | Country Code <sup>2</sup> | Kind Code <sup>4</sup> | Publication Date | Name of Patentee or Applicant of cited Document   | Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear                                    | T <sup>5</sup> |
|-------------------|---------|--------------------------------------|---------------------------|------------------------|------------------|---------------------------------------------------|-------------------------------------------------------------------------------------------------------------|----------------|
|                   | 1       | 4963744                              | JP                        | B2                     | 2012-06-27       | JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.        | Evidence Kou 2 (Evidence submitted by the Plaintiffs 2), for 2014 (wa) 25200 Case of Claiming Damages in    | +              |
|                   | 2       | 5002788                              | JP                        | B2                     | 2012-08-15       | JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.        | Evidence Kou 4 (Evidence submitted by the Plaintiffs 4), for 2014 (wa) 25200 Case of Claiming Damages in    | +              |
|                   | 3       | 5120680                              | JP                        | B2                     | 2013-01-16       | JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.        | Evidence Kou 6 (Evidence submitted by the Plaintiffs 6), for 2014 (wa) 25200 Case of Claiming Damages in    | +              |
|                   | 4       | 5152734                              | JP                        | B2                     | 2013-02-27       | JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.        | Evidence Kou 8 (Evidence submitted by the Plaintiffs 8), for 2014 (wa) 25200 Case of Claiming Damages in    | +              |
|                   | 5       | 4774092                              | JP                        | B2                     | 2011-09-14       | JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.        | Evidence Kou 10 (Evidence submitted by the Plaintiffs 10), for 2014(wa) 25200 Case of Claiming Damages in   | +              |
|                   | 6       | 2005/88745                           | WO                        | A1                     | 2005-09-22       | JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.        | Evidence Otsu 3-1 (Evidence submitted by the Defendant 3-1), for 2014(wa) 25200 Case of Claiming Damages in | +              |
|                   | 7       | 2006-196612                          | JP                        | A                      | 2006-07-27       | SONY CORP.                                        | Evidence Otsu 28 (Evidence submitted by the Defendant 28), for 2014(wa) 25200 Case of Claiming Damages in   | +              |
|                   | 8       | 2003-318465                          | JP                        | A                      | 2003-11-07       | ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY et al. | Evidence Otsu 34 (Evidence submitted by the Defendant 34) for 2014(wa) 25200 Case of Claiming Damages in    | +              |
|                   | 9       | 2002-540594                          | JP                        | T                      | 2002-11-26       | INFINEON TECHNOLOGIES AG                          | Evidence Otsu 35 (Evidence submitted by the Defendant 35) for 2014(wa) 25200 Case of Claiming Damages in    | +              |
|                   | 10      | 2001-23140                           | JP                        | A                      | 2001-01-26       | HITACHI, LTD.                                     | Evidence Otsu 49 (Evidence submitted by the Defendant 49) for 2014(wa) 25200 Case of Claiming Damages in    | +              |

# INFORMATION DISCLOSURE STATEMENT BY APPLICANT

( Not for submission under 37 CFR 1.99)

|                        |              |  |
|------------------------|--------------|--|
| Application Number     |              |  |
| Filing Date            |              |  |
| First Named Inventor   | Shinji YUASA |  |
| Art Unit               |              |  |
| Examiner Name          |              |  |
| Attorney Docket Number | IBTH 13318Aa |  |

|    |             |    |   |            |                                                  |                                                                                                                      |   |
|----|-------------|----|---|------------|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|---|
| 11 | H08-181289  | JP | A | 1996-07-12 | NISSAN MOTOR CORP.                               | Evidence Otsu 50<br>(Evidence submitted by<br>the Defendant 50) for<br>2014(wa) 25200 Case of<br>Claiming Damages in | + |
| 12 | 2004-227667 | JP | A | 2004-08-12 | FUJITSU LIMITED                                  | Evidence Otsu 51<br>(Evidence submitted by<br>the Defendant 51) for<br>2014(wa) 25200 Case of<br>Claiming Damages in | + |
| 13 | 2003-133531 | JP | A | 2003-05-09 | FUJITSU LIMITED                                  | Evidence Otsu 52<br>(Evidence submitted by<br>the Defendant 52) for<br>2014(wa) 25200 Case of<br>Claiming Damages in | + |
| 14 | 2009-21626  | JP | A | 2009-01-29 | JAPAN SCIENCE AND<br>TECHNOLOGY AGENCY<br>et al. | Evidence Otsu 58<br>(Evidence submitted by<br>the Defendant 58) for<br>2014(wa) 25200 Case of<br>Claiming Damages in | + |
| 15 | 2008-4956   | JP | A | 2008-01-10 | JAPAN SCIENCE AND<br>TECHNOLOGY AGENCY<br>et al. | Evidence Otsu 59<br>(Evidence submitted by<br>the Defendant 59) for<br>2014(wa) 25200 Case of<br>Claiming Damages in | + |

If you wish to add additional Foreign Patent Document citation information please click the Add button

Add

## NON-PATENT LITERATURE DOCUMENTS

Remove

| Examiner<br>Initials* | Cite<br>No | Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item<br>(book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s),<br>publisher, city and/or country where published. | T <sup>5</sup> |
|-----------------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
|                       | 1          | Defendant Preliminary Documents (1) Page 33 line 11 - Page 57 submitted on January 30, 2015 for 2014(wa)25200<br>Case of Claiming Damages in Japan, with English machine translation                                                                                  |                |
|                       | 2          | Plaintiffs Preliminary Documents (1) Page 69 - Page 74 submitted on March 13, 2015 for 2014(wa)25200 Case of<br>Claiming Damages in Japan, with English machine translation                                                                                           |                |
|                       | 3          | Defendant Preliminary Documents (2) Page 23 line 16 - Page 46 submitted on June 4, 2015 for 2014(wa)25200 Case<br>of Claiming Damages in Japan, with English machine translation                                                                                      |                |
|                       | 4          | Plaintiffs Preliminary Documents (2) Page 31 line 13 - Page 32 submitted on July 23, 2015 for 2014(wa)25200 Case of<br>Claiming Damages in Japan, with English machine translation                                                                                    |                |

# INFORMATION DISCLOSURE STATEMENT BY APPLICANT

( Not for submission under 37 CFR 1.99)

|                        |                          |  |
|------------------------|--------------------------|--|
| Application Number     |                          |  |
| Filing Date            |                          |  |
| First Named Inventor   | Shinji YUASA             |  |
| Art Unit               |                          |  |
| Examiner Name          |                          |  |
| Attorney Docket Number | IBTH 13318A <sub>a</sub> |  |

|    |                                                                                                                                                                                                                                                  |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5  | Defendant Preliminary Documents (3) Page 47 line 14 - Page 79 submitted on October 1, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                 |
| 6  | Plaintiffs Preliminary Documents (4) Page 2 - Page 16 submitted on November 20, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                       |
| 7  | Defendant Preliminary Documents (5) Page 5 - Page 39 submitted on February 5, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                         |
| 8  | Plaintiffs Preliminary Documents (6) submitted on March 4, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                            |
| 9  | Defendant Preliminary Documents (7) Page 4 - Page 23 submitted on April 4, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                            |
| 10 | Defendant Preliminary Documents (10) Page 4 line 4 from the bottom - Page 8 line 3 from the bottom and Page 23 line 9 - Page 24 submitted on July 29, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation |
| 11 | Plaintiffs Preliminary Documents (9) Page 8 - Page 14 line 13 and Page 18 line 19 - Page 22 submitted on August 9, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                    |
| 12 | Defendant Preliminary Documents (11) Page 17 line 3 - Page 21 line 5 from the bottom and Page 22 line 5 - Page 27 line 12 submitted on October 14, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation    |
| 13 | Plaintiffs Preliminary Documents (10) Page 8 - Page 10 submitted on October 21, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                       |
| 14 | Plaintiffs Preliminary Documents (11) Page 2 - Page 8 and Page 15 - Page 19 submitted on November 18, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                 |
| 15 | Defendant Preliminary Documents (12) Page 10 line 5 - Page 14 line 8 and Page 16 - Page 35 submitted on January 20, 2017 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                   |

# INFORMATION DISCLOSURE STATEMENT BY APPLICANT

( Not for submission under 37 CFR 1.99)

|                        |              |  |
|------------------------|--------------|--|
| Application Number     |              |  |
| Filing Date            |              |  |
| First Named Inventor   | Shinji YUASA |  |
| Art Unit               |              |  |
| Examiner Name          |              |  |
| Attorney Docket Number | IBTH 13318Aa |  |

|    |                                                                                                                                                                                                                                                                                                                                                                                                             |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 16 | Plaintiffs Preliminary Documents (12) Page 12 - Page 16 submitted on January 25, 2017 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                                                                                 |
| 17 | Plaintiffs Preliminary Documents (13) submitted on January 26, 2017 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                                                                                                   |
| 18 | Defendant Preliminary Documents(13) Page 3 line 6 - Page 6 line 6 from the bottom and Page 8 line 13 - Page 19 submitted on March 17, 2017 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                            |
| 19 | Plaintiffs Preliminary Documents (16) Page 6 line 21 - Page 7 submitted on August 25, 2017 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                                                                            |
| 20 | Defendant Preliminary Documents(15) Page 2 line 3 from the bottom - Page 3 line 7 submitted on September 19, 2017 for 2014(wa)25200 Case of Claiming Damages in Japan, with English translation                                                                                                                                                                                                             |
| 21 | Defendant Preliminary Documents (19) Page 15 line 9 - Page 19 submitted on April 13, 2018 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                                                                             |
| 22 | Plaintiffs Preliminary Documents (20) Page 3 line 7 from the bottom - Page 6 submitted on April 17, 2018 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                                                              |
| 23 | Plaintiffs Preliminary Documents (22) submitted on July 20, 2018 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                                                                                                      |
| 24 | Plaintiffs Preliminary Documents (23) submitted on August 9, 2018 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                                                                                                     |
| 25 | Defendant Preliminary Documents (21) submitted on September 14, 2018 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                                                                                                  |
| 26 | YUASA, S., "Recent Developments of Spintronics Device Technologies Based on Magnetic Tunnel Junctions with Magnesium Oxide Tunnel Barrier", IEEJ Transactions on Electronics, Information and Systems, Vol.133, No.3, pp.471-478, which is Attachment(1) of Evidence Kou 11 (Evidence submitted by the Plaintiffs 11) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation |

**INFORMATION DISCLOSURE  
STATEMENT BY APPLICANT**  
( Not for submission under 37 CFR 1.99)

|                        |                          |  |
|------------------------|--------------------------|--|
| Application Number     |                          |  |
| Filing Date            |                          |  |
| First Named Inventor   | Shinji YUASA             |  |
| Art Unit               |                          |  |
| Examiner Name          |                          |  |
| Attorney Docket Number | IBTH 13318A <sub>a</sub> |  |

|    |                                                                                                                                                                                                                                                                                                                                                                                   |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 27 | Plaintiffs Technical briefing Documents Page 26 - Page 30, which is Evidence Kou 38 (Evidence submitted by the Plaintiffs 38) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                               |
| 28 | YUASA, S. et al., "Giant Room-Temperature Magnetoresistance in Single-Crystal Fe/MgO/Fe Magnetic Tunnel Junctions", Nature Materials, Vol. 3, (October 31, 2004), pp. 868-871, which is Evidence Kou 41 (Evidence submitted by the Plaintiffs 41) for 2014(wa)25200 Case of Claiming Damages in Japan, already submitted as IDS on August 12, 2019                                |
| 29 | DONG, K.F. et, al., "Nanocomposite L10 FePt-SiNx and FePt-SiNx-C films with large coercivity and small grain size on a TiN intermediate layer", Journal of Magnetism and Magnetic Materials, 324, (2012), 2637-2644, which is Evidence Kou 45 (Evidence submitted by the Plaintiffs 45) for 2014(wa)25200 Case of Claiming Damages in Japan                                       |
| 30 | Research report (7) Page 8- Page 12 line14, which is Evidence Kou 47 (Evidence submitted by the Plaintiffs 47) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                                              |
| 31 | Decision on Appeal (Correction 2016-390151) on January 17, 2017 for Japanese Patent No.4963744, which is Evidence Kou 48 (Evidence submitted by the Plaintiffs 48) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                          |
| 32 | Decision on Appeal (Correction 2017-390051) on August 17, 2017 for Japanese Patent No.5120680, which is Evidence Kou 57 (Evidence submitted by the Plaintiffs 57) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                           |
| 33 | HAYAKAWA J. et al., "Dependence of Giant Tunnel Magnetoresistance of Sputtered CoFeB/MgO/CoFeB Magnetic Tunnel Junctions on MgO Barrier Thickness and Annealing Temperature", Japanese Journal of Applied Physics, Vol. 44, No. 19, (2005), pp. L587-L589, which is Evidence Kou 58 (Evidence submitted by the Plaintiffs 58) for 2014(wa)25200 Case of Claiming Damages in Japan |
| 34 | Written Statement submitted on August 10, 2007 for Japanese Patent Application No.2006-511062, which is Evidence Otsu 3-2 (Evidence submitted by the Defendant 3-2) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                         |
| 35 | Written Statement submitted on August 10, 2007 for Japanese Patent Application No.2007-210197, which is Evidence Otsu 4 (Evidence submitted by the Defendant 4) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                             |
| 36 | Notice of Reasons for Refusal drafted on December 8, 2010 for Japanese Patent Application No.2008-238154, which is Evidence Otsu 5-1 (Evidence submitted by the Defendant 5-1) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                              |
| 37 | Written Statement submitted on November 11, 2011 for Japanese Patent Application No.2011-226906, which is Evidence Otsu 6-1 (Evidence submitted by the Defendant 6-1) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                       |

# INFORMATION DISCLOSURE STATEMENT BY APPLICANT

( Not for submission under 37 CFR 1.99)

|                        |              |  |
|------------------------|--------------|--|
| Application Number     |              |  |
| Filing Date            |              |  |
| First Named Inventor   | Shinji YUASA |  |
| Art Unit               |              |  |
| Examiner Name          |              |  |
| Attorney Docket Number | IBTH 13318Aa |  |

|    |                                                                                                                                                                                                                                                                                                                                                                                                      |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 38 | Written Opinion submitted on March 23, 2012 for Japanese Patent Application No.2011-226907, which is Evidence Otsu 7-1 (Evidence submitted by the Defendant 7-1) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                               |
| 39 | Notice of Reasons for Refusal drafted on January 18, 2012 for Japanese Patent Application No.2011-226907, which is Evidence Otsu 7-2 (Evidence submitted by the Defendant 7-2) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation, already submitted as IDS on August 12, 2019                                                                                    |
| 40 | Written Statement submitted on April 20, 2012 for Japanese Patent Application No.2012-067089, which is Evidence Otsu 8 (Evidence submitted by the Defendant 8) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                                 |
| 41 | Written Opinion submitted on October 9, 2012 for Japanese Patent Application No.2011-226908, which is Evidence Otsu 9-2 (Evidence submitted by the Defendant 9-2) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                              |
| 42 | Written Statement submitted on November 11, 2011 for Japanese Patent Application No.2011-226908, which is Evidence Otsu 9-3 (Evidence submitted by the Defendant 9-3) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                          |
| 43 | Written Amendment submitted on March 10, 2008 for Japanese Patent Application No.2004-259280, which is Evidence Otsu 10-1 (Evidence submitted by the Defendant 10-1) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                           |
| 44 | Notice of Reasons for Refusal drafted on July 29, 2008 for Japanese Patent Application No.2004-259280, which is Evidence Otsu 10-2 (Evidence submitted by the Defendant 10-2) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                  |
| 45 | Written Amendment submitted on October 3, 2008 for Japanese Patent Application No.2004-259280, which is Evidence Otsu 10-3 (Evidence submitted by the Defendant 10-3) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                          |
| 46 | Written Opinion submitted on October 3, 2008 for Japanese Patent Application No.2004-259280, which is Evidence Otsu 10-4 (Evidence submitted by the Defendant 10-4) for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation                                                                                                                                            |
| 47 | DJYAPRAWIRA, D.D. et al, "230% Room-Temperature Magnetoresistance in CoFeB/MgO/CoFeB Magnetic Tunnel Junctions", Appl. Phys. Lett., vol. 86, (2005), pp. 092502-1 – 092502-3, which is Evidence Otsu 12 (Evidence submitted by the Defendant 12) for 2014(wa)25200 Case of Claiming Damages in Japan, and which is also called as "Djyaprawira article", already submitted as IDS on August 12, 2019 |
| 48 | "Part I Chapter 1" of "Examination Guidelines for Patent and Utility Model in Japan" of July 2013, which is Evidence Otsu 13 (Evidence submitted by the Defendant 13) for 2014(wa)25200 Case of Claiming Damages in Japan, with English translation                                                                                                                                                  |

**INFORMATION DISCLOSURE  
STATEMENT BY APPLICANT**  
( Not for submission under 37 CFR 1.99)

|                        |               |
|------------------------|---------------|
| Application Number     |               |
| Filing Date            |               |
| First Named Inventor   | Shinji YUASA  |
| Art Unit               |               |
| Examiner Name          |               |
| Attorney Docket Number | IBTH 13318A a |

|    |                                                                                                                                                                                                                                                                                   |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 49 | YUASA, S. et al., " Creating non-volatile electronics by spintronics technology", Synthesiology, Vol.2, No.3, (2009), p.211-222, which is Evidence Otsu 22 (Evidence submitted by the Defendant 22) for 2014(wa)25200 Case of Claiming Damages in Japan, with English translation |
| 50 | 'IT Appliances with Zero Standby Power: Is the Dream Close to Reality?', AIST Stories, No.1, (2013), pp.4-9, which is Evidence Otsu 26 (Evidence submitted by the Defendant 26) for 2014(wa)25200 Case of Claiming Damages in Japan, with English translation                     |

If you wish to add additional non-patent literature document citation information please click the Add button **EXAMINER SIGNATURE**

|                    |                    |                 |            |
|--------------------|--------------------|-----------------|------------|
| Examiner Signature | /ALONZO CHAMBLISS/ | Date Considered | 10/01/2023 |
|--------------------|--------------------|-----------------|------------|

\*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

<sup>1</sup> See Kind Codes of USPTO Patent Documents at [www.USPTO.GOV](http://www.USPTO.GOV) or MPEP 901.04. <sup>2</sup> Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). <sup>3</sup> For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. <sup>4</sup> Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. <sup>5</sup> Applicant is to place a check mark here if English language translation is attached.

Customized PTO/SB/08a+b (07-09)

|                                                                                              |                |                          |
|----------------------------------------------------------------------------------------------|----------------|--------------------------|
| Substitute for Form 1449/PTO<br><br><b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b> | Application #  |                          |
|                                                                                              | Confirmation # |                          |
|                                                                                              | Filing Date    |                          |
|                                                                                              | First Inventor | Shinji YUASA             |
|                                                                                              | Art Unit       |                          |
|                                                                                              | Examiner       |                          |
| Sheet 1 of 3                                                                                 | Docket #       | IBTH 13318A <sub>a</sub> |

| U.S. PATENT DOCUMENTS |                                    |                          |                               |                   |
|-----------------------|------------------------------------|--------------------------|-------------------------------|-------------------|
| Initial<br>(*)        | Document No.<br>Number – Kind Code | Publ. Date<br>MM-DD-YYYY | Name<br>Patentee or Applicant | Corresponds<br>to |
|                       | US-2006/003185                     | 01-05-2006               | PARKIN                        |                   |
|                       | US-7,252,852                       | 08/07/2007               | PARKIN                        |                   |
|                       |                                    |                          |                               |                   |

| FOREIGN PATENT DOCUMENTS |                                       |                          |                               |                  |
|--------------------------|---------------------------------------|--------------------------|-------------------------------|------------------|
| Initial<br>(*)           | Country-Number-<br>Kind Code if known | Publ. Date<br>MM-DD-YYYY | Name<br>Patentee or Applicant | Trans-<br>lation |
|                          |                                       |                          |                               |                  |
|                          |                                       |                          |                               |                  |
|                          |                                       |                          |                               |                  |

| NON PATENT LITERATURE DOCUMENTS |                                                                                                                                                  |                  |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Exam.<br>Initial*               | Include NAME of the author (in CAPS), Title of Article/Item, Date, Page(s), Volume-<br>Issue No., Publisher, City and/or Country where published | Trans-<br>lation |
|                                 |                                                                                                                                                  |                  |
|                                 |                                                                                                                                                  |                  |
|                                 |                                                                                                                                                  |                  |

|                    |                    |                 |            |
|--------------------|--------------------|-----------------|------------|
| Examiner Signature | /ALONZO CHAMBLISS/ | Date Considered | 10/01/2023 |
|--------------------|--------------------|-----------------|------------|

\* Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP §609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.

Customized PTO/SB/08a+b (07-09)

|                                                                                              |                |              |
|----------------------------------------------------------------------------------------------|----------------|--------------|
| Substitute for Form 1449/PTO<br><br><b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b> | Application #  |              |
|                                                                                              | Confirmation # |              |
|                                                                                              | Filing Date    |              |
|                                                                                              | First Inventor | Shinji YUASA |
|                                                                                              | Art Unit       |              |
|                                                                                              | Examiner       |              |
| Sheet <u>2</u> of <u>3</u>                                                                   | Docket #       | IBTH 13318Aa |

| U.S. PATENT DOCUMENTS |                                    |                          |                               |                   |
|-----------------------|------------------------------------|--------------------------|-------------------------------|-------------------|
| Initial<br>(*)        | Document No.<br>Number – Kind Code | Publ. Date<br>MM-DD-YYYY | Name<br>Patentee or Applicant | Corresponds<br>to |
|                       | US-2007/0128470                    | 06/07/2007               | Nagahama et al.               |                   |
|                       | US-2004/0144995                    | 07/29/2004               | Nagahama et al.               |                   |
|                       | US-2004/0245553                    | 12/09/2004               | Hosomi et al.                 |                   |
|                       | US-2006/0056115                    | 03/16/2006               | Djayaprawira et al.           |                   |
|                       | US-2002/0159203                    | 10/31/2002               | Saito et al.                  |                   |
|                       | US-2005/0207071                    | 09/22/2005               | Sato et al.                   |                   |
|                       | US-2002/0191355                    | 12/19/2002               | Hiramoto et al.               |                   |
|                       | US-2002/0149962                    | 10/17/2002               | Horiguchi                     |                   |
|                       | US-2007/0195592                    | 08/23/2007               | Yuasa                         |                   |
|                       | US-2009/0324814                    | 12/31/2009               | Parkin                        |                   |
|                       | US-2008/0062581                    | 03/13/2008               | Parkin                        |                   |
|                       | US-2007/0258170                    | 11/08/2007               | Yuasa                         |                   |
|                       | US-7,884,403                       | 02/08/2011               | Yuasa                         |                   |
|                       | US-6,544,801                       | 04/08/2003               | Slaughter et al.              |                   |
|                       | US-5,514,484                       | 05/07/1996               | Nishimoto                     |                   |
|                       | US-6,379,978                       | 04/30/2002               | Goebel et al.                 |                   |
|                       | US-7,276,384                       | 10/02/2007               | Parkin et al.                 |                   |
|                       | US-5,759,265                       | 06/02/1998               | Nashimoto et al.              |                   |
|                       | US-6,911,685                       | 06/28/2005               | Anthony et al.                |                   |
|                       | US-6,767,655                       | 07/27/2004               | Hiramoto et al.               |                   |
|                       | US-6,054,226                       | 04/25/2000               | Takeda et al.                 |                   |
|                       | US-2008/0055793                    | 03/06/2008               | Djayaprawira et al.           |                   |
|                       | US-2002/0080641                    | 06/27/2002               | Asao et al.                   |                   |
|                       | US-2002/0064595                    | 05/30/2002               | Nomura et al.                 |                   |
|                       | US-2003/0128483                    | 07/10/2003               | Kamijo                        |                   |
|                       | US-2004/0082201                    | 04/29/2004               | Sharma et al.                 |                   |
|                       | US-2004/0136232                    | 07/15/2004               | Hosomi et al.                 |                   |
|                       | US-2004/0139914                    | 07/22/2004               | Yamazaki et al.               |                   |
|                       | US-2004/0234818                    | 11/25/2004               | Tanahashi et al.              |                   |
|                       | US-2004/0257719                    | 12/23/2004               | Ohba et al.                   |                   |
|                       | US-2005/0110004                    | 05/26/2005               | Parkin et al.                 |                   |
|                       | US-2006/0012926                    | 01/19/2006               | Parkin                        |                   |
|                       | US-2006/0125034                    | 06/15/2006               | Ohba et al.                   |                   |
|                       | US-2006/0261425                    | 11/23/2006               | Suemitsu et al.               |                   |
|                       | US-2008/0124454                    | 05/29/2008               | Djayaprawira et al.           |                   |
|                       | US-2008/0180862                    | 07/31/2008               | Djayaprawira et al.           |                   |
|                       | US-2008/0182342                    | 07/31/2008               | Parkin                        |                   |
|                       | US-2008/0212243                    | 09/04/2008               | Zhao et al.                   |                   |

|  |                 |            |                  |              |
|--|-----------------|------------|------------------|--------------|
|  | US-2008/0253039 | 10/16/2008 | Nagamine et al.  |              |
|  | US-2009/0128167 | 05/21/2009 | Hamada et al.    |              |
|  | US-5,506,063    | 04/09/1996 | Kamijo et al.    |              |
|  | US-5,817,366    | 10/06/1998 | Arai et al.      |              |
|  | US-5,945,694    | 08/31/1999 | Reyes et al.     |              |
|  | US-6,181,537    | 01/30/2001 | Gill             |              |
|  | US-6,201,672    | 03/13/2001 | Pinarbasi        |              |
|  | US-6,252,750    | 06/26/2001 | Gill             |              |
|  | US-6,275,362    | 08/14/2001 | Pinarbasi        |              |
|  | US-6,828,260    | 12/07/2004 | Sharma et al.    |              |
|  | US-6,831,312    | 12/14/2004 | Slaughter et al. |              |
|  | US-6,839,206    | 01/04/2005 | Saito et al.     |              |
|  | US-6,927,952    | 08/09/2005 | Shimizu et al.   |              |
|  | US-6,999,287    | 02/14/2006 | Hayashi et al.   |              |
|  | US-7,149,105    | 12/12/2006 | Brown            |              |
|  | US-7,220,498    | 05/22/2007 | Nagahama et al.  |              |
|  | US-7,252,852    | 08/07/2007 | Parkin           |              |
|  | US-7,262,064    | 08/28/2007 | Ohba et al.      |              |
|  | US-7,270,896    | 09/18/2007 | Parkin           |              |
|  | US-2006/0003185 | 01/05/2006 | Parkin           |              |
|  | US-7,408,749    | 08/05/2008 | Gill             |              |
|  | US-7,443,639    | 10/28/2008 | Parkin           |              |
|  | US-7,453,672    | 11/18/2008 | Dieny et al.     |              |
|  | US-7,570,463    | 08/04/2009 | Parkin           |              |
|  | US-7,598,555    | 10/06/2009 | Papworth Parkin  |              |
|  | US-6,828,260    | 12/07/2004 | Sharma et al.    |              |
|  | US-2006/0049441 | 03-09-2006 | Janesky, et al.  |              |
|  | US-5,800,635    | 09-01-1998 | Collins, et al.  |              |
|  | US-5,239,504    | 08-24-1993 | Brady, et al.    |              |
|  | US-2003/0203189 | 10-30-2003 | FUTAMOTO et al.  | JP2001023140 |
|  | US-2004/0001372 | 01-01-2004 | HIGO et al.      | JP2004031694 |
|  | US-6,819,586    | 11-16-2004 | ANTHONY et al.   |              |
|  | US-2005/0047027 | 03-03-2005 | LIN, et al.      |              |
|  | US-8,319,263    | 11-27-2012 | YUASA, Shinji    |              |
|  | US-9,123,463    | 09-01-2015 | YUASA, Shinji    |              |
|  | US-8,405,134    | 03-26-2013 | YUASA, Shinji    |              |
|  | US-9,608,198    | 03-28-2017 | YUASA            |              |
|  |                 |            |                  |              |

### FOREIGN PATENT DOCUMENTS

| Initial<br>(*) | Country-Number-<br>Kind Code <small>if known</small> | Publ. Date<br>MM-DD-YYYY | Name<br>Patentee or Applicant              | Trans-<br>lation |
|----------------|------------------------------------------------------|--------------------------|--------------------------------------------|------------------|
|                | JP 2002-204004                                       | 7/19/2002                |                                            | Abst             |
|                | JP 2003-318465                                       | 11/7/2003                |                                            | Abst             |
|                | JP 2002-289943                                       | 10/4/2002                |                                            |                  |
|                | JP 2003-304010                                       | 10/24/2003               | Sony Corp                                  | Abst             |
|                | WO 2002/099905                                       | 5/24/2002                | Nat. Inst. Of Adv. Ind. & Technol., et al. | Abst             |
|                | EP 1 391 942                                         | 5/24/2002                | Nat. Inst. Of Adv. Ind. & Technol., et al. | Yes              |
|                | WO 2003/085750                                       | 10/16/2003               | Sony Corp                                  | Abst             |

|  |                 |            |                                            |                |
|--|-----------------|------------|--------------------------------------------|----------------|
|  | EP 1 494 295    | 1/5/2005   | Sony Corp                                  | Yes            |
|  | JP 2006-080116  | 3/23/2006  |                                            | Abst           |
|  | EP 1 633 007    | 3/8/2006   | Anelva Corporation                         | Yes            |
|  | EP 1 633 007    | 3/8/2006   | Anelva Corporation                         | Yes            |
|  | EP 1 085 586    | 3/21/2001  | Kabushiki Kaisha Toshiba                   | Yes            |
|  | JP 2000-030236  | 1/28/2000  | Hitachi Ltd.                               | Yes            |
|  | JP 2001-101645  | 4/13/2001  | Akita Prefecture                           | Yes            |
|  | JP 2004-022599  | 1/22/2004  | Sony Corp                                  | Yes            |
|  | JP 2002-270921  | 9/20/2002  | Toshiba Corp                               | Abst           |
|  | JP 2002-319722  | 10/31/2002 | Matsushita Electric Ind Co Ltd             | Abst           |
|  | WO 2004/025744  | 3/25/2004  | Fujitsu Limited                            | Abst           |
|  | JP 2003-283001  | 10/3/2003  | Toshiba Corp                               | Yes            |
|  | JP 2002-246567  | 8/30/2002  | Toshiba Corp                               | Abst           |
|  | WO 2005/088745  | 9/22/2005  | JP Science & Technology Agency, et al.     | Abst           |
|  | JP 11-097766    | 4/9/1999   | Res Inst Electric Magnetic Alloys          | Abst,<br>22,23 |
|  | JP 2008-004956  | 01/10/2008 | JP Science & Technology Agency, et al.     | Abst           |
|  | JP 2002-270790  | 09/20/2002 | Toshiba Corp.                              | Abst           |
|  | JP 2003-304012  | 10/24/2003 | Matsushita Electric Ind Co. Ltd.           | Partial        |
|  | JP H05-144729   | 06/11/1993 | Hitachi Ltd.                               | Partial        |
|  | EP 0 145 403    | 06/19/1985 | Energy Conversion Devices, Inc.            | Yes            |
|  | EP 1 061 592    | 12/20/2000 | Odagawa et al.                             | Yes            |
|  | EP 1 793 434    | 06/06/2007 | Japan Science and Technology Agency        | Yes            |
|  | JP 2002-359413  | 12/13/2002 | Nat. Inst. Of Adv. Ind. & Technol., et al. | Abstr          |
|  | JP 2003-86863   | 03/20/2003 | Nat. Inst. Of Adv. Ind. & Technol, et al.  | Abst           |
|  | JP 2004-063592  | 02/26/2004 | Sony Corp.                                 | Abst           |
|  | JP 2004-128015  | 04/22/2004 | Sony Corp.                                 |                |
|  | JP 2004-153258  | 05/27/2004 | Hewlett Packard Development Co.            | Abst           |
|  | KR 2002-0042448 | 06/05/2002 | Anelva Corp.                               | Abst           |
|  | KR 2003-0097904 | 12/31/2003 | Nagahama et al.                            | Partial        |
|  | WO 01/056090    | 08/02/2001 | Takahashi                                  | Abst           |
|  | JP2004022599    | 01-22-2004 | MIZUGUCHI TETSUA et al.                    | Yes            |
|  |                 |            |                                            |                |

### NON PATENT LITERATURE DOCUMENTS

| Exam. Initial* | Include NAME of the author (in CAPS), Title of Article/Item, Date, Page(s), Volume-Issue No., Publisher, City and/or Country where published                | Translation |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
|                | International Search Report of PCT/JP2005/004720 mailed June 21, 2005                                                                                       | Yes         |
|                | WOLF, S.A. et al., "Spintronics: A Spin-Based Electronics Vision for the Future", Science, Vol. 294, November 16, 2001, pp. 1488-1495.                      | Yes         |
|                | WULFHEKEL, W. et al., "Single-Crystal Magnetotunnel Junctions", Applied Physics Letters, Vol. 78, No. 4, January 22, 2001, pp. 509-511                      | Yes         |
|                | JULLIERE, M., "Tunneling Between Ferromagnetic Films", Physics Letters, Vol. 54A, No. 3, September 8, 1975, pp.225-226.                                     | Yes         |
|                | SOULEN, R.J., Jr. et al., "Measuring the Spin Polarization of a Metal with a Superconducting Point Contact", Science, Vol. 282, October 2, 1998, pp. 85-88. | Yes         |

|  |                                                                                                                                                                                                                                                          |     |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|  | SAITO, Y. et al., "Correlation between Barrier Width, Barrier Height, and DC Bias Voltage Dependences on the Magnetoresistance Ratio in Ir-Mn Exchange Biased Single and Double Tunnel Junctions", Jpn. J. Appl. Phys., Vol. 39 (2000), pp. L1035-L1-38. | Yes |
|  | IURA, S. et al., "Enhancement of Thermal Stability in Ferromagnetic Tunnel Junctions Prepared by the Radical Oxidation Method", Journal of the Magnetism Society of Japan, Vol. 26, No. 6 (2002), pp. 839-842, abstract only in English.                 | Yes |
|  | BOWEN, M. et al., "Large Magnetoresistance in Fe/MgO/FeCo(001) Epitaxial Tunnel Junctions on GaAs(001)", Applied Physics Letters, Vol. 79, No. 11, September 10, 2001, pp. 1655-1657.                                                                    | Yes |
|  | SIMMONS, JOHN G., "Generalized Formula for the Electric Tunnel Effect between Similar Electrodes Separated by a Thin Insulating Film", Journal of Applied Physics, Vol. 34, NO. 6, June 1963, pp. 1793-1803.                                             | Yes |
|  | VASSENT, J.L. et al., "A Study of Growth and the Relaxation of Elastic Strain in MgO on Fe(001)", J. Appl. Phys. Vol. 80, No. 10, November 15, 1996, pp. 5727-5735.                                                                                      | Yes |
|  | FAURE-VINCENT, J. et al., "High Tunnel Magnetoresistance in Expitaxial Fe/MgO/Fe Tunnel Junctions", Applied Physics Letters, Vol. 82, No. 25, June 23, 2003, pp. 4507-4509. X                                                                            | Yes |
|  | MEYERHEIM, H.L. et al., "Geometrical and Compositional Structure at Metal-Oxide Interfaces: MgO on Fe(001)", Physical Review Letters, Vol. 87, No. 7, August 13, 2001, pp. 076102-1 – 076102-4.                                                          | Yes |
|  | MATHON, J. et al., "Theory of Tunneling Magnetoresistance of an Epitaxial Fe/MgO/Fe(001) Junction", Physical Review B., Vol. 63, 220403(R), 2001, pp. 220403-1 – 220403-4.                                                                               | Yes |
|  | ZHANG, X.-G. et al., "Effects of the Iron-Oxide Layer in Fe-FeO-MgO-Fe Tunneling Junctions", Physical Review B, Vol. 68, 092402, 2003, pp. 092402-1 – 092402-4.                                                                                          | Yes |
|  | ZHANG, X.-G. et al., "Large Magnetoresistance in bcc Co/MgO/Co and FeCo/MgO/FeCo Tunnel Junctions", Physical Review B., Vol. 70, 172407, 2004, pp. 172407-1 – 172407-4.                                                                                  | Yes |
|  | GIBSON, A. et al., "Stability of Vacancy Defects in MgO: The Role of Charge Neutrality", Physical Review B., Vol. 50, No. 4, July 15, 1994-II, pp. 2582-2592.                                                                                            | Yes |
|  | YUASA, S. et al., "High Tunnel Magnetoresistance at Room Temperature in Fully Expitaxial Fe/MgO/Fe Tunnel Junctions Due to Coherent Spin-Polarized Tunneling", Japanese Journal of Applied Physics, Vol. 43, No. 4B, 2004, pp. L588-L590.                | Yes |
|  | MITANI, S., et al., "Fe/MgO/FeCo (100) Epitaxial Magnetic Tunnel Junctions Prepared by Using in situ Plasma Oxidation", Journal of Applied Physics, Vol. 93, No. 10, Parts 2 and 3, May 15, 2003, pp. 8041 8043.                                         | Yes |
|  | POPOVA, E., et al., "Epitaxial MgO Layer for Low-Resistance and Coupling-Free Magnetic Tunnel Junctions", Applied Physics Letters, Vol. 81, No. 6, August 5, 2002, pp.1035-1037.                                                                         | Yes |
|  | BOUBETA, C. MARTINEZ, et al., "Magnetic Coupling in Epitaxial TM/MgO/Fe(001) (TM=FeCo, Fe/Co, Fe) Macroscopic and Microscopic Trilayers", Journal of Applied Physics, Vo. 94, No. 6, September 15, 2003, pp. 4006-4012.                                  | Yes |
|  | Supplementary European Search Report from European Patent Office for Application No. 05720955.3 2222, Patent No. 1737055, PCT/JP2005004720 dated July 2, 2008.                                                                                           |     |

|  |                                                                                                                                                                                                                                        |          |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|  | Office Action from European Patent Office dated November 6, 2009                                                                                                                                                                       |          |
|  | F. ERNULT et al., "Preparation of Nanometer-Scale Iron Dots on Insulating Layer", Science and Technology of Advanced Materials, Vol. 4, (2003), pp. 383-389                                                                            | Yes      |
|  | DAVID J. SMITH et al., "Structural Characterization of Thin Film Ferromagnetic Tunnel Junctions", Journal of Applied Physics, Vol. 83, No. 10, 15 May 1998, pp. 5154-5158                                                              | Yes      |
|  | X. W. LI et al., "Fabrication and Properties of Heteroepitaxial Magnetite (Fe <sub>3</sub> O <sub>4</sub> ) Tunnel Junctions", Applied Physics Letters, Vol. 73, No. 22, 30 November 1998, pp.3282-3284                                | Yes      |
|  | C. L. PLATT, et al., "Spin Polarized Tunneling in Reactively Sputtered Tunnel Junctions", Journal of Applied Physics, Vol. 81, No. 8, 15 April 1997, pp. 5523-5525                                                                     | Yes      |
|  | P. TURBAN et al., "Growth and Characterization of Single Crystalline NiMnSb Thin Films and Epitaxial NiMnSb/MgO/NiMnSb(001) Trilayers", 2002 The American Physical Society, Physical Review B., Vol. 65, pp. 134417-1 to 134417-13     | Yes      |
|  | T. MORIYAMA et al., "Preparation and Magnetoresistance in Single-Crystal and Polycrystal Fe/MgO/FeCo Tunnel Junctions", The Physical Society of Japan, 2003 Spring meeting, Abstracts Book 58(1-3), 460, (2003-03-06)                  | Yes      |
|  | MOODERA et al., "Ferromagnetic-Insulator-Ferromagnetic Tunneling: Spin-Dependent Tunneling and Large Magnetoresistance in Trilayer Junctions (Invited)", Journal of Physics DF, Vol. 79, No. 8, 15 April 1996, pp. 4724-4729           | Yes      |
|  | MASAYOSHI TONOUCHI et al., "Epitaxial Growth of NbN on an Ultrathin MgO/Semiconductor System", Journal of Applied Physics, Vol. 62, No. 3, 1 August 1987, pp. 961-966                                                                  | Yes      |
|  | "Giant tunnel magnetoresistance in magnetic tunnel junctions with a crystalline MgO(001) barrier," S. Yuasa and D.D. Djayaprawira, Journal of Physics D: Applied Physics, 1 Phys. D: Appl. Phys. 40 (2007) R337-R354                   | Yes      |
|  | Office Action issued from Japanese Patent Office, in corresponding Japanese Patent Application No. 2011-226907, dated January 31, 2012, pp. 1-3.                                                                                       | Yes      |
|  | ARAKI et al., "Fabrication and Electric Properties of Lapped Type of TMR Heads for ~50 Gb/In <sup>2</sup> and Beyond," IEEE Transactions on Magnetics, Vol. 38, No. 1, pp. 72-77, January 2002.                                        | Yes      |
|  | David D. DJAYAPRAWIRA et al., "Novel Sputtering Technology of Magnetic Tunnel Junctions for MRAM Application," Papers 01 the 66 <sup>th</sup> Symposium on Semiconductors and Integrated Circuits Technology, Vol. 66, pp. 58-61, 2004 | Yes      |
|  | H. DOMON et al., "Effect of Ge Addition on Postannealed CoCrGePt Thin Film Media," Journal of Applied Physics, Vol. 91, No. 10, pp. 8632-8634, May 15, 2002.                                                                           | Yes      |
|  | H. DOMON et al. "Reduction of Magnetic Interaction in CoB/Pd Multilayer Perpendicular Media Using a Phase-Separated Pd-SiO Underlayer," Journal of Applied Physics, Vol. 93, No. 10, pp. 8164-8166, May 15, 2003.                      | Yes      |
|  | Extended European Search Report, issued from European Patent Office, of European Application No. 08159511.8, dated June 5, 2009.                                                                                                       | Yes      |
|  | Office Action issued from Japanese Patent Office, in corresponding Japanese Patent Application No. 2011-226907, dated January 31, 2012, pp. 1-3.                                                                                       | Yes      |
|  | T. KAKUTA et al., " Novel PVD Tool for Magnetoresistive Random Access Memory (MRAM) Mass Production," Anelva Technical Report, Vol. 10, pp. 27-33, January 25, 2004.                                                                   | Abstract |

|                                                                                                                                                                                                                                          |          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| A. KOBAYASHI et al., "TMR Devices Fabricated with RIE Etching Using Co+NH <sub>3</sub> ," Journal of the Magnetism Society of Japan, Vol. 28, No. 2, February 1, 2004.                                                                   | Abstract |
| J.S. MOODERA et al., "Large Magnetoresistance at Room Temperature in Ferromagnetic Thin Film Tunnel Junctions," Physical Review Letters, Vol. 74, No. 16, pp. 3273-3276, April 17, 1995.                                                 | Yes      |
| J.S. MOODERA, "Interface Magnetism and Spin Wave Scattering in Ferromagnet-Insulator-Ferromagnet Tunnel Junctions," Physical Review Letters, Vol. 80, No. 13, pp. 2941-2944, March 30, 1998.                                             | Yes      |
| J. MURAI et al., "Direct Observation of Magnon Excitation in a Ferromagnetic Tunnel Junction Using Inelastic-Electron-Tunneling Spectroscopy," Japanese Journal of Applied Physics, Vol. 38, pp. L1106-L1108, October 1, 1999.           | Yes      |
| K. NAGASAKA et al., "CPP Operational Mode of GMR Head," Fujitsu Sci. Tech. J., Vol. 37, No. 2, pp. 192-200, December 2001.                                                                                                               | Yes      |
| T. OSADA et al., "Dry Etching of Magnetic Thin Film Stacks Using CO/NH <sub>3</sub> and CH <sub>3</sub> OH Gases for Tunneling Magneto-Resistance Devices," 2004 Dry Process International Symposium, Vol. 4, pp. 127-131, 2004.         | Yes      |
| Stuart S.P. PARKIN et al., "Giant Tunneling Magnetoresistance At Room Temperature with MgO (100) Tunnel Barriers," Nature Materials, Vol. 3, pp. 862-867, December 2004.                                                                 | Yes      |
| M. TAKAGISHI et al., "The Applicability of CPP-GMR Heads for Magnetic Recording," IEEE Transactions on Magnetism, Vol. 38, No. 5, pp. 2277-2282, September 2002.                                                                         | Yes      |
| A. TANAKA et al., "Spin-Valve Heads in the Current-Perpendicular-to-Plane Mode for Ultrahigh-Density Recording," IEEE Transactions on Magnetism, Vol. 38, No. 1, January 2002.                                                           | Yes      |
| K. TSUNEKAWA et al., "Surface Treatment Techniques in Fabrication of GMR and TMR Films," Journal of the Magnetism Society of Japan, Vol. 28, No. 11, pp. 1074-1080, November 1, 2004.                                                    | Yes      |
| D. WANG et al., "70% TMR at Room Temperature for SDT Sandwich Junctions With CoFeB as Free and Reference Layers," IEEE Transactions on Magnetism, Vol. 40, No. 4, pp. 2270-2271, July 2004. 004                                          | Yes      |
| S. YOSHIMURA et al., "Magnetic Grain Size Reduction by Using Oxygen Exposure Process Onto Very Thin Islandlike WCr Seedlayer in Longitudinal Recording Media," Journal of Applied Physics, Vol. 91, No. 10, pp. 8629-8631, May 15, 2002. | Yes      |
| S. YOSHIMURA et al. "Grain Size Reduction by Utilizing A Very Thin, High-Melting-Point WCr Seedlayer in Longitudinal Media: Media Noise Reduction in High H <sub>k</sub> grain Media, Vol. 25, No. 4-2, pp. 627-630 (2001).              | Abstract |
| YU et al., "Electron Transport Properties in Magnetic Tunnel Junctions with Epitaxial NiFe (111) Ferromagnetic Bottom Electrodes," Applied Physics Letters, Vol. 82, No. 26, pp. 4735-4737, June 30, 2003.                               | Yes      |
| S. YUASA et al. "Magnetic Tunnel Junctions With Single-Crystal Electrodes: A Crystal Anisotropy of Tunnel Magneto-Resistance," Europhysics Letters, Vol. 52, No. 3, pp. 344-350 November 1, 2000.                                        | Yes      |
| S. YUASA et al., "Giant Room-Temperature Magnetoresistance in Single-Crystal Fe/MgO/Fe Magnetic Tunnel Junctions," Nature Materials Vol. 3, pp. 868-871, October 31, 2004                                                                | Yes      |
| S. YUASA et al., "Spin-Polarized Resonant Tunneling In Magnetic Tunnel Junctions," Science, Vol. 297, pp. 234-237, July 12, 2002.                                                                                                        | Yes      |

|  |                                                                                                                                                                                                                    |     |
|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|  | S. Zhang et al. "Quenching of Magnetoresistance by Hot Electrons in Magnetic Tunnel Junctions," Physical Review Letters, Vol. 79, No. 19, pp. 3744-3747, November 10, 1997.                                        | Yes |
|  | SHANG, et al "The First-principles Study of Electronic Structure of Fe/MgO/Fe Magnetic Tunnel Junctions Interface", 2005, pp.2255-2258, vols. 475-479, Materials Science Forum                                     |     |
|  | MEYERHEIM, et al "Surface X-Ray Diffraction Analysis of the MGO/FE(001) Interface: Evidence for an FEO Layer", 2002, pp. 144433-1- 144433-7, vol. 65, Physical Review B                                            |     |
|  | DJAYAPRAWIRA, et al, "230% Room-Temperature Magnetoresistance in COFEB/MGO/COFEB Magnetic Tunnel Junctions" 2005, pp. 092502-1 – 092502-3, vol. 86, Appl. Phys. Lett.                                              |     |
|  | MIYOKAWA, et al., "X-Ray Absorption and X-Ray Magnetic Circular Dichroism Studies of a Monatomic FE(001) Layer Facing a Single-Crystalline", 2005, pp. L9-L11, vol. 44, no. 1, Japanese Journal of Applied Physics |     |
|  | KLAUA, et al, "Growth, Structure, Electronic, and Magnetic Properties of MGO/FE(001) Bilayers and FE/MGO/FE(001) Trilayers" 2001, vol. 64, pp. 134411-1 – 134411-8, Physical Review B                              |     |
|  | NOZAKI, et al, "Bias Voltage Effect on Tunnel Magnetoresistance in Fully Epitaxial MGO Double-Barrier Magnetic Tunnel Junctions" 2005, pp. 082501-1-082501-3, vol. 86, Appl. Phys. Lett.                           |     |
|  | BUTLER, et al. "Spin-Dependent Tunneling and Conductance of FE/MGO/FE Sandwiches", 2001, pp. 054416-1 – 054416-11, vol. 63, Physical Review                                                                        |     |
|  | ZHANG, et al, "Large Magnetoresistance in BCC. CO/MGO/CO and FECO/MGO/FECO Tunneling Junctions", November 17, 2012, pp. 1-9                                                                                        |     |
|  | BOUBETA, et al "Magnetization Reversal and Magnetic Anisotropies in Epitaxial FE/MGO and Fe/MgO/Fe heterostructures grown on Si(001)", February 15, 2003, pp. 2126-2134, vol. 93, no. 4, J. Appl. Phys.            |     |

|                    |                    |                 |            |
|--------------------|--------------------|-----------------|------------|
| Examiner Signature | /ALONZO CHAMBLISS/ | Date Considered | 10/01/2023 |
|--------------------|--------------------|-----------------|------------|

\* Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP §609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.

Customized PTO/SB/08a+b (07-09)

|                                                                                                     |                |              |
|-----------------------------------------------------------------------------------------------------|----------------|--------------|
| <i>Substitute for Form 1449/PTO</i><br><br><b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b> | Application #  |              |
|                                                                                                     | Confirmation # |              |
|                                                                                                     | Filing Date    |              |
|                                                                                                     | First Inventor | Shinji YUASA |
|                                                                                                     | Art Unit       |              |
|                                                                                                     | Examiner       |              |
| Sheet <u>3</u> of <u>3</u>                                                                          | Docket #       | IBTH 13318Aa |

| U.S. PATENT DOCUMENTS |                                    |                          |                               |                   |
|-----------------------|------------------------------------|--------------------------|-------------------------------|-------------------|
| Initial<br>(*)        | Document No.<br>Number – Kind Code | Publ. Date<br>MM-DD-YYYY | Name<br>Patentee or Applicant | Corresponds<br>to |
|                       |                                    |                          |                               |                   |
|                       |                                    |                          |                               |                   |
|                       |                                    |                          |                               |                   |

| FOREIGN PATENT DOCUMENTS |                                                      |                          |                               |                  |
|--------------------------|------------------------------------------------------|--------------------------|-------------------------------|------------------|
| Initial<br>(*)           | Country-Number-<br>Kind Code <small>if known</small> | Publ. Date<br>MM-DD-YYYY | Name<br>Patentee or Applicant | Trans-<br>lation |
|                          | JPA-2004-31605                                       | 01-29-2004               | SONY CORPORATION              | Yes              |
|                          |                                                      |                          |                               |                  |
|                          |                                                      |                          |                               |                  |

| NON PATENT LITERATURE DOCUMENTS |                                                                                                                                                  |                  |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Exam.<br>Initial*               | Include NAME of the author (in CAPS), Title of Article/Item, Date, Page(s), Volume-<br>Issue No., Publisher, City and/or Country where published | Trans-<br>lation |
|                                 |                                                                                                                                                  |                  |
|                                 |                                                                                                                                                  |                  |

|                    |                    |                 |            |
|--------------------|--------------------|-----------------|------------|
| Examiner Signature | /ALONZO CHAMBLISS/ | Date Considered | 10/01/2023 |
|--------------------|--------------------|-----------------|------------|

\* Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP §609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
**United States Patent and Trademark Office**  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

|                          |             |                      |                     |                  |
|--------------------------|-------------|----------------------|---------------------|------------------|
| APPLICATION NO.          | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
| 18/232,576               | 08/10/2023  | Shinji YUASA         | IBTH 13318Aa        | 1021             |
| 61650                    | 7590        | 10/05/2023           | EXAMINER            |                  |
| MYERS WOLIN, LLC         |             |                      | CHAMBLISS, ALONZO   |                  |
| 100 SOUTH JEFFERSON ROAD |             |                      |                     |                  |
| SUITE 202                |             |                      |                     |                  |
| WHIPPANY, NJ 07981-1009  |             |                      |                     |                  |
|                          |             |                      | ART UNIT            | PAPER NUMBER     |
|                          |             |                      | 2897                |                  |
|                          |             |                      | NOTIFICATION DATE   | DELIVERY MODE    |
|                          |             |                      | 10/05/2023          | ELECTRONIC       |

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patent@myerswolin.com

|                              |                                      |                                      |                                |
|------------------------------|--------------------------------------|--------------------------------------|--------------------------------|
| <b>Office Action Summary</b> | <b>Application No.</b><br>18/232,576 | <b>Applicant(s)</b><br>YUASA, Shinji |                                |
|                              | <b>Examiner</b><br>ALONZO CHAMBLISS  | <b>Art Unit</b><br>2897              | <b>AIA (FITF) Status</b><br>No |

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --**

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

1) ☒ Responsive to communication(s) filed on 9/7/2023.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on \_\_\_\_.

2a) ☐ This action is **FINAL**.

2b) ☒ This action is non-final.

3) ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on \_\_\_\_; the restriction requirement and election have been incorporated into this action.

4) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims\*

5) ☒ Claim(s) 1-22 is/are pending in the application.

5a) Of the above claim(s) \_\_\_\_ is/are withdrawn from consideration.

6) ☐ Claim(s) \_\_\_\_ is/are allowed.

7) ☒ Claim(s) 1-22 is/are rejected.

8) ☐ Claim(s) \_\_\_\_ is/are objected to.

9) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement

\* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see [http://www.uspto.gov/patents/init\\_events/pph/index.jsp](http://www.uspto.gov/patents/init_events/pph/index.jsp) or send an inquiry to [PPHfeedback@uspto.gov](mailto:PPHfeedback@uspto.gov).

### Application Papers

10) ☒ The specification is objected to by the Examiner.

11) ☒ The drawing(s) filed on 8/10/2023 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

### Priority under 35 U.S.C. § 119

12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

#### Certified copies:

a) ☒ All      b) ☐ Some\*\*      c) ☐ None of the:

1. ☐ Certified copies of the priority documents have been received.

2. ☒ Certified copies of the priority documents have been received in Application No. 10/591,947.

3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\*\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

3) ☐ Interview Summary (PTO-413)

Paper No(s)/Mail Date \_\_\_\_.

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)

4) ☐ Other: \_\_\_\_.

Paper No(s)/Mail Date 8/10/2023.

***Notice of Pre-AIA or AIA Status***

1. The present application is being examined under the pre-AIA first to invent provisions.

***Priority***

2. Acknowledgment is made of applicant's claim for foreign priority under 35 U.S.C. 119 (a)-(d). The certified copy has been filed in parent Application No.10/591,947 filed on 9/8/2006.

***Drawings***

3. The formal drawings filed on 8/10/2023 have been approved by the examiner.

***Specification***

4. The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.

The following title is suggested:" MAGNETIC TUNNEL JUNCTION DEVICE ".

***Double Patenting***

5. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at

least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP § 2146 *et seq.* for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The filing of a terminal disclaimer by itself is not a complete reply to a nonstatutory double patenting (NSDP) rejection. A complete reply requires that the terminal disclaimer be accompanied by a reply requesting reconsideration of the prior Office action. Even where the NSDP rejection is provisional the reply must be complete. See MPEP § 804, subsection I.B.1. For a reply to a non-final Office action, see 37 CFR 1.111(a). For a reply to final Office action, see 37 CFR 1.113(c). A request for

reconsideration while not provided for in 37 CFR 1.113(c) may be filed after final for consideration. See MPEP §§ 706.07(e) and 714.13.

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit [www.uspto.gov/patent/patents-forms](http://www.uspto.gov/patent/patents-forms). The actual filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to [www.uspto.gov/patents/apply/applying-online/eterminal-disclaimer](http://www.uspto.gov/patents/apply/applying-online/eterminal-disclaimer).

6. Claims 3-10 are rejected on the ground of nonstatutory double patenting as being unpatentable over claim 5 of U.S. Patent No. 7,884,403. Although the claims at issue are not identical, they are not patentably distinct from each other because both the application and patent recite a first ferromagnetic material layer and a second ferromagnetic material layer. A tunnel barrier layer between the first ferromagnetic material layer and the second ferromagnetic material layer, wherein said tunnel barrier layer comprises crystalline MgOx (001) with oxygen vacancy defects and  $(0 < x < 1)$ .

7. Claims 11-16 are rejected on the ground of nonstatutory double patenting as being unpatentable over claim 5 of U.S. Patent No. 7,884,403. Although the claims at issue are not identical, they are not patentably distinct from each other because both the application and patent recite a first ferromagnetic material layer and a second ferromagnetic material layer. A tunnel barrier layer between the first ferromagnetic

material layer and the second ferromagnetic material layer, wherein said tunnel barrier layer comprises magnesium oxide and has a barrier height in a range of 0.1 eV to 0.85 eV.

8. Claims 17- 22 are rejected on the ground of nonstatutory double patenting as being unpatentable over claim 5 of U.S. Patent No. 7,884,403. Although the claims at issue are not identical, they are not patentably distinct from each other because both the application and patent recite a first ferromagnetic material layer and a tunnel barrier layer disposed on the first ferromagnetic material layer, wherein said tunnel barrier layer comprises magnesium oxide and has a barrier height in a range of 0.2 eV to 0.5 eV. A second ferromagnetic material layer disposed on the tunnel barrier layer.

The prior art made of record and not relied upon is cited primarily to show the product of the instant invention.

### **Conclusion**

9. Any inquiry concerning the communication or earlier communications from the examiner should be directed to Alonzo Chambliss whose telephone number is (571) 272-1927.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Fernando L. Toledo can be reached on (571) 272-1867. The fax phone number for the organization where this application or proceeding is assigned is 571 - 273- 8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PMR or Public PMR.

Status information for unpublished applications is available through Private PMR only. For more information about the PMR system see <http://pair-dkect.uspto.gov>.

Should you have questions on access to the Private PMR system contact the Electronic Center (EBC) at 866-217-9197 (toll-free).

**AC**/October 1, 2023

/Alonzo Chambliss/

Primary Examiner, Art Unit 2897

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Application No.: 18/232,576  
First Named Inventor: Shinji YUASA  
Filed: August 10, 2023  
Confirmation No.: 1021  
Art Unit: 2897  
Examiner: CHAMBLISS, ALONZO  
Attorney Docket No.: IBTH 13318Aa

**Response under 37 C.F.R. 1.111**

Mail Stop: **AMENDMENT**  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

In response to the Office Action mailed on October 5, 2023, kindly amend and further examine the above-identified application as set forth below.

This response includes:

**Amendments to the Specification** begin at page 2 of this response; and  
**Remarks** begin at page 3 of this response.

Terminal Disclaimer is filed concurrently with the response.

**Amendments to the Specification**

Please amend the Title of the application on page 1 of the Specification as shown below, with insertions indicated by underlining and deletions by strikethrough.

~~METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS~~  
~~MEMORY (MRAM)~~ MAGNETIC TUNNEL JUNCTION DEVICE

### **Remarks**

The Office Action mailed on October 5, 2023 indicates that claims 3-22 are pending and stand rejected. Claims 1-2 were previously canceled without prejudice. By this response, the specification is amended for clarification to change the Title. None of the claims are amended by this response. Claims 3, 11 and 17 are independent. No new matter has been added.

### **Specification**

By this response, the specification is amended for clarification to change the title to "**MAGNETIC TUNNEL JUNCTION DEVICE**," as suggested by the Examiner.

Withdrawal of the objections is respectfully requested.

### **Double Patenting**

Claims 3-22 stand rejected on the ground of nonstatutory double patenting over claim 5 of U.S. Patent No. 7,884,403.

In this response, Applicant respectfully submits a **Terminal Disclaimer** to obviate this rejection.

The filing of the Terminal Disclaimer should not be interpreted as any indication that Applicant agrees that the double rejection was appropriate, or with the Office's characterization of the claims of the present application or the reference patent. In fact, Applicant respectfully notes that the Office does not provide a detailed explanation of how the pending claims compare to those of the reference patent.

Withdrawal of the rejections is respectfully requested.

### **Conclusion**

In view of at least the remarks set forth above, this application is in condition for allowance, which action is respectfully requested. However, if for any reason the Examiner should consider this application not to be in condition for allowance, the Examiner is respectfully requested to telephone the undersigned attorney at the number listed below prior to issuing a further Action.

Any fee due with this paper, not already paid through an EFS-Web filing, may be charged to Deposit Account No. 50-3894. Any overpayment may be credited to Deposit Account No. 50-3894.

Respectfully submitted,  
MYERS WOLIN, LLC

/Akihiro Matsuya/  
Akihiro Matsuya  
Reg. No. 76,573

/Brian S. Myers/  
Brian S. Myers  
Reg. No. 46,947

**CUSTOMER NUMBER 61650**

PHONE: (973) 828-1284

FAX: (866) 864-3947

## Electronic Acknowledgement Receipt

|                                             |                                                                        |
|---------------------------------------------|------------------------------------------------------------------------|
| <b>EFS ID:</b>                              | 48790841                                                               |
| <b>Application Number:</b>                  | 18232576                                                               |
| <b>International Application Number:</b>    |                                                                        |
| <b>Confirmation Number:</b>                 | 1021                                                                   |
| <b>Title of Invention:</b>                  | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM) |
| <b>First Named Inventor/Applicant Name:</b> | Shinji YUASA                                                           |
| <b>Customer Number:</b>                     | 61650                                                                  |
| <b>Filer:</b>                               | Brian S. Myers/Oleksandra Onishchuk                                    |
| <b>Filer Authorized By:</b>                 | Brian S. Myers                                                         |
| <b>Attorney Docket Number:</b>              | IBTH 13318Aa                                                           |
| <b>Receipt Date:</b>                        | 02-NOV-2023                                                            |
| <b>Filing Date:</b>                         | 10-AUG-2023                                                            |
| <b>Time Stamp:</b>                          | 13:26:02                                                               |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)                                            |

### Payment information:

|                        |    |
|------------------------|----|
| Submitted with Payment | no |
|------------------------|----|

### File Listing:

| Document Number | Document Description | File Name                              | File Size(Bytes)/<br>Message Digest      | Multi Part /.zip | Pages (if appl.) |
|-----------------|----------------------|----------------------------------------|------------------------------------------|------------------|------------------|
| 1               |                      | ibth_13318aa_20231005_nfoa_resp_r1.pdf | 89219                                    | yes              | 4                |
|                 |                      |                                        | b1074d85e9e1727db0cbc3750cb7920d803e8418 |                  |                  |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Multipart Description/PDF files in .zip description             |       |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|-------|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Document Description                                            | Start | End |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Amendment/Request for Reconsideration-After Non-Final Rejection | 1     | 1   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Specification                                                   | 2     | 2   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Applicant Arguments/Remarks Made in an Amendment                | 3     | 4   |
| Warnings:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                 |       |     |
| Information:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                 |       |     |
| Total Files Size (in bytes):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                 | 89219 |     |
| <p>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b><br/>If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</p> <p><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b><br/>If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</p> <p><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b><br/>If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</p> |                                                                 |       |     |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                         |                                                                         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| <b>Doc Code: DIST.E.FILE</b><br><b>Document Description: Electronic Terminal Disclaimer - Filed</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                         | PTO/SB/26<br>U.S. Patent and Trademark Office<br>Department of Commerce |
| Electronic Petition Request                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>TERMINAL DISCLAIMER TO OBIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT</b> |                                                                         |
| Application Number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 18232576                                                                                |                                                                         |
| Filing Date                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 10-Aug-2023                                                                             |                                                                         |
| First Named Inventor                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Shinji YUASA                                                                            |                                                                         |
| Attorney Docket Number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | IBTH 13318Aa                                                                            |                                                                         |
| Title of Invention                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM)                  |                                                                         |
| <input checked="" type="checkbox"/> Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action<br><br><input checked="" type="checkbox"/> This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                         |                                                                         |
| Owner                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Percent Interest                                                                        |                                                                         |
| Godo Kaisha IP Bridge 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 100%                                                                                    |                                                                         |
| <p>The owner(s) with percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of prior patent number(s)</p> <p>7884403</p> <p>as the term of said prior patent is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the prior patent are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.</p> <p>In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the prior patent, "as the term of said prior patent is presently shortened by any terminal disclaimer," in the event that said prior patent later:</p> <ul style="list-style-type: none"> <li>- expires for failure to pay a maintenance fee;</li> <li>- is held unenforceable;</li> <li>- is found invalid by a court of competent jurisdiction;</li> <li>- is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;</li> <li>- has all claims canceled by a reexamination certificate;</li> <li>- is reissued; or</li> <li>- is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.</li> </ul> <p><input checked="" type="radio"/> Terminal disclaimer fee under 37 CFR 1.20(d) is included with Electronic Terminal Disclaimer request.</p> |                                                                                         |                                                                         |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| <input type="radio"/> I certify, in accordance with 37 CFR 1.4(d)(4), that the terminal disclaimer fee under 37 CFR 1.20(d) required for this terminal disclaimer has already been paid in the above-identified application.                                                                                                                                                                                                                                                                                                                                                                                                                                              |                  |
| Applicant claims the following fee status:<br><br><input type="radio"/> Small Entity<br><br><input type="radio"/> Micro Entity<br><br><input checked="" type="radio"/> Regular Undiscounted                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  |
| I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.                                                                                                                                                             |                  |
| THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES<br><br>I certify, in accordance with 37 CFR 1.4(d)(4) that I am:<br><br><input checked="" type="radio"/> An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application<br><br>Registration Number <u>46947</u><br><br><input type="radio"/> A sole inventor<br><br><input type="radio"/> A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application<br><br><input type="radio"/> A joint inventor; all of whom are signing this request |                  |
| Signature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | /Brian S. Myers/ |
| Name                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Brian S. Myers   |

\*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).  
 Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

| Electronic Patent Application Fee Transmittal |          |                                                                        |        |                      |
|-----------------------------------------------|----------|------------------------------------------------------------------------|--------|----------------------|
| Application Number:                           |          | 18232576                                                               |        |                      |
| Filing Date:                                  |          | 10-Aug-2023                                                            |        |                      |
| Title of Invention:                           |          | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM) |        |                      |
| First Named Inventor/Applicant Name:          |          | Shinji YUASA                                                           |        |                      |
| Filer:                                        |          | Brian S. Myers/Oleksandra Onishchuk                                    |        |                      |
| Attorney Docket Number:                       |          | IBTH 13318Aa                                                           |        |                      |
| Filed as Large Entity                         |          |                                                                        |        |                      |
| Filing Fees for Utility under 35 USC 111(a)   |          |                                                                        |        |                      |
| Description                                   | Fee Code | Quantity                                                               | Amount | Sub-Total in USD(\$) |
| Basic Filing:                                 |          |                                                                        |        |                      |
| STATUTORY OR TERMINAL DISCLAIMER              | 1814     | 1                                                                      | 170    | 170                  |
| Pages:                                        |          |                                                                        |        |                      |
| Claims:                                       |          |                                                                        |        |                      |
| Miscellaneous-Filing:                         |          |                                                                        |        |                      |
| Petition:                                     |          |                                                                        |        |                      |
| Patent-Appeals-and-Interference:              |          |                                                                        |        |                      |
| Post-Allowance-and-Post-Issuance:             |          |                                                                        |        |                      |

| Description        | Fee Code | Quantity | Amount | Sub-Total in USD(\$) |
|--------------------|----------|----------|--------|----------------------|
| Extension-of-Time: |          |          |        |                      |
| Miscellaneous:     |          |          |        |                      |
| Total in USD (\$)  |          |          |        | 170                  |

Doc Code: DISQ.E.FILE

Document Description: Electronic Terminal Disclaimer – Approved

Application No.: 18232576

Filing Date: 10-Aug-2023

Applicant/Patent under Reexamination: YUASA

Electronic Terminal Disclaimer filed on November 2, 2023

☒ APPROVED

**This patent is subject to a terminal disclaimer**

☐ DISAPPROVED

Approved/Disapproved by: Electronic Terminal Disclaimer automatically approved by EFS-Web

U.S. Patent and Trademark Office

## Electronic Acknowledgement Receipt

|                                             |                                                                        |
|---------------------------------------------|------------------------------------------------------------------------|
| <b>EFS ID:</b>                              | 48790813                                                               |
| <b>Application Number:</b>                  | 18232576                                                               |
| <b>International Application Number:</b>    |                                                                        |
| <b>Confirmation Number:</b>                 | 1021                                                                   |
| <b>Title of Invention:</b>                  | METHOD OF MANUFACTURING A MAGNETORESISTIVE RANDOM ACCESS MEMORY (MRAM) |
| <b>First Named Inventor/Applicant Name:</b> | Shinji YUASA                                                           |
| <b>Customer Number:</b>                     | 61650                                                                  |
| <b>Filer:</b>                               | Brian S. Myers/Oleksandra Onishchuk                                    |
| <b>Filer Authorized By:</b>                 | Brian S. Myers                                                         |
| <b>Attorney Docket Number:</b>              | IBTH 13318Aa                                                           |
| <b>Receipt Date:</b>                        | 02-NOV-2023                                                            |
| <b>Filing Date:</b>                         | 10-AUG-2023                                                            |
| <b>Time Stamp:</b>                          | 13:56:05                                                               |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)                                            |

### Payment information:

|                                          |                  |
|------------------------------------------|------------------|
| Submitted with Payment                   | yes              |
| Payment Type                             | CARD             |
| Payment was successfully received in RAM | \$ 170           |
| RAM confirmation Number                  | E2023A2D56039041 |
| Deposit Account                          |                  |
| Authorized User                          |                  |

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

| <b>File Listing:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                        |                          |                                          |                  |                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|--------------------------|------------------------------------------|------------------|------------------|
| Document Number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Document Description                   | File Name                | File Size(Bytes)/<br>Message Digest      | Multi Part /.zip | Pages (if appl.) |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Terminal Disclaimer-Filed (Electronic) | eTerminal-Disclaimer.pdf | 41266                                    | no               | 2                |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                        |                          | 6a2535a3ec3ff30920c8b4d3804101af1af11c3f |                  |                  |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                        |                          |                                          |                  |                  |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                        |                          |                                          |                  |                  |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Fee Worksheet (SB06)                   | fee-info.pdf             | 37940                                    | no               | 2                |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                        |                          | 017d812ba857e7506f4d0875a10c7c50fd6d3e27 |                  |                  |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                        |                          |                                          |                  |                  |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                        |                          |                                          |                  |                  |
| <b>Total Files Size (in bytes):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                        |                          | 79206                                    |                  |                  |
| <p><b>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</b></p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b><br/> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</p> <p><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b><br/> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</p> <p><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b><br/> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</p> |                                        |                          |                                          |                  |                  |

|                                                                                                                  |                                              |                                                                 |
|------------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------------------------|
| <b>Issue Classification</b><br> | <b>Application/Control No.</b><br>18/232,576 | <b>Applicant(s)/Patent Under Reexamination</b><br>YUASA, Shinji |
|                                                                                                                  | <b>Examiner</b><br>ALONZO CHAMBLISS          | <b>Art Unit</b><br>2897                                         |

| CPC    |   |    |   |      |      |            |
|--------|---|----|---|------|------|------------|
| Symbol |   |    |   |      | Type | Version    |
| H10N   | / | 50 | / | 85   | F    | 2023-02-01 |
| G11C   | / | 11 | / | 16   | I    | 2013-01-01 |
| H10B   | / | 61 | / | 00   | I    | 2023-02-01 |
| H01F   | / | 10 | / | 3254 | I    | 2013-01-01 |
| H10B   | / | 61 | / | 22   | I    | 2023-02-01 |
| H10N   | / | 50 | / | 10   | I    | 2023-02-01 |
| H01F   | / | 10 | / | 132  | I    | 2013-01-01 |
| H01L   | / | 28 | / | 55   | I    | 2013-01-01 |
| H10N   | / | 50 | / | 80   | I    | 2023-02-01 |
| G11C   | / | 11 | / | 15   | I    | 2013-01-01 |
| B82Y   | / | 25 | / | 00   | I    | 2013-01-01 |
| G11C   | / | 11 | / | 161  | I    | 2013-01-01 |
| H10N   | / | 50 | / | 01   | I    | 2023-02-01 |
| H10B   | / | 53 | / | 30   | I    | 2023-02-01 |
| H10N   | / | 59 | / | 00   | A    | 2023-02-01 |
| B82Y   | / | 10 | / | 00   | A    | 2013-01-01 |

| CPC Combination Sets |      |     |         |         |
|----------------------|------|-----|---------|---------|
| Symbol               | Type | Set | Ranking | Version |
| /                    |      |     |         |         |

|                                                       |                              |                     |
|-------------------------------------------------------|------------------------------|---------------------|
| NONE                                                  | <b>Total Claims Allowed:</b> |                     |
| (Assistant Examiner)                                  | (Date)                       | 20                  |
| /ALONZO CHAMBLISS/<br>Primary Examiner, Art Unit 2897 | 06 November 2023             | O.G. Print Claim(s) |
| (Primary Examiner)                                    | (Date)                       | 3                   |
|                                                       |                              | O.G. Print Figure   |
|                                                       |                              | 1B                  |

|                                                                                                                  |                                              |                                                                 |
|------------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------------------------|
| <b>Issue Classification</b><br> | <b>Application/Control No.</b><br>18/232,576 | <b>Applicant(s)/Patent Under Reexamination</b><br>YUASA, Shinji |
|                                                                                                                  | <b>Examiner</b><br>ALONZO CHAMBLISS          | <b>Art Unit</b><br>2897                                         |

|                                     |   |    |   |    |  |
|-------------------------------------|---|----|---|----|--|
| <b>INTERNATIONAL CLASSIFICATION</b> |   |    |   |    |  |
| <b>CLAIMED</b>                      |   |    |   |    |  |
| H10N                                | / | 50 | / | 85 |  |
| B82Y                                | / | 25 | / | 00 |  |
| G11C                                | / | 11 | / | 15 |  |
| G11C                                | / | 11 | / | 16 |  |
| H01F                                | / | 10 | / | 32 |  |
| H10B                                | / | 53 | / | 30 |  |
| H10B                                | / | 61 | / | 00 |  |
| <b>NON-CLAIMED</b>                  |   |    |   |    |  |
|                                     | / |    | / |    |  |

|                                   |                 |
|-----------------------------------|-----------------|
| <b>US ORIGINAL CLASSIFICATION</b> |                 |
| <b>CLASS</b>                      | <b>SUBCLASS</b> |
|                                   |                 |

|                            |                                          |  |  |  |  |  |
|----------------------------|------------------------------------------|--|--|--|--|--|
| <b>CROSS REFERENCES(S)</b> |                                          |  |  |  |  |  |
| <b>CLASS</b>               | <b>SUBCLASS (ONE SUBCLASS PER BLOCK)</b> |  |  |  |  |  |
|                            |                                          |  |  |  |  |  |

|                                                                             |                            |                              |                         |
|-----------------------------------------------------------------------------|----------------------------|------------------------------|-------------------------|
| NONE                                                                        |                            | <b>Total Claims Allowed:</b> |                         |
| (Assistant Examiner)                                                        | (Date)                     | 20                           |                         |
| /ALONZO CHAMBLISS/<br>Primary Examiner, Art Unit 2897<br>(Primary Examiner) | 06 November 2023<br>(Date) | O.G. Print Claim(s)<br>3     | O.G. Print Figure<br>1B |

|                                                                                                                  |                                              |                                                                 |
|------------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------------------------|
| <b>Issue Classification</b><br> | <b>Application/Control No.</b><br>18/232,576 | <b>Applicant(s)/Patent Under Reexamination</b><br>YUASA, Shinji |
|                                                                                                                  | <b>Examiner</b><br>ALONZO CHAMBLISS          | <b>Art Unit</b><br>2897                                         |

☐ Claims renumbered in the same order as presented by applicant    ☐ CPA    ☐ T.D.    ☐ R.1.47

| CLAIMS |          |       |          |       |          |       |          |       |          |       |          |       |          |       |          |
|--------|----------|-------|----------|-------|----------|-------|----------|-------|----------|-------|----------|-------|----------|-------|----------|
| Final  | Original | Final | Original | Final | Original | Final | Original | Final | Original | Final | Original | Final | Original | Final | Original |
|        | 1        | 8     | 10       | 17    | 19       |       |          |       |          |       |          |       |          |       |          |
|        | 2        | 9     | 11       | 18    | 20       |       |          |       |          |       |          |       |          |       |          |
| 1      | 3        | 10    | 12       | 19    | 21       |       |          |       |          |       |          |       |          |       |          |
| 2      | 4        | 11    | 13       | 20    | 22       |       |          |       |          |       |          |       |          |       |          |
| 3      | 5        | 12    | 14       |       |          |       |          |       |          |       |          |       |          |       |          |
| 4      | 6        | 13    | 15       |       |          |       |          |       |          |       |          |       |          |       |          |
| 5      | 7        | 14    | 16       |       |          |       |          |       |          |       |          |       |          |       |          |
| 6      | 8        | 15    | 17       |       |          |       |          |       |          |       |          |       |          |       |          |
| 7      | 9        | 16    | 18       |       |          |       |          |       |          |       |          |       |          |       |          |

|                                                       |                              |                     |
|-------------------------------------------------------|------------------------------|---------------------|
| NONE                                                  | <b>Total Claims Allowed:</b> |                     |
| (Assistant Examiner)                                  | (Date)                       | 20                  |
| /ALONZO CHAMBLISS/<br>Primary Examiner, Art Unit 2897 | 06 November 2023             | O.G. Print Claim(s) |
| (Primary Examiner)                                    | (Date)                       | 3                   |
|                                                       |                              | O.G. Print Figure   |
|                                                       |                              | 1B                  |

|                                                                                                                 |                                              |                                                                 |
|-----------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------------------------|
| <b><i>Search Notes</i></b><br> | <b>Application/Control No.</b><br>18/232,576 | <b>Applicant(s)/Patent Under Reexamination</b><br>YUASA, Shinji |
|                                                                                                                 | <b>Examiner</b><br>ALONZO CHAMBLISS          | <b>Art Unit</b><br>2897                                         |

| CPC - Searched*                                                                                                               |            |          |
|-------------------------------------------------------------------------------------------------------------------------------|------------|----------|
| Symbol                                                                                                                        | Date       | Examiner |
| H10B61/00, 53/30, 61/22; H01F10/132, 10/3254; G11C11/15, 11/16, 11/161; H10N 50/85, 50/01, 50/80, 50/10; H01L28/55; B82Y25/00 | 10/01/2023 | AC       |
| H10B61/00, 53/30, 61/22; H01F10/132, 10/3254; G11C11/15, 11/16, 11/161; H10N 50/85, 50/01, 50/80, 50/10; H01L28/55; B82Y25/00 | 11/06/2023 | AC       |

| CPC Combination Sets - Searched* |      |          |
|----------------------------------|------|----------|
| Symbol                           | Date | Examiner |
|                                  |      |          |

| US Classification - Searched* |          |      |          |
|-------------------------------|----------|------|----------|
| Class                         | Subclass | Date | Examiner |
|                               |          |      |          |

\* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

| Search Notes                                                     |            |          |
|------------------------------------------------------------------|------------|----------|
| Search Notes                                                     | Date       | Examiner |
| East text search only - see attached printout                    | 10/01/2023 | AC       |
| Ip.com text search only - see attached printout                  | 10/01/2023 | AC       |
| Updated previous East text search only - see attached printout   | 11/06/2023 | AC       |
| Updated previous Ip.com text search only - see attached printout | 11/06/2023 | AC       |

|  |  |
|--|--|
|  |  |
|--|--|

|                                                                                                                 |                                              |                                                                 |
|-----------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------------------------|
| <b><i>Search Notes</i></b><br> | <b>Application/Control No.</b><br>18/232,576 | <b>Applicant(s)/Patent Under Reexamination</b><br>YUASA, Shinji |
|                                                                                                                 | <b>Examiner</b><br>ALONZO CHAMBLISS          | <b>Art Unit</b><br>2897                                         |

| Interference Search             |                       |            |          |
|---------------------------------|-----------------------|------------|----------|
| US Class/CPC Symbol             | US Subclass/CPC Group | Date       | Examiner |
| US PGPUB<br>text search<br>only |                       | 11/06/2023 | AC       |

|  |  |
|--|--|
|  |  |
|--|--|

# PE2E SEARCH - Search History (Prior Art)

| Ref # | Hits | Search Query                                                                                                                                                                                                        | DBs                                                                                                                                                                                                                                                            | Default Operator | Plurals | British Equivalents | Time Stamp             |
|-------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------|---------------------|------------------------|
| L1    | 9    | ("11737372"<br>"11233193" "10680167"<br>"10367138" "9608198"<br>"9123463" "8405134"<br>"8319263"<br>"7884403").pn.                                                                                                  | (US-PGPUB; USPAT)                                                                                                                                                                                                                                              | OR               | ON      | ON                  | 2023/10/01<br>01:53 PM |
| L2    | 1    | ("20040109347").pn.                                                                                                                                                                                                 | (US-PGPUB; USPAT)                                                                                                                                                                                                                                              | OR               | ON      | ON                  | 2023/10/01<br>07:22 PM |
| L3    | 1    | ("11737372").pn.                                                                                                                                                                                                    | (US-PGPUB; USPAT)                                                                                                                                                                                                                                              | OR               | ON      | ON                  | 2023/10/01<br>07:23 PM |
| L4    | 1    | godo.as. AND (bottom<br>first) adj2 ferromagnetic<br>adj2 (layer film) AND<br>(second top) adj2<br>ferromagnetic adj2<br>(layer film) AND (MgO<br>magnesium adj2 oxide)<br>WITH barrier adj2 (layer<br>film)        | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB) | OR               | ON      | ON                  | 2023/10/01<br>10:12 PM |
| L5    | 75   | yuasa.in. AND (bottom<br>first) adj2 ferromagnetic<br>adj2 (layer film) AND<br>(second top) adj2<br>ferromagnetic adj2<br>(layer film) AND (MgO<br>magnesium adj2 oxide)<br>WITH barrier adj2 (layer<br>film)       | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB) | OR               | ON      | ON                  | 2023/10/01<br>10:14 PM |
| L6    | 454  | 257/\$.ccls. AND<br>(bottom first) adj2<br>ferromagnetic adj2<br>(layer film) AND<br>(second top) adj2<br>ferromagnetic adj2<br>(layer film) AND (MgO<br>magnesium adj2 oxide)<br>WITH barrier adj2 (layer<br>film) | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB) | OR               | ON      | ON                  | 2023/10/01<br>10:19 PM |
| L7    | 166  | 438/\$.ccls. AND<br>(bottom first) adj2<br>ferromagnetic adj2<br>(layer film) AND<br>(second top) adj2<br>ferromagnetic adj2<br>(layer film) AND (MgO<br>magnesium adj2 oxide)                                      | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,                                                                 | OR               | ON      | ON                  | 2023/10/01<br>10:19 PM |

|     |     |                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                            |    |    |    |                     |
|-----|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|---------------------|
| L8  | 0   | WITH barrier adj2 (layer film)<br>361/\$.ccls. AND (bottom first) adj2 ferromagnetic adj2 (layer film) AND (second top) adj2 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) WITH barrier adj2 (layer film) | MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)<br>(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2023/10/01 10:19 PM |
| L9  | 481 | L6 L7                                                                                                                                                                                                                      | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                           | OR | ON | ON | 2023/10/01 10:20 PM |
| L10 | 469 | L9 AND ( (H10N50/10 OR H10N50/01 OR H10N50/85 OR H10N50/80 OR G11C11/161 OR G11C11/16 OR G11C11/15 OR B82Y25/00 OR H10B53/30 OR H10B61/22 OR H10B61/00 OR H01F10/3254 OR H01F10/132 OR H01L28/55).cpc.)                    | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                           | OR | ON | ON | 2023/10/01 10:29 PM |
| L11 | 24  | "11737372"                                                                                                                                                                                                                 | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                           | OR | ON | ON | 2023/10/01 10:31 PM |
| L12 | 2   | ("11737372").pn.                                                                                                                                                                                                           | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB,                                                                                                                                                                  | OR | ON | ON | 2023/10/01 10:32 PM |

|     |     |                                                                                                                                                                                                      |                                                                                                                                                                                                                                  |    |    |    |                     |
|-----|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|---------------------|
| L13 | 4   | ("11233193").pn.                                                                                                                                                                                     | HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                                                                                           | OR | ON | ON | 2023/10/01 10:34 PM |
| L14 | 597 | 257/\$.ccls. AND (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film) | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2023/11/06 05:04 PM |
| L15 | 220 | 438/\$.ccls. AND (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film) | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2023/11/06 05:05 PM |
| L16 | 0   | 361/\$.ccls. AND (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film) | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2023/11/06 05:05 PM |
| L17 | 634 | L14 L15                                                                                                                                                                                              | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS,                                                                                | OR | ON | ON | 2023/11/06 05:05 PM |

|     |     |                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                 |    |    |    |                     |
|-----|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|---------------------|
| L18 | 613 | L17 AND ( (H10N50/10 OR H10N50/01 OR H10N50/85 OR H10N50/80 OR G11C11/161 OR G11C11/16 OR G11C11/15 OR B82Y25/00 OR H10B53/30 OR H10B61/22 OR H10B61/00 OR H01F10/3254 OR H01F10/132 OR H01L28/55).cpc.) | IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2023/11/06 05:12 PM |
|-----|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|---------------------|

## PE2E SEARCH - Search History (Interference)

| Ref # | Hits | Search Query                                                                                                                                                                                         | DBs               | Default Operator | Plurals | British Equivalents | Time Stamp          |
|-------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|------------------|---------|---------------------|---------------------|
| N1    | 566  | 257/\$.ccls. AND (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film) | (US-PGPUB; USPAT) | OR               | ON      | ON                  | 2023/11/06 05:19 PM |
| N2    | 208  | 438/\$.ccls. AND (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film) | (US-PGPUB; USPAT) | OR               | ON      | ON                  | 2023/11/06 05:19 PM |



# Search History

## 18232576

Report Run Date: 2023-11-06 UTC

Searches: 1

Markers: 0

| Search # | Timestamp                            | Results    | Page |
|----------|--------------------------------------|------------|------|
| 1        | <a href="#">2023-11-06 22:20 UTC</a> | 11,145,222 | 3    |



## Content: Patent Publications (169)

US Patents | US Designs | US Applications | EPO Patents | EPO Applications | China Patents | China Applications | Japan Patents | Japan Applications | Korea Patents | Korea Applications | WIPO Applications | Argentina Patents | Argentina Applications | Brazil Patents | Brazil Applications | Canada Patents | Canada Applications | Chile Patents | Chile Applications | Colombia Applications | Costa Rica Applications | Cuba Patents | Cuba Applications | Dominican Republic Applications | Ecuador Patents | Ecuador Applications | El Salvador Applications | Guatemala Applications | Honduras Applications | Mexico Patents | Mexico Applications | Nicaragua Patents | Panama Applications | Peru Applications | Trinidad & Tobago Patents | Uruguay Applications | Austria Patents | Austria Applications | Belarus Patents | Belgium Patents | Belgium Applications | Bosnia & Herzegovina Patents | Bosnia & Herzegovina Applications | Bulgaria Patents | Bulgaria Applications | Croatia Patents | Croatia Applications | Czech Republic Patents | Czech Republic Applications | Czechoslovakia Patents | Czechoslovakia Applications | Denmark Patents | Denmark Applications | Estonia Patents | Estonia Applications | EUIPO Patents | Finland Patents | Finland Applications | France Patents | France Applications | Germany Patents | Germany Applications | Great Britain Patents | Great Britain Applications | Greece Patents | Greece Applications | Hungary Patents | Hungary Applications | Iceland Patents | Iceland Applications | Ireland Patents | Ireland Applications | Italy Patents | Italy Applications | Latvia Patents | Latvia Applications | Lithuania Patents | Lithuania Applications | Luxembourg Patents | Luxembourg Applications | Malta Patents | Monaco Patents | Montenegro Patents | Montenegro Applications | Netherlands Patents | Netherlands Applications | Norway Patents | Norway Applications | Poland Patents | Poland Applications | Portugal Patents | Portugal Applications | Republic of Moldova Patents | Republic of Moldova Applications | Romania Patents | Romania Applications | San Marino Patents | San Marino Applications | Serbia Patents | Serbia Applications | Slovakia Patents | Slovakia Applications | Slovenia Patents | Spain Patents | Spain Applications | Sweden Patents | Sweden Applications | Switzerland Patents | Switzerland Applications | Ukraine Patents | Yugoslavia/Serbia and Montenegro Patents | Yugoslavia/Serbia and Montenegro Applications | Armenia Patents | Australia Patents | Australia Applications | Cyprus Patents | Gulf Cooperation Council Patents | Hong Kong Patents | India Patents | India Applications | Indonesia Patents | Indonesia Applications | Israel Patents | Israel Applications | Jordan Patents | Jordan Applications | Kyrgyzstan Patents | Macao Applications | Malaysia Patents | Mongolia Patents | New Zealand Patents | Philippines Patents | Philippines Applications | Saudi Arabia Patents | Saudi Arabia Applications | Singapore Patents | Singapore Applications | Taiwan Patents | Taiwan Applications | Tajikistan Patents | Tajikistan Applications | Thailand Patents | Thailand Applications | Uzbekistan Patents | Vietnam Patents | Algeria Patents | ARIPO Patents | ARIPO Applications | Egypt Patents | Kenya Patents | Malawi Patents | Morocco Patents | Morocco Applications | OAPI Patents | South Africa Patents | Tunisia Applications | Zambia Patents | Zimbabwe Patents | EAPO Patents | EAPO Applications | Georgia Patents | Georgia Applications | Kazakhstan Patents | Kazakhstan Applications | Russia Patents | Russia Applications | Turkey Patents | Turkey Applications

1 2023-11-06 22:20 UTC | 11,145,222 results from

**De-Dup:** None | **Relevance Cut-off:** None | **Sort:** Relevance

**Main Concept:** Text

(bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film)

**Concept Modifiers:** None

**Filters:** None



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

## NOTICE OF ALLOWANCE AND FEE(S) DUE

61650 7590 11/15/2023  
MYERS WOLIN, LLC  
100 SOUTH JEFFERSON ROAD  
SUITE 202  
WHIPPANY, NJ 07981-1009

|                   |              |
|-------------------|--------------|
| EXAMINER          |              |
| CHAMBLISS, ALONZO |              |
| ART UNIT          | PAPER NUMBER |
| 2897              |              |

DATE MAILED: 11/15/2023

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 18/232,576      | 08/10/2023  | Shinji YUASA         |                     | 1021             |

TITLE OF INVENTION: MAGNETIC TUNNEL JUNCTION DEVICE

| APPLN. TYPE    | ENTITY STATUS | ISSUE FEE DUE | PUBLICATION FEE DUE | PREV. PAID ISSUE FEE | TOTAL FEE(S) DUE | DATE DUE   |
|----------------|---------------|---------------|---------------------|----------------------|------------------|------------|
| nonprovisional | UNDISCOUNTED  | \$1200        | \$0.00              | \$0.00               | \$1200           | 02/15/2024 |

**THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.**

**THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.**

### HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 40% the amount of undiscounted fees, and micro entity fees are 20% the amount of undiscounted fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

**IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at [www.uspto.gov/PatentMaintenanceFees](http://www.uspto.gov/PatentMaintenanceFees).**

**PART B - FEE(S) TRANSMITTAL**

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

**INSTRUCTIONS:** This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

61650 7590 11/15/2023  
MYERS WOLIN, LLC  
100 SOUTH JEFFERSON ROAD  
SUITE 202  
WHIPPANY, NJ 07981-1009

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

**Certificate of Mailing or Transmission**

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

|                         |
|-------------------------|
| (Typed or printed name) |
| (Signature)             |
| (Date)                  |

| APPLICATION NO.                                     | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------------------------------------------|-------------|----------------------|---------------------|------------------|
| 18/232,576                                          | 08/10/2023  | Shinji YUASA         |                     | 1021             |
| TITLE OF INVENTION: MAGNETIC TUNNEL JUNCTION DEVICE |             |                      |                     |                  |

| APPLN. TYPE       | ENTITY STATUS | ISSUE FEE DUE | PUBLICATION FEE DUE | PREV. PAID ISSUE FEE | TOTAL FEE(S) DUE | DATE DUE   |
|-------------------|---------------|---------------|---------------------|----------------------|------------------|------------|
| nonprovisional    | UNDISCOUNTED  | \$1200        | \$0.00              | \$0.00               | \$1200           | 02/15/2024 |
| EXAMINER          |               | ART UNIT      | CLASS-SUBCLASS      |                      |                  |            |
| CHAMBLISS, ALONZO |               | 2897          | 257-421000          |                      |                  |            |

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 \_\_\_\_\_

2 \_\_\_\_\_

3 \_\_\_\_\_

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☐ Issue Fee ☐ Publication Fee (if required)

4b. Method of Payment: (Please first reapply any previously paid fee shown above)

☐ Electronic Payment via Patent Center or EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. \_\_\_\_\_

5. Change in Entity Status (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

**NOTE:** Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

**NOTE:** If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

**NOTE:** Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

**NOTE:** This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature \_\_\_\_\_

Date \_\_\_\_\_

Typed or printed name \_\_\_\_\_

Registration No. \_\_\_\_\_



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

| APPLICATION NO.          | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|--------------------------|-------------|----------------------|---------------------|------------------|
| 18/232,576               | 08/10/2023  | Shinji YUASA         |                     | 1021             |
| 61650                    | 7590        | 11/15/2023           |                     |                  |
| MYERS WOLIN, LLC         |             |                      |                     |                  |
| 100 SOUTH JEFFERSON ROAD |             |                      |                     |                  |
| SUITE 202                |             |                      |                     |                  |
| WHIPPANY, NJ 07981-1009  |             |                      |                     |                  |
| EXAMINER                 |             |                      |                     |                  |
| CHAMBLISS, ALONZO        |             |                      |                     |                  |
| ART UNIT                 |             | PAPER NUMBER         |                     |                  |
| 2897                     |             |                      |                     |                  |

DATE MAILED: 11/15/2023

## Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

## OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

### Privacy Act Statement

**The Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

|                               |                                      |                                      |                                |
|-------------------------------|--------------------------------------|--------------------------------------|--------------------------------|
| <b>Notice of Allowability</b> | <b>Application No.</b><br>18/232,576 | <b>Applicant(s)</b><br>YUASA, Shinji |                                |
|                               | <b>Examiner</b><br>ALONZO CHAMBLISS  | <b>Art Unit</b><br>2897              | <b>AIA (FITF) Status</b><br>No |

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--**

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to the terminal disclaimer filed on 11/2/2023.  
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on \_\_\_\_\_.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on \_\_\_\_\_; the restriction requirement and election have been incorporated into this action.

3. ☒ The allowed claim(s) is/are 3-22. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see [http://www.uspto.gov/patents/init\\_events/pph/index.jsp](http://www.uspto.gov/patents/init_events/pph/index.jsp) or send an inquiry to [PPHfeedback@uspto.gov](mailto:PPHfeedback@uspto.gov).

4. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

**Certified copies:**

a) ☒ All      b) ☐ Some\*      c) ☐ None of the:

1. ☐ Certified copies of the priority documents have been received.

2. ☒ Certified copies of the priority documents have been received in Application No. 10/591,947.

3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

\* Certified copies not received: \_\_\_\_\_.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.  
**THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.**

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.  
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date \_\_\_\_\_.

**Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).**

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

**Attachment(s)**

|                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. <input type="checkbox"/> Notice of References Cited (PTO-892)<br>2. <input type="checkbox"/> Information Disclosure Statements (PTO/SB/08),<br>Paper No./Mail Date _____.<br>3. <input type="checkbox"/> Examiner's Comment Regarding Requirement for Deposit<br>of Biological Material _____.<br>4. <input type="checkbox"/> Interview Summary (PTO-413),<br>Paper No./Mail Date _____. | 5. <input type="checkbox"/> Examiner's Amendment/Comment<br>6. <input checked="" type="checkbox"/> Examiner's Statement of Reasons for Allowance<br>7. <input checked="" type="checkbox"/> Other <u>see Detailed Action</u> . |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

/ALONZO CHAMBLISS/  
Primary Examiner, Art Unit 2897

***Notice of Pre-AIA or AIA Status***

1. The present application is being examined under the pre-AIA first to invent provisions.

***Terminal Disclaimer***

2. The terminal disclaimer filed on 11/2/2023 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of U.S. Patent No. 7,884,403 has been reviewed and is accepted. The terminal disclaimer has been recorded.

***Allowable Subject Matter***

3. The following is a statement of reasons for the indication of allowance subject matter: the prior art of record does not teach or suggest matter: the prior art of record does not teach or suggest the combination of the a tunnel barrier layer between the first ferromagnetic material layer and the second ferromagnetic material layer, wherein said tunnel barrier layer comprises crystalline MgOx (001) with oxygen vacancy defects and  $(0 < x < 1)$  in claim 3.

A tunnel barrier layer between the first ferromagnetic material layer and the second ferromagnetic material layer, wherein said tunnel barrier layer comprises magnesium oxide and has a barrier height in a range of 0.1 eV to 0.85 eV in claim 11.

A tunnel barrier layer disposed on the first ferromagnetic material layer, wherein said tunnel barrier layer comprises magnesium oxide and has a barrier height in a range of 0.2 eV to 0.5 eV in claim 17.

Any inquiry concerning the communication or earlier communications from the examiner should be directed to Alonzo Chambliss whose telephone number is (571) 272-1927.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Fernando L. Toledo can be reached on (571) 272-1867. The fax phone number for the organization where this application or proceeding is assigned is 571 - 273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PMR or Public PMR.

Status information for unpublished applications is available through Private PMR only. For more information about the PMR system see <http://pair-dkect.uspto.gov>.

Should you have questions on access to the Private PMR system contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free) or [EBC\\_Support@uspto.gov](mailto:EBC_Support@uspto.gov).

**AC**/November 6, 2023

/Alonzo Chambliss/

Primary Examiner, Art Unit 2897



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
[www.uspto.gov](http://www.uspto.gov)

| APPLICATION NUMBER | FILING OR 371(C) DATE | FIRST NAMED APPLICANT | ATTY. DOCKET NO./TITLE |
|--------------------|-----------------------|-----------------------|------------------------|
| 18/232,576         | 08/10/2023            | Shinji YUASA          |                        |

61650  
MYERS WOLIN, LLC  
100 SOUTH JEFFERSON ROAD  
SUITE 202  
WHIPPANY, NJ 07981-1009

**CONFIRMATION NO. 1021**

## PUBLICATION NOTICE



\*OC000000066182440\*

Date Mailed: 12/22/2023

**Title:**MAGNETIC TUNNEL JUNCTION DEVICE

**Publication No.**US-2023-0413685-A1

**Publication Date:**12/21/2023

## NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at [www.uspto.gov](http://www.uspto.gov). The direct link to access the publication is currently <http://www.uspto.gov/patft/>.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at [www.uspto.gov](http://www.uspto.gov) using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently <https://portal.uspto.gov/pair/> PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

UNITED STATES  
PATENT AND TRADEMARK OFFICEP.O. Box 1450  
Alexandria, VA 22313 - 1450  
www.uspto.gov

## ELECTRONIC PAYMENT RECEIPT

APPLICATION #  
**18/232,576**RECEIPT DATE / TIME  
**02/12/2024 03:51:37 PM Z ET**ATTORNEY DOCKET #  
**IBTH 13318Aa**

### Title of Invention

MAGNETIC TUNNEL JUNCTION DEVICE

### Application Information

APPLICATION TYPE    Utility - Nonprovisional Application  
under 35 USC 111(a)

PATENT #    -

CONFIRMATION #    1021

FILED BY    Monica Franke

PATENT CENTER #    64291235

AUTHORIZED BY    Brian MYERS

CUSTOMER #    61650

FILING DATE    08/10/2023

CORRESPONDENCE  
ADDRESS    -FIRST NAMED  
INVENTOR    Shinji YUASA

### Payment Information

PAYMENT METHOD  
CARD / 1248PAYMENT TRANSACTION ID  
E20242BF53168802PAYMENT AUTHORIZED BY  
Oleksandra Onishchuk

| FEE CODE                 | DESCRIPTION       | ITEM PRICE(\$) | QUANTITY | ITEM TOTAL(\$)    |
|--------------------------|-------------------|----------------|----------|-------------------|
| 1501                     | UTILITY ISSUE FEE | 1200.00        | 1        | 1200.00           |
| <b>TOTAL<br/>AMOUNT:</b> |                   |                |          | <b>\$1,200.00</b> |

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

#### New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

#### National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

**WD EX1086**  
**Western Digital v IP Bridge, IPR2024-01494**  
**Page 222**

**New International Application Filed with the USPTO as a Receiving Office**

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

61650 7590 11/15/2023  
MYERS WOLIN, LLC  
100 SOUTH JEFFERSON ROAD  
SUITE 202  
WHIPPANY, NJ 07981-1009

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

|                         |
|-------------------------|
| (Typed or printed name) |
| (Signature)             |
| (Date)                  |

| APPLICATION NO.                                     | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------------------------------------------|-------------|----------------------|---------------------|------------------|
| 18/232,576                                          | 08/10/2023  | Shinji YUASA         |                     | 1021             |
| TITLE OF INVENTION: MAGNETIC TUNNEL JUNCTION DEVICE |             |                      |                     |                  |

| APPLN. TYPE       | ENTITY STATUS | ISSUE FEE DUE | PUBLICATION FEE DUE | PREV. PAID ISSUE FEE | TOTAL FEE(S) DUE | DATE DUE   |
|-------------------|---------------|---------------|---------------------|----------------------|------------------|------------|
| nonprovisional    | UNDISCOUNTED  | \$1200        | \$0.00              | \$0.00               | \$1200           | 02/15/2024 |
| EXAMINER          |               | ART UNIT      | CLASS-SUBCLASS      |                      |                  |            |
| CHAMBLISS, ALONZO |               | 2897          | 257-421000          |                      |                  |            |

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Myers Wolin, LLC

2

3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

Godo Kaisha IP Bridge 1

(B) RESIDENCE: (CITY AND STATE OR COUNTRY)

Tokyo, Japan

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required)

4b. Method of Payment: (Please first reapply any previously paid fee shown above)

☒ Electronic Payment via Patent Center or EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 50-3894

5. Change in Entity Status (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Brian S. Myers/

Date February 12, 2024

Typed or printed name Brian S. Myers

Registration No. 46947

UNITED STATES  
PATENT AND TRADEMARK OFFICEP.O. Box 1450  
Alexandria, VA 22313 - 1450  
www.uspto.gov

# ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #  
**18/232,576**RECEIPT DATE / TIME  
**02/12/2024 03:51:37 PM Z ET**ATTORNEY DOCKET #  
**IBTH 13318Aa**

## Title of Invention

MAGNETIC TUNNEL JUNCTION DEVICE

## Application Information

APPLICATION TYPE    Utility - Nonprovisional Application  
under 35 USC 111(a)

PATENT #    -

CONFIRMATION #    1021

FILED BY    Monica Franke

PATENT CENTER #    64291235

FILING DATE    08/10/2023

CUSTOMER #    61650

FIRST NAMED  
INVENTOR    Shinji YUASACORRESPONDENCE  
ADDRESS    -

AUTHORIZED BY    Brian MYERS

## Documents

**TOTAL DOCUMENTS: 1**

| DOCUMENT                                  | PAGES | DESCRIPTION                 | SIZE<br>(KB) |
|-------------------------------------------|-------|-----------------------------|--------------|
| ibth_13318aa_20231115_Fee_Trans_PartB.pdf | 1     | Issue Fee Payment (PTO-85B) | 130 KB       |

## Digest

| DOCUMENT                                  | MESSAGE DIGEST(SHA-512)                                                                                                                  |
|-------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| ibth_13318aa_20231115_Fee_Trans_PartB.pdf | F1537DF6FC3D1D8135453CB4858857EE8FBADDD782A41359<br>E049E855A5BCBE2AE6A5B8E72A35CB4F6A8B46F24566FA0B<br>994041A5752C0463B8A0848BBDEEB4FE |

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

**New Applications Under 35 U.S.C. 111**

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

**National Stage of an International Application under 35 U.S.C. 371**

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

**New International Application Filed with the USPTO as a Receiving Office**

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
**United States Patent and Trademark Office**  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

| APPLICATION NO.          | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|--------------------------|-------------|----------------------|---------------------|------------------|
| 18/232,576               | 08/10/2023  | Shinji YUASA         | IBTH 13318Aa        | 1021             |
| 61650                    | 7590        | 06/12/2024           | EXAMINER            |                  |
| MYERS WOLIN, LLC         |             |                      | CHAMBLISS, ALONZO   |                  |
| 100 SOUTH JEFFERSON ROAD |             |                      |                     |                  |
| SUITE 202                |             |                      |                     |                  |
| WHIPPANY, NJ 07981-1009  |             |                      |                     |                  |
|                          |             |                      | ART UNIT            | PAPER NUMBER     |
|                          |             |                      | 2897                |                  |
|                          |             |                      | MAIL DATE           | DELIVERY MODE    |
|                          |             |                      | 06/12/2024          | PAPER            |

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.



UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents  
United States Patent and Trademark Office  
P.O. Box 1450  
Alexandria, VA 22313-1450  
[www.uspto.gov](http://www.uspto.gov)

MYERS WOLIN, LLC  
100 South Jefferson Road  
Suite 202  
Whippany, NJ 07981-1009

*In re* Application of YUASA, Shinji  
Application No.: 18/232576  
Filed: 10 August 2023  
For: **Magnetic Tunnel Junction Device**

:  
:  
: **WITHDRAWAL FROM ISSUE**  
: *37 CFR 1.313*  
:

The purpose of this communication is to inform you that the above-identified application is being withdrawn from issue due to unpatentability of one or more claims pursuant to 37 C.F.R. § 1.313.

The above-identified application is hereby withdrawn from issue. The Notice of Allowance and Issue Fee(s) Due and the Notice of Allowability mailed 15 November 2023 are hereby vacated.

The application is being withdrawn to permit reopening of prosecution. The reasons therefor will be communicated to you by the examiner.

The U.S. Patent and Trademark Office records reveal that the issue fee has been paid. The applicant may request a refund, or may request that the fee be credited to a deposit account. However, applicant may wait until the application is either again found allowable or held abandoned. If the application is allowed, upon receipt of a new Notice of Allowance and Fee(s) Due, applicant may request that the previously submitted issue fee be applied toward payment of the issue fee in the amount identified on the new Notice of Allowance and Fee(s) Due. If the application is abandoned, applicant may request either a refund or a credit to a Deposit Account.



UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents  
United States Patent and Trademark Office  
P.O. Box 1450  
Alexandria, VA 22313-1450  
[www.uspto.gov](http://www.uspto.gov)

Any question regarding this communication should be directed to Fernando Toledo, Supervisory Patent Examiner, at (571) 272-1867.

**/JOSEPH THOMAS/**

\_\_\_\_\_  
Joseph Thomas, Director  
Technology Center 2800  
JT/ft;ms

|                                   |                                       |                                                             |             |
|-----------------------------------|---------------------------------------|-------------------------------------------------------------|-------------|
| <i>Notice of References Cited</i> | Application/Control No.<br>18/232,576 | Applicant(s)/Patent Under<br>Reexamination<br>YUASA, Shinji |             |
|                                   | Examiner<br>ALONZO CHAMBLISS          | Art Unit<br>2897                                            | Page 1 of 1 |

U.S. PATENT DOCUMENTS

| * |   | Document Number<br>Country Code-Number-Kind Code | Date<br>YYYY-MM-DD | Name | CPC Classification | US Classification |
|---|---|--------------------------------------------------|--------------------|------|--------------------|-------------------|
|   | A |                                                  |                    |      |                    |                   |
|   | B |                                                  |                    |      |                    |                   |
|   | C |                                                  |                    |      |                    |                   |
|   | D |                                                  |                    |      |                    |                   |
|   | E |                                                  |                    |      |                    |                   |
|   | F |                                                  |                    |      |                    |                   |
|   | G |                                                  |                    |      |                    |                   |
|   | H |                                                  |                    |      |                    |                   |
|   | I |                                                  |                    |      |                    |                   |
|   | J |                                                  |                    |      |                    |                   |
|   | K |                                                  |                    |      |                    |                   |
|   | L |                                                  |                    |      |                    |                   |
|   | M |                                                  |                    |      |                    |                   |

FOREIGN PATENT DOCUMENTS

| * |   | Document Number<br>Country Code-Number-Kind Code | Date<br>YYYY-MM-DD | Country | Name      | CPC Classification |
|---|---|--------------------------------------------------|--------------------|---------|-----------|--------------------|
|   | N | JP-2000106462-A                                  | 2000-04-11         | JP      | INOMATA K | B82Y25/00          |
|   | O |                                                  |                    |         |           |                    |
|   | P |                                                  |                    |         |           |                    |
|   | Q |                                                  |                    |         |           |                    |
|   | R |                                                  |                    |         |           |                    |
|   | S |                                                  |                    |         |           |                    |
|   | T |                                                  |                    |         |           |                    |

NON-PATENT DOCUMENTS

| * |   | Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages) |
|---|---|-------------------------------------------------------------------------------------------|
|   | U |                                                                                           |
|   | V |                                                                                           |
|   | W |                                                                                           |
|   | X |                                                                                           |

\*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)  
Dates in YYYY-MM-DD format are publication dates. Classifications may be US or foreign.

|                                                                                                                    |                                              |                                                                 |
|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------------------------|
| <b><i>Index of Claims</i></b><br> | <b>Application/Control No.</b><br>18/232,576 | <b>Applicant(s)/Patent Under Reexamination</b><br>YUASA, Shinji |
|                                                                                                                    | <b>Examiner</b><br>ALONZO CHAMBLISS          | <b>Art Unit</b><br>2897                                         |

|   |          |   |            |   |              |   |          |
|---|----------|---|------------|---|--------------|---|----------|
| ✓ | Rejected | - | Cancelled  | N | Non-Elected  | A | Appeal   |
| = | Allowed  | ÷ | Restricted | I | Interference | O | Objected |

| CLAIMS                                                                                                                                                                            |          |            |            |            |  |  |  |  |  |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------------|------------|------------|--|--|--|--|--|--|
| <input type="checkbox"/> Claims renumbered in the same order as presented by applicant <input type="checkbox"/> CPA <input type="checkbox"/> T.D. <input type="checkbox"/> R.1.47 |          |            |            |            |  |  |  |  |  |  |
| CLAIM                                                                                                                                                                             |          | DATE       |            |            |  |  |  |  |  |  |
| Final                                                                                                                                                                             | Original | 10/01/2023 | 04/23/2024 | 06/14/2024 |  |  |  |  |  |  |
|                                                                                                                                                                                   | 1        | ✓          |            |            |  |  |  |  |  |  |
|                                                                                                                                                                                   | 2        | ✓          |            |            |  |  |  |  |  |  |
|                                                                                                                                                                                   | 3        | ✓          | =          | =          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 4        | ✓          | =          | =          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 5        | ✓          | =          | =          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 6        | ✓          | =          | =          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 7        | ✓          | =          | =          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 8        | ✓          | =          | =          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 9        | ✓          | =          | =          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 10       | ✓          | =          | =          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 11       | ✓          | ✓          | ✓          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 12       | ✓          | ✓          | ✓          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 13       | ✓          | ✓          | ✓          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 14       | ✓          | ✓          | ✓          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 15       | ✓          | ✓          | ✓          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 16       | ✓          | ✓          | ✓          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 17       | ✓          | ✓          | ✓          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 18       | ✓          | ✓          | ✓          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 19       | ✓          | ✓          | ✓          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 20       | ✓          | ✓          | ✓          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 21       | ✓          | ✓          | ✓          |  |  |  |  |  |  |
|                                                                                                                                                                                   | 22       | ✓          | ✓          | ✓          |  |  |  |  |  |  |
|                                                                                                                                                                                   |          |            |            |            |  |  |  |  |  |  |
|                                                                                                                                                                                   |          |            |            |            |  |  |  |  |  |  |
|                                                                                                                                                                                   |          |            |            |            |  |  |  |  |  |  |

|                                                                                                          |                                              |                                                                 |
|----------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------------------------|
| <b>Search Notes</b><br> | <b>Application/Control No.</b><br>18/232,576 | <b>Applicant(s)/Patent Under Reexamination</b><br>YUASA, Shinji |
|                                                                                                          | <b>Examiner</b><br>ALONZO CHAMBLISS          | <b>Art Unit</b><br>2897                                         |

| CPC - Searched*                                                                                                               |            |          |
|-------------------------------------------------------------------------------------------------------------------------------|------------|----------|
| Symbol                                                                                                                        | Date       | Examiner |
| H10B61/00, 53/30, 61/22; H01F10/132, 10/3254; G11C11/15, 11/16, 11/161; H10N 50/85, 50/01, 50/80, 50/10; H01L28/55; B82Y25/00 | 10/01/2023 | AC       |
| H10B61/00, 53/30, 61/22; H01F10/132, 10/3254; G11C11/15, 11/16, 11/161; H10N 50/85, 50/01, 50/80, 50/10; H01L28/55; B82Y25/00 | 11/06/2023 | AC       |
| H10B61/00, 53/30, 61/22; H01F10/132, 10/3254; G11C11/15, 11/16, 11/161; H10N 50/85, 50/01, 50/80, 50/10; H01L28/55; B82Y25/00 | 04/23/2024 | AC       |

| CPC Combination Sets - Searched* |      |          |
|----------------------------------|------|----------|
| Symbol                           | Date | Examiner |
|                                  |      |          |

| US Classification - Searched* |          |      |          |
|-------------------------------|----------|------|----------|
| Class                         | Subclass | Date | Examiner |
|                               |          |      |          |

\* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

| Search Notes                                                     |            |          |
|------------------------------------------------------------------|------------|----------|
| Search Notes                                                     | Date       | Examiner |
| East text search only - see attached printout                    | 10/01/2023 | AC       |
| Ip.com text search only - see attached printout                  | 10/01/2023 | AC       |
| Updated previous East text search only - see attached printout   | 11/06/2023 | AC       |
| Updated previous Ip.com text search only - see attached printout | 11/06/2023 | AC       |
| Updated previous East text search only - see attached printout   | 04/23/2024 | AC       |
| Updated previous Ip.com text search only - see attached printout | 04/23/2024 | AC       |

|  |  |
|--|--|
|  |  |
|--|--|

|                                                                                                                 |                                              |                                                                 |
|-----------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------------------------|
| <b><i>Search Notes</i></b><br> | <b>Application/Control No.</b><br>18/232,576 | <b>Applicant(s)/Patent Under Reexamination</b><br>YUASA, Shinji |
|                                                                                                                 | <b>Examiner</b><br>ALONZO CHAMBLISS          | <b>Art Unit</b><br>2897                                         |

| Interference Search             |                       |            |          |
|---------------------------------|-----------------------|------------|----------|
| US Class/CPC Symbol             | US Subclass/CPC Group | Date       | Examiner |
| US PGPUB<br>text search<br>only |                       | 11/06/2023 | AC       |

|  |  |
|--|--|
|  |  |
|--|--|



# 18232576 Ip.com Search History

Report Run Date: 2024-04-23 UTC

Searches: 1

Markers: 0

| Search # | Timestamp            | Results    | Page |
|----------|----------------------|------------|------|
| 1        | 2024-04-23 21:31 UTC | 19,494,167 | 3    |



## Content: Patent Publications (169)

US Patents | US Designs | US Applications | EPO Patents | EPO Applications | China Patents | China Applications | Japan Patents | Japan Applications | Korea Patents | Korea Applications | WIPO Applications | Argentina Patents | Argentina Applications | Brazil Patents | Brazil Applications | Canada Patents | Canada Applications | Chile Patents | Chile Applications | Colombia Applications | Costa Rica Applications | Cuba Patents | Cuba Applications | Dominican Republic Applications | Ecuador Patents | Ecuador Applications | El Salvador Applications | Guatemala Applications | Honduras Applications | Mexico Patents | Mexico Applications | Nicaragua Patents | Panama Applications | Peru Applications | Trinidad & Tobago Patents | Uruguay Applications | Austria Patents | Austria Applications | Belarus Patents | Belgium Patents | Belgium Applications | Bosnia & Herzegovina Patents | Bosnia & Herzegovina Applications | Bulgaria Patents | Bulgaria Applications | Croatia Patents | Croatia Applications | Czech Republic Patents | Czech Republic Applications | Czechoslovakia Patents | Czechoslovakia Applications | Denmark Patents | Denmark Applications | Estonia Patents | Estonia Applications | EUIPO Patents | Finland Patents | Finland Applications | France Patents | France Applications | Germany Patents | Germany Applications | Great Britain Patents | Great Britain Applications | Greece Patents | Greece Applications | Hungary Patents | Hungary Applications | Iceland Patents | Iceland Applications | Ireland Patents | Ireland Applications | Italy Patents | Italy Applications | Latvia Patents | Latvia Applications | Lithuania Patents | Lithuania Applications | Luxembourg Patents | Luxembourg Applications | Malta Patents | Monaco Patents | Montenegro Patents | Montenegro Applications | Netherlands Patents | Netherlands Applications | Norway Patents | Norway Applications | Poland Patents | Poland Applications | Portugal Patents | Portugal Applications | Republic of Moldova Patents | Republic of Moldova Applications | Romania Patents | Romania Applications | San Marino Patents | San Marino Applications | Serbia Patents | Serbia Applications | Slovakia Patents | Slovakia Applications | Slovenia Patents | Spain Patents | Spain Applications | Sweden Patents | Sweden Applications | Switzerland Patents | Switzerland Applications | Ukraine Patents | Yugoslavia/Serbia and Montenegro Patents | Yugoslavia/Serbia and Montenegro Applications | Armenia Patents | Australia Patents | Australia Applications | Cyprus Patents | Gulf Cooperation Council Patents | Hong Kong Patents | India Patents | India Applications | Indonesia Patents | Indonesia Applications | Israel Patents | Israel Applications | Jordan Patents | Jordan Applications | Kyrgyzstan Patents | Macao Applications | Malaysia Patents | Mongolia Patents | New Zealand Patents | Philippines Patents | Philippines Applications | Saudi Arabia Patents | Saudi Arabia Applications | Singapore Patents | Singapore Applications | Taiwan Patents | Taiwan Applications | Tajikistan Patents | Tajikistan Applications | Thailand Patents | Thailand Applications | Uzbekistan Patents | Vietnam Patents | Algeria Patents | ARIPO Patents | ARIPO Applications | Egypt Patents | Kenya Patents | Malawi Patents | Morocco Patents | Morocco Applications | OAPI Patents | South Africa Patents | Tunisia Applications | Zambia Patents | Zimbabwe Patents | EAPO Patents | EAPO Applications | Georgia Patents | Georgia Applications | Kazakhstan Patents | Kazakhstan Applications | Russia Patents | Russia Applications | Turkey Patents | Turkey Applications

1 2024-04-23 21:31 UTC | 19,494,167 results from

De-Dup: None | Relevance Cut-off: None | Sort: Relevance

Main Concept: Text

ferromagnetic adj2 (layer film) SAME crystal\$4 AND (MJT magnetic ADJ tunnel magnetoresistive)

Concept Modifiers: None

Filters: None

# PE2E SEARCH - Search History (Prior Art)

| Ref # | Hits | Search Query                                                                                                                                                                                                        | DBs                                                                                                                                                                                                                                                            | Default Operator | Plurals | British Equivalents | Time Stamp             |
|-------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------|---------------------|------------------------|
| L1    | 9    | ("11737372"<br>"11233193" "10680167"<br>"10367138" "9608198"<br>"9123463" "8405134"<br>"8319263"<br>"7884403").pn.                                                                                                  | (US-PGPUB; USPAT)                                                                                                                                                                                                                                              | OR               | ON      | ON                  | 2023/10/01<br>01:53 PM |
| L2    | 1    | ("20040109347").pn.                                                                                                                                                                                                 | (US-PGPUB; USPAT)                                                                                                                                                                                                                                              | OR               | ON      | ON                  | 2023/10/01<br>07:22 PM |
| L3    | 1    | ("11737372").pn.                                                                                                                                                                                                    | (US-PGPUB; USPAT)                                                                                                                                                                                                                                              | OR               | ON      | ON                  | 2023/10/01<br>07:23 PM |
| L4    | 1    | godo.as. AND (bottom<br>first) adj2 ferromagnetic<br>adj2 (layer film) AND<br>(second top) adj2<br>ferromagnetic adj2<br>(layer film) AND (MgO<br>magnesium adj2 oxide)<br>WITH barrier adj2 (layer<br>film)        | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB) | OR               | ON      | ON                  | 2023/10/01<br>10:12 PM |
| L5    | 75   | yuasa.in. AND (bottom<br>first) adj2 ferromagnetic<br>adj2 (layer film) AND<br>(second top) adj2<br>ferromagnetic adj2<br>(layer film) AND (MgO<br>magnesium adj2 oxide)<br>WITH barrier adj2 (layer<br>film)       | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB) | OR               | ON      | ON                  | 2023/10/01<br>10:14 PM |
| L6    | 454  | 257/\$.ccls. AND<br>(bottom first) adj2<br>ferromagnetic adj2<br>(layer film) AND<br>(second top) adj2<br>ferromagnetic adj2<br>(layer film) AND (MgO<br>magnesium adj2 oxide)<br>WITH barrier adj2 (layer<br>film) | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB) | OR               | ON      | ON                  | 2023/10/01<br>10:19 PM |
| L7    | 166  | 438/\$.ccls. AND<br>(bottom first) adj2<br>ferromagnetic adj2<br>(layer film) AND<br>(second top) adj2<br>ferromagnetic adj2<br>(layer film) AND (MgO                                                               | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,                                                                                            | OR               | ON      | ON                  | 2023/10/01<br>10:19 PM |

|     |     |                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                               |    |    |    |                        |
|-----|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|------------------------|
| L8  | 0   | magnesium adj2 oxide)<br>WITH barrier adj2 (layer<br>film)<br><br>361/\$.ccls. AND<br>(bottom first) adj2<br>ferromagnetic adj2<br>(layer film) AND<br>(second top) adj2<br>ferromagnetic adj2<br>(layer film) AND (MgO<br>magnesium adj2 oxide)<br>WITH barrier adj2 (layer<br>film) | IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB)<br><br>(US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB) | OR | ON | ON | 2023/10/01<br>10:19 PM |
| L9  | 481 | L6 L7                                                                                                                                                                                                                                                                                 | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB)                                                                                                | OR | ON | ON | 2023/10/01<br>10:20 PM |
| L10 | 469 | L9 AND ( (H10N50/10<br>OR H10N50/01 OR<br>H10N50/85 OR<br>H10N50/80 OR<br>G11C11/161 OR<br>G11C11/16 OR<br>G11C11/15 OR<br>B82Y25/00 OR<br>H10B53/30 OR<br>H10B61/22 OR<br>H10B61/00 OR<br>H01F10/3254 OR<br>H01F10/132 OR<br>H01L28/55).cpc.)                                        | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB)                                                                                                | OR | ON | ON | 2023/10/01<br>10:29 PM |
| L11 | 24  | "11737372"                                                                                                                                                                                                                                                                            | (US-PGPUB; USPAT;<br>USOCR; FIT (AP, AT,<br>AU, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB)                                                                                                | OR | ON | ON | 2023/10/01<br>10:31 PM |
| L12 | 2   | ("11737372").pn.                                                                                                                                                                                                                                                                      | (US-PGPUB; USPAT;<br>USOCR; FIT (AP, AT,<br>AU, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,                                                                                                                                                                                                                                                 | OR | ON | ON | 2023/10/01<br>10:32 PM |

|     |     |                                                                                                                                                                                                      |                                                                                                                                                                                                                                  |    |    |    |                     |
|-----|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|---------------------|
| L13 | 4   | ("11233193").pn.                                                                                                                                                                                     | EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                                                                   | OR | ON | ON | 2023/10/01 10:34 PM |
| L14 | 597 | 257/\$.ccls. AND (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film) | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2023/11/06 05:04 PM |
| L15 | 220 | 438/\$.ccls. AND (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film) | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2023/11/06 05:05 PM |
| L16 | 0   | 361/\$.ccls. AND (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film) | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2023/11/06 05:05 PM |
| L17 | 634 | L14 L15                                                                                                                                                                                              | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB,                                                                                                        | OR | ON | ON | 2023/11/06 05:05 PM |

|     |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                      |    |    |    |                     |
|-----|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|---------------------|
| L18 | 613 | L17 AND ( (H10N50/10 OR H10N50/01 OR H10N50/85 OR H10N50/80 OR G11C11/161 OR G11C11/16 OR G11C11/15 OR B82Y25/00 OR H10B53/30 OR H10B61/22 OR H10B61/00 OR H01F10/3254 OR H01F10/132 OR H01L28/55).cpc.)                                                                                                                                                                                                                                                       | HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                                                                                                                                                                               | OR | ON | ON | 2023/11/06 05:12 PM |
| L20 | 1   | ("20220148934").pn.                                                                                                                                                                                                                                                                                                                                                                                                                                            | (US-PGPUB; USPAT)                                                                                                                                                                                                                                                                                                    | OR | ON | ON | 2023/11/07 06:00 PM |
| L21 | 7   | ("2005088745").pn.                                                                                                                                                                                                                                                                                                                                                                                                                                             | (FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                                                                                                                                                                                                                                                   | OR | ON | ON | 2024/04/21 03:52 PM |
| L22 | 37  | (Artificial Intelligence) More like doc: WO-2005088745-A1<br>Text:<br>(JP-WO2005088745-A1 OR JP-4963744-B2 OR JP-2012033957-A OR JP-2012039144-A OR JP-5002788-B2 OR JP-5120680-B2 OR JP-4082711-B2 OR US-20070195592-A1 OR EP-1737055-A1 OR JP-2012151494-A OR JP-4581133-B2 OR US-20110031570-A1 OR JP-2012054577-A OR JP-2008004956-A OR JP-2009021626-A OR JP-5152734-B2 OR EP-1737055-B1 OR US-8319263-B2 OR US-20130228883-A1 OR US-20100181632-A1).did. | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/21 03:52 PM |
| L23 | 1   | ("8405134").pn.                                                                                                                                                                                                                                                                                                                                                                                                                                                | (US-PGPUB; USPAT)                                                                                                                                                                                                                                                                                                    | OR | ON | ON | 2024/04/21 03:58 PM |
| L24 | 8   | ("11737372" "11233193" "16680167" "10367138" "9608198" "9123463" "8405134" "8319263" "7884403").pn.                                                                                                                                                                                                                                                                                                                                                            | (US-PGPUB; USPAT)                                                                                                                                                                                                                                                                                                    | OR | ON | ON | 2024/04/21 09:13 PM |

|     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                   |    |    |    |                        |
|-----|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|------------------------|
| L25 | 1  | ("7847327").pn.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | (US-PGPUB; USPAT)                                                                                                                                                                                                                                                                                                                                                 | OR | ON | ON | 2024/04/21<br>09:46 PM |
| L26 | 1  | ("7800149").pn.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | (US-PGPUB; USPAT)                                                                                                                                                                                                                                                                                                                                                 | OR | ON | ON | 2024/04/21<br>09:47 PM |
| L27 | 1  | ("7884403").pn.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | (US-PGPUB; USPAT)                                                                                                                                                                                                                                                                                                                                                 | OR | ON | ON | 2024/04/21<br>09:50 PM |
| L28 | 30 | (Artificial Intelligence)<br>More like doc:<br>US-7884403-B2<br>Text:<br>(US-20110031570-A1<br>OR EP-1737055-B1 OR<br>US-20120161262-A1<br>OR US-8319263-B2 OR<br>US-8405134-B2 OR<br>US-11737372-B2 OR<br>US-20230413685-A1<br>OR US-20230363288-<br>A1 OR US-<br>20130228883-A1 OR<br>US-20160020385-A1<br>OR US-20100181632-<br>A1 OR EP-1737055-A1<br>OR US-20070195592-<br>A1 OR US-<br>20170155042-A1 OR<br>US-20200259077-A1<br>OR JP-4963744-B2 OR<br>KR-100867662-B1 OR<br>JP-2012033957-A OR<br>KR-20060122970-A OR<br>WO-2005088745-<br>A1).did. | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO,<br>MC, MD, MY, NL, NO,<br>NZ, PH, PL, PT, RO,<br>RS, SE, SG, SI, SK,<br>TH, TN, TR, TW, UA,<br>VN); FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2024/04/21<br>09:51 PM |
| L29 | 37 | (Artificial Intelligence)<br>More like doc:<br>WO-2005088745-A1<br>Text:<br>(JP-WO2005088745-A1<br>OR JP-4963744-B2 OR<br>JP-2012033957-A OR<br>JP-2012039144-A OR<br>JP-5002788-B2 OR JP-<br>5120680-B2 OR JP-<br>4082711-B2 OR US-<br>20070195592-A1 OR<br>EP-1737055-A1 OR JP-<br>2012151494-A OR JP-<br>4581133-B2 OR US-<br>20110031570-A1 OR<br>JP-2012054577-A OR<br>JP-2008004956-A OR<br>JP-2009021626-A OR<br>JP-5152734-B2 OR EP-<br>1737055-B1 OR US-<br>8319263-B2 OR US-<br>20130228883-A1 OR                                                 | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO,<br>MC, MD, MY, NL, NO,<br>NZ, PH, PL, PT, RO,<br>RS, SE, SG, SI, SK,<br>TH, TN, TR, TW, UA,<br>VN); FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2024/04/21<br>09:51 PM |

|     |     |                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                  |    |    |    |                     |
|-----|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|---------------------|
| L30 | 287 | US-20100181632-A1).did.<br>257/\$.ccls. AND (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film) SAME (height thick\$4) | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/22 07:27 PM |
| L31 | 112 | 438/\$.ccls. AND (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film) SAME (height thick\$4)                            | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/22 07:30 PM |
| L32 | 0   | 361/\$.ccls. AND (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film) SAME (height thick\$4)                            | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/22 07:30 PM |
| L33 | 306 | L30 L31                                                                                                                                                                                                                                                | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/22 07:31 PM |
| L34 | 0   | 257/\$.ccls. AND (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film) SAME                                              | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO;                   | OR | ON | ON | 2024/04/22 07:33 PM |

|     |      |                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                  |    |    |    |                     |
|-----|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|---------------------|
| L35 | 0    | (height thick\$4) SAME partially WITH entirely WITH crystal\$5<br>257/\$.ccls. AND (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film) SAME partially WITH entirely WITH crystal\$5 | DERWENT; IBM_TDB)                                                                                                                                                                                                                | OR | ON | ON | 2024/04/22 07:34 PM |
| L36 | 1    | (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film) SAME partially WITH entirely WITH crystal\$5                                                                                    | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/22 07:34 PM |
| L37 | 0    | (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) AND barrier adj2 (layer film) SAME partially WITH entirely WITH crystal\$5                                                                                     | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/22 07:35 PM |
| L38 | 0    | (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) AND barrier adj2 (layer film) SAME partially SAME entirely SAME crystal\$5                                                                                     | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/22 07:35 PM |
| L39 | 1044 | (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2                                                                                                                                              | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV,                                                        | OR | ON | ON | 2024/04/22 07:36 PM |

|     |     |                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                |    |    |    |                     |
|-----|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|---------------------|
| L40 | 829 | (layer film) SAME crystal\$5<br><br>(bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film) WITH crystal\$5 | MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)<br><br>(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/22 07:36 PM |
| L41 | 154 | 257/\$.ccls. AND (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film) WITH crystal\$5                    | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                               | OR | ON | ON | 2024/04/22 07:36 PM |
| L42 | 41  | 438/\$.ccls. AND (bottom first lower) adj3 ferromagnetic adj2 (layer film) AND (second top upper) adj3 ferromagnetic adj2 (layer film) AND (MgO magnesium adj2 oxide) SAME barrier adj2 (layer film) WITH crystal\$5                    | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                               | OR | ON | ON | 2024/04/22 07:36 PM |
| L43 | 159 | L41 L42                                                                                                                                                                                                                                 | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                               | OR | ON | ON | 2024/04/22 07:37 PM |
| L44 | 38  | (Artificial Intelligence) More like doc: US-20040144995-A1<br>Text:<br>(EP-1391942-A1 OR US-7514160-B2 OR US-20070128470-A1 OR US-7220498-B2 OR EP-1925946-A2 OR                                                                        | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO,                                                                                                  | OR | ON | ON | 2024/04/22 07:40 PM |

|     |     |                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                |    |    |    |                        |
|-----|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|------------------------|
|     |     | KR-20030097904-A OR<br>WO-02099905-A1 OR<br>KR-100886602-B1 OR<br>JP-WO2006022183-A1<br>OR EP-1085586-A2 OR<br>EP-1085586-B1 OR<br>US-20100028530-A1<br>OR US-20060003185-<br>A1 OR CN-1308317-A<br>OR US-20080182342-<br>A1 OR US-7906231-B2<br>OR EP-1391942-A4 OR<br>US-7807218-B2 OR<br>US-7357995-B2 OR<br>US-20080062581-<br>A1).did. | MC, MD, MY, NL, NO,<br>NZ, PH, PL, PT, RO,<br>RS, SE, SG, SI, SK,<br>TH, TN, TR, TW, UA,<br>VN); FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB)                                                                                                                       |    |    |    |                        |
| L45 | 535 | 257/\$.ccls. AND (MTJ<br>magnetic adj2 tunnel<br>adj2 junction) AND<br>crystalline SAME barrier<br>adj2 (layer film) SAME<br>crystalline                                                                                                                                                                                                    | (US-PGPUB; USPAT;<br>USOCR; FIT (AP, AT,<br>AU, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/22<br>07:54 PM |
| L46 | 535 | 257/\$.ccls. AND (MTJ<br>magnetic adj2 tunnel<br>adj2 junction) AND<br>crystalline SAME barrier<br>adj2 (layer film)                                                                                                                                                                                                                        | (US-PGPUB; USPAT;<br>USOCR; FIT (AP, AT,<br>AU, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/22<br>07:55 PM |
| L47 | 347 | 257/\$.ccls. AND (MTJ<br>magnetic adj2 tunnel<br>adj2 junction) AND<br>crystalline WITH barrier<br>adj2 (layer film)                                                                                                                                                                                                                        | (US-PGPUB; USPAT;<br>USOCR; FIT (AP, AT,<br>AU, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/22<br>07:55 PM |
| L48 | 230 | 257/\$.ccls. AND (MTJ<br>magnetic adj2 tunnel<br>adj2 junction) AND<br>crystalline WITH barrier<br>adj2 (layer film) SAME<br>(MgO magnesium adj2<br>oxide)                                                                                                                                                                                  | (US-PGPUB; USPAT;<br>USOCR; FIT (AP, AT,<br>AU, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,                                                                                            | OR | ON | ON | 2024/04/22<br>07:57 PM |

|     |     |                                                                                                                                          |                                                                                                                                                                                                                                  |    |    |    |                     |
|-----|-----|------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|---------------------|
| L49 | 201 | 257/\$.ccls. AND (MTJ magnetic adj2 tunnel adj2 junction) AND crystalline WITH barrier adj2 (layer film) WITH (MgO magnesium adj2 oxide) | IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                                                                                                                   | OR | ON | ON | 2024/04/22 07:57 PM |
| L50 | 100 | 438/\$.ccls. AND (MTJ magnetic adj2 tunnel adj2 junction) AND crystalline WITH barrier adj2 (layer film) WITH (MgO magnesium adj2 oxide) | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/22 07:57 PM |
| L51 | 206 | L49 L50                                                                                                                                  | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/22 07:58 PM |
| L52 | 347 | 257/\$.ccls. AND (MTJ magnetic adj2 tunnel adj2 junction) AND crystalline WITH barrier adj2 (layer film)                                 | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/22 08:01 PM |
| L53 | 157 | 438/\$.ccls. AND (MTJ magnetic adj2 tunnel adj2 junction) AND crystalline WITH barrier adj2 (layer film)                                 | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV,                                                        | OR | ON | ON | 2024/04/22 08:01 PM |

|     |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                   |    |    |    |                        |
|-----|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|------------------------|
| L54 | 358 | L52 L53                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB)<br><br>(US-PGPUB; USPAT;<br>USOCR; FIT (AP, AT,<br>AU, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB)                                | OR | ON | ON | 2024/04/22<br>08:01 PM |
| L55 | 38  | (Artificial Intelligence)<br>More like doc:<br>US-5966012-A<br><br>Text:<br>(EP-0913830-A2 OR<br>EP-0913830-B1 OR<br>KR-100271141-B1 OR<br>KR-19990036653-A OR<br>JP-H11161919-A OR<br>JP-3004005-B2 OR DE-<br>69826090-T2 OR MY-<br>124179-A OR EP-<br>0913830-A3 OR US-<br>5729410-A OR US-<br>6023395-A OR JP-<br>H11353621-A OR US-<br>6005753-A OR EP-<br>0911810-A2 OR KR-<br>100261385-B1 OR US-<br>5901018-A OR US-<br>5898547-A OR US-<br>5898548-A OR EP-<br>0911811-A2 OR EP-<br>0911811-B1).did. | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO,<br>MC, MD, MY, NL, NO,<br>NZ, PH, PL, PT, RO,<br>RS, SE, SG, SI, SK,<br>TH, TN, TR, TW, UA,<br>VN); FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2024/04/22<br>08:07 PM |
| L56 | 147 | 438/\$.ccls. AND<br>ferromagnetic adj2<br>(layer film) SAME<br>crystal                                                                                                                                                                                                                                                                                                                                                                                                                                       | (US-PGPUB; USPAT;<br>USOCR; FIT (AP, AT,<br>AU, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB)                                                                                                    | OR | ON | ON | 2024/04/22<br>08:50 PM |
| L57 | 567 | 257/\$.ccls. AND<br>ferromagnetic adj2<br>(layer film) SAME<br>crystal                                                                                                                                                                                                                                                                                                                                                                                                                                       | (US-PGPUB; USPAT;<br>USOCR; FIT (AP, AT,<br>AU, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,                                                                                                                                                                                               | OR | ON | ON | 2024/04/22<br>08:50 PM |

|     |     |                                                                                                                 |                                                                                                                                                                                                                                                                                                                 |    |    |    |                     |
|-----|-----|-----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|---------------------|
| L58 | 379 | 257/\$.ccls. AND ferromagnetic adj2 (layer film) WITH crystal                                                   | IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/22 08:51 PM |
| L59 | 626 | 257/\$.ccls. AND ferromagnetic adj2 (layer film) WITH crystal\$4                                                | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                                                | OR | ON | ON | 2024/04/22 08:51 PM |
| L60 | 476 | 257/\$.ccls. AND ferromagnetic adj2 (layer film) WITH crystal\$4 AND (MJT magnetic ADJ tunnel magnetoresistive) | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                                                | OR | ON | ON | 2024/04/22 08:51 PM |
| L61 | 141 | 438/\$.ccls. AND ferromagnetic adj2 (layer film) WITH crystal\$4 AND (MJT magnetic ADJ tunnel magnetoresistive) | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                                                | OR | ON | ON | 2024/04/22 10:03 PM |
| L62 | 231 | 438/\$.ccls. AND ferromagnetic adj2 (layer film) SAME crystal\$4 AND (MJT magnetic ADJ tunnel magnetoresistive) | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV,                                                                                                                                       | OR | ON | ON | 2024/04/22 10:05 PM |

|     |     |                                                                                                                                  |                                                                                                                                                                                                                                                                                         |    |    |    |                     |
|-----|-----|----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|---------------------|
| L63 | 705 | 257/\$.ccls. AND ferromagnetic adj2 (layer film) SAME crystal\$4 AND (MJT magnetic ADJ tunnel magnetoresistive)                  | MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/22 10:05 PM |
| L64 | 731 | L62 L63                                                                                                                          | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                        | OR | ON | ON | 2024/04/22 10:05 PM |
| L73 | 27  | (magnetoresistive magnetic adj2 tunnel adj2 junction) AND (MgO magnesium adj2 oxide) WITH partially near6 crystal\$4             | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                        | OR | ON | ON | 2024/04/22 10:35 PM |
| L74 | 41  | (magnetoresistive magnetic adj2 tunnel adj2 junction MTJ) AND (MgO magnesium adj2 oxide) WITH (fully partially) near6 crystal\$4 | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                        | OR | ON | ON | 2024/04/22 10:49 PM |
| L75 | 11  | ("6054226" "6379978").pn.                                                                                                        | (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO);                                                                                          | OR | ON | ON | 2024/04/22 11:24 PM |

|     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                   |    |    |    |                        |
|-----|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|------------------------|
| L76 | 2  | ("6054226"<br>"6379978").pn.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | FPRS; EPO; JPO;<br>DERWENT; IBM_TDB)<br>(US-PGPUB; USPAT)                                                                                                                                                                                                                                                                                                         | OR | ON | ON | 2024/04/22<br>11:24 PM |
| L77 | 1  | ("5640343").pn.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | (US-PGPUB; USPAT)                                                                                                                                                                                                                                                                                                                                                 | OR | ON | ON | 2024/04/23<br>01:07 PM |
| L78 | 47 | (Artificial Intelligence)<br>More like doc:<br>US-5640343-A<br>Text:<br>(US-5793697-A OR<br>GB-2356502-A OR<br>WO-0026918-A1 OR<br>US-20040017721-A1<br>OR JP-2019075533-A<br>OR GB-2343308-A OR<br>CN-109427381-B OR<br>DE-102018115209-A1<br>OR US-20020006058-<br>A1 OR US-6473336-B2<br>OR JP-6799566-B2 OR<br>EP-1109170-A2 OR<br>US-20190378552-A1<br>OR US-6597618-B2 OR<br>JP-3868699-B2 OR EP-<br>1653516-A2 OR CN-<br>109427381-A OR US-<br>5734605-A OR KR-<br>20030078032-A OR<br>CN-102314927-B).did. | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO,<br>MC, MD, MY, NL, NO,<br>NZ, PH, PL, PT, RO,<br>RS, SE, SG, SI, SK,<br>TH, TN, TR, TW, UA,<br>VN); FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2024/04/23<br>01:08 PM |
| L79 | 3  | ("2000106462").pn.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO,<br>MC, MD, MY, NL, NO,<br>NZ, PH, PL, PT, RO,<br>RS, SE, SG, SI, SK,<br>TH, TN, TR, TW, UA,<br>VN); FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2024/04/23<br>02:15 PM |
| L80 | 45 | (Artificial Intelligence)<br>More like doc:<br>JP-2000106462-A<br>Text:<br>(JP-3593472-B2 OR<br>JP-2001144345-A OR<br>JP-2000156531-A OR<br>JP-3697369-B2 OR JP-<br>H11134620-A OR JP-<br>2000251230-A OR KR-                                                                                                                                                                                                                                                                                                      | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO,<br>MC, MD, MY, NL, NO,                                                                                                                      | OR | ON | ON | 2024/04/23<br>02:16 PM |

|     |     |                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                |    |    |    |                     |
|-----|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|---------------------|
| L81 | 524 | 20010043167-A OR JP-H11238925-A OR JP-3520192-B2 OR JP-2000020922-A OR JP-4124533-B2 OR JP-WO2004025744-A1 OR JP-3946355-B2 OR JP-H11238923-A OR WO-2004025744-A1 OR EP-1085586-A2 OR US-20050207071-A1 OR DE-60037784-T2 OR CN-1185630-C OR CN-1308317-A).did.<br><br>257/\$.ccls. AND tunnel adj2 barrier WITH crystal\$4 | NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)<br><br>(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2024/04/23 02:29 PM |
| L82 | 414 | 257/\$.ccls. AND tunnel adj2 barrier WITH crystal\$4 AND (magnetoresistive magnetic adj2 tunnel adj2 junction MTJ)                                                                                                                                                                                                          | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)                                                                                                           | OR | ON | ON | 2024/04/23 02:30 PM |
| L83 | 267 | 257/\$.ccls. AND tunnel adj2 barrier WITH crystal\$4 SAME (MgO magnesium adj2 oxide) AND (magnetoresistive magnetic adj2 tunnel adj2 junction MTJ)                                                                                                                                                                          | (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO,                                                                                                                                                                                          | OR | ON | ON | 2024/04/23 02:30 PM |

|     |     |                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |    |    |    |                        |
|-----|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|------------------------|
| L84 | 117 | 257/\$.ccls. AND tunnel<br>adj2 barrier WITH<br>crystal\$4 SAME (MgO<br>magnesium adj2 oxide)<br>AND (magnetoresistive<br>magnetic adj2 tunnel<br>adj2 junction MTJ) AND<br>(body adj2 centered<br>ADJ cubic BCC) | RS, SE, SG, SI, SK,<br>TH, TN, TR, TW, UA,<br>VN); FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB)<br>(US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO,<br>MC, MD, MY, NL, NO,<br>NZ, PH, PL, PT, RO,<br>RS, SE, SG, SI, SK,<br>TH, TN, TR, TW, UA,<br>VN); FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2024/04/23<br>02:31 PM |
| L85 | 43  | 438/\$.ccls. AND tunnel<br>adj2 barrier WITH<br>crystal\$4 SAME (MgO<br>magnesium adj2 oxide)<br>AND (magnetoresistive<br>magnetic adj2 tunnel<br>adj2 junction MTJ) AND<br>(body adj2 centered<br>ADJ cubic BCC) | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO,<br>MC, MD, MY, NL, NO,<br>NZ, PH, PL, PT, RO,<br>RS, SE, SG, SI, SK,<br>TH, TN, TR, TW, UA,<br>VN); FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB)                                                                                               | OR | ON | ON | 2024/04/23<br>02:31 PM |
| L86 | 124 | L84 L85                                                                                                                                                                                                           | (US-PGPUB; USPAT;<br>USOCR; FIT (AU, AP,<br>AT, BE, BG, BR, BY,<br>CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO,<br>MC, MD, MY, NL, NO,<br>NZ, PH, PL, PT, RO,<br>RS, SE, SG, SI, SK,<br>TH, TN, TR, TW, UA,<br>VN); FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB)                                                                                               | OR | ON | ON | 2024/04/23<br>02:31 PM |
| L87 | 682 | L64 AND ( H10N50/10<br>OR H10N50/01 OR<br>H10N50/85 OR                                                                                                                                                            | (US-PGPUB; USPAT;<br>USOCR; FIT (AP, AT,<br>AU, BE, BG, BR, BY,                                                                                                                                                                                                                                                                                                                                                                                                 | OR | ON | ON | 2024/04/23<br>05:30 PM |

|  |  |                                                                                                                                                                                      |                                                                                                                                                                                             |  |  |  |  |
|--|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|--|
|  |  | H10N50/80 OR<br>G11C11/161 OR<br>G11C11/16 OR<br>G11C11/15 OR<br>B82Y25/00 OR<br>H10B53/30 OR<br>H10B61/22 OR<br>H10B61/00 OR<br>H01F10/3254 OR<br>H01F10/132 OR<br>H01L28/55).cpc.) | CA, CH, CN, CS, CU,<br>CZ, DD, DE, DK, EA,<br>EE, EP, ES, FI, FR, GB,<br>HR, HU, ID, IE, IL, IS,<br>IT, JP, KR, LT, LU, LV,<br>MA, OA, RU, SU, WO);<br>FPRS; EPO; JPO;<br>DERWENT; IBM_TDB) |  |  |  |  |
|--|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|--|

## PE2E SEARCH - Search History (Interference)

| Ref # | Hits | Search Query                                                                                                                                                                                                                    | DBs               | Default Operator | Plurals | British Equivalents | Time Stamp             |
|-------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|------------------|---------|---------------------|------------------------|
| N1    | 566  | 257/\$.ccls. AND<br>(bottom first lower) adj3<br>ferromagnetic adj2<br>(layer film) AND<br>(second top upper) adj3<br>ferromagnetic adj2<br>(layer film) AND (MgO<br>magnesium adj2 oxide)<br>SAME barrier adj2<br>(layer film) | (US-PGPUB; USPAT) | OR               | ON      | ON                  | 2023/11/06<br>05:19 PM |
| N2    | 208  | 438/\$.ccls. AND<br>(bottom first lower) adj3<br>ferromagnetic adj2<br>(layer film) AND<br>(second top upper) adj3<br>ferromagnetic adj2<br>(layer film) AND (MgO<br>magnesium adj2 oxide)<br>SAME barrier adj2<br>(layer film) | (US-PGPUB; USPAT) | OR               | ON      | ON                  | 2023/11/06<br>05:19 PM |
| N3    | 4    | "11664290"                                                                                                                                                                                                                      | (US-PGPUB; USPAT) | OR               | ON      | ON                  | 2023/11/06<br>07:47 PM |
| N4    | 8    | "11158558"                                                                                                                                                                                                                      | (US-PGPUB; USPAT) | OR               | ON      | ON                  | 2023/11/06<br>07:48 PM |
| N5    | 1    | ("11158558").pn.                                                                                                                                                                                                                | (US-PGPUB; USPAT) | OR               | ON      | ON                  | 2023/11/06<br>07:53 PM |



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
**United States Patent and Trademark Office**  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

|                          |             |                      |                     |                  |
|--------------------------|-------------|----------------------|---------------------|------------------|
| APPLICATION NO.          | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
| 18/232,576               | 08/10/2023  | Shinji YUASA         | IBTH 13318Aa        | 1021             |
| 61650                    | 7590        | 06/26/2024           | EXAMINER            |                  |
| MYERS WOLIN, LLC         |             |                      | CHAMBLISS, ALONZO   |                  |
| 100 SOUTH JEFFERSON ROAD |             |                      |                     |                  |
| SUITE 202                |             |                      |                     |                  |
| WHIPPANY, NJ 07981-1009  |             |                      |                     |                  |
|                          |             |                      | ART UNIT            | PAPER NUMBER     |
|                          |             |                      | 2897                |                  |
|                          |             |                      | NOTIFICATION DATE   | DELIVERY MODE    |
|                          |             |                      | 06/26/2024          | ELECTRONIC       |

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patent@myerswoln.com



***Notice of Pre-AIA or AIA Status***

1. The present application is being examined under the pre-AIA first to invent provisions.

***Prosecution Reopened***

2. Prosecution on the merits of this application is reopened on claims 11-16 considered unpatentable for the reasons indicated below:

Claims 11 and 14 should be rejected under 102(b) and 103(a) rejection of claims 12, 13, 15, and 16.

3. Applicant is advised that the Notice of Allowance mailed **11/15/2023** is vacated. If the issue fee has already been paid, applicant may request a refund or request that the fee be credited to a deposit account. However, applicant may wait until the application is either found allowable or held abandoned. If allowed, upon receipt of a new Notice of Allowance, applicant may request that the previously submitted issue fee be applied. If abandoned, applicant may request refund or credit to a specified Deposit Account.

***Terminal Disclaimer***

4. The terminal disclaimer filed on 11/2/2023 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of U.S. Patent no. **7,884,403** has been reviewed and is accepted. The terminal disclaimer has been recorded.

5. Also, each U.S. Patents **11,737,372, 11,233,193, 10,680,167, 10,367,138, 9,608,198, 9,123,463, 8,405,134, 8,319,263** have terminal disclaimers filed linking these patents to U.S. Patent no. **7,884,403**.

***Claim Rejections - 35 USC § 102***

6. The following is a quotation of the appropriate paragraphs of pre-AIA 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

7. Claims 11, 14, 16, 17, and 22 are rejected under pre-AIA 35 U.S.C. 102b as being clearly anticipated by Kishi et al. (JP2000-106462).

With respect to Claims 11, 14, and 17, Kishi teaches a first ferromagnetic material layer 2 and a second ferromagnetic material layer 4. A tunnel barrier layer 3 between the first ferromagnetic material layer 2 and the second ferromagnetic material layer 3. The tunnel barrier layer 3 comprises magnesium oxide and has a barrier height in a range of .3eV to .7eV (i.e. for example .4eV) (see paragraphs 20, 32, and 38; Fig. 1). Thus, Kishi teaches a barrier height of (0.1 eV to 0.85 eV) and (.2eV to .5eV).

With respect to Claim 16, Kishi teaches the first ferromagnetic material layer and/or the second ferromagnetic material layer comprises Cobalt and Iron (i.e. CoFe alloy)(see paragraph 23).

With respect to Claim 22, Kishi teaches wherein the tunnel barrier layer has a thickness less than 10nm (i.e. 1.2 nm or more)(see paragraph 33).

***Claim Rejections - 35 USC § 103***

8. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

9. The factual inquiries for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

10. Claims 12, 13, 15 and 18-21 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Kishi et al. (JP2000-106462) as applied to claim 11 above, and further in view of Papworth Parkin (US 7,598,555).

With respect to Claims 12 and 18, Kishi discloses the claimed invention except for the tunnel barrier layer comprises partially or fully crystalline magnesium oxide.

However, Parkin discloses a tunnel barrier layer (i.e. made of MgO) comprises a polycrystalline magnesium oxide. Polycrystalline MgO indicates or implies that the material is fully crystalline in that they are entirely made up of crystalline grains or crystallites arranged in a regular lattice pattern. Parkin discloses partially or fully crystalline magnesium oxide as claimed (see col. 11 lines 10-20). Thus, Kishi and

Parkin have substantially the same environment of a tunnel barrier layer made of MgO between a plurality of ferromagnetic material layer. Therefore, it would have been obvious to one of ordinary skill in the art before the effective filing date of the claim invention to substitute the polycrystalline magnesium oxide for the MgO tunnel barrier layer of Kishi, since the polycrystalline magnesium oxide would improve the formation of the MgO to the substrate as taught by Parkin.

With respect to Claims 13 and 19, Kishi discloses the claimed invention except for the first ferromagnetic material layer and/or the second ferromagnetic material layer is partially or entirely crystallized.

However, Parkin discloses the first ferromagnetic material layer and/or the second ferromagnetic material layer is partially or entirely crystallized (i.e. polycrystalline indicates or implies that the material is fully crystalline in that they are entirely made up of crystalline grains or crystallites arranged in a regular lattice pattern) (see col. 11 lines 10-20). Thus, Kishi and Parkin have substantially the same environment of a tunnel barrier layer made of MgO between a plurality of ferromagnetic material layer. Therefore, it would have been obvious to one of ordinary skill in the art before the effective filing date of the claim invention to incorporate an entirely crystalline first or second ferromagnetic material layer of Kishi, since the fully crystalline first or second ferromagnetic material layer since would facilitate in yielding a maximum TMR in the film structures based on the highly textured ferromagnetic layers as taught by Parkin.

With respect to Claims 15 and 20, Kishi discloses the claimed invention except for the first ferromagnetic material layer and/or the second ferromagnetic material layer exhibits a body-centered cubic (BCC) structure.

However, Parkin discloses wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer exhibits a body-centered cubic (BCC) structure (see col. 8 lines 10-20, col. 10 lines 65-67, and col. 11 lines 1-10). Thus, Kishi and Parkin have substantially the same environment of a tunnel barrier layer made of MgO between a plurality of ferromagnetic material layer. Thus, Kishi and Parkin have substantially the same environment of a tunnel barrier layer made of MgO between a plurality of ferromagnetic material layer. Therefore, it would have been obvious to one of ordinary skill in the art before the effective filing date of the claim invention to incorporate a BCC structure for the first or second ferromagnetic material layer of Kishi, since the BCC structure would improve the performance of the MgO tunnel barrier layer by yielding a higher TMR value for a MGO tunnel junction as taught by Parkin.

With respect to Claim 21, Kishi discloses wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer comprises Cobalt and Iron (see paragraph 23).

### **Allowable Subject Matter**

11. Claims 3-10 are allowed.
12. The following is a statement of reasons for the indication of allowance subject matter: the prior art of record does not teach or suggest the combination of a tunnel barrier layer between the first ferromagnetic material layer and the second ferromagnetic material layer. The tunnel barrier layer comprises crystalline  $\text{MgO}_x(001)$  with oxygen vacancy defects and  $(0 < x < 1)$  in claim 3.

The prior art made of record and not relied upon is cited primarily to show the product of the instant invention.

### **Conclusion**

13. Any inquiry concerning the communication or earlier communications from the examiner should be directed to Alonzo Chambliss whose telephone number is (571) 272-1927.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Fernando L. Toledo can be reached on (571) 272-1867. The fax phone number for the organization where this application or proceeding is assigned is 571 - 273- 8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system Status information for published applications may be obtained from either Private PMR or Public PMR.

Status information for unpublished applications is available through Private PMR only. For more information about the PMR system see <http://pair-dkect.uspto.gov>.

Should you have questions on access to the Private PMR system contact the Electronic Center (EBC) at 866-217-9197 (toll-free).

/FERNANDO L TOLEDO/  
Supervisory Patent Examiner, Art Unit 2897

**AC**/April 23, 2024

/Alonzo Chambliss/  
Primary Examiner, Art Unit 2897



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
**United States Patent and Trademark Office**  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

| APPLICATION NO.                                                                      | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO.           | CONFIRMATION NO. |
|--------------------------------------------------------------------------------------|-------------|----------------------|-------------------------------|------------------|
| 18/232,576                                                                           | 08/10/2023  | Shinji YUASA         | IBTH 13318Aa                  | 1021             |
| 61650                                                                                | 7590        | 01/14/2025           |                               |                  |
| MYERS WOLIN, LLC<br>100 SOUTH JEFFERSON ROAD<br>SUITE 202<br>WHIPPANY, NJ 07981-1009 |             |                      | EXAMINER<br>CHAMBLISS, ALONZO |                  |
|                                                                                      |             |                      | ART UNIT                      | PAPER NUMBER     |
|                                                                                      |             |                      | 2897                          |                  |
|                                                                                      |             |                      | NOTIFICATION DATE             | DELIVERY MODE    |
|                                                                                      |             |                      | 01/14/2025                    | ELECTRONIC       |

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patent@myerswoln.com

|                              |                        |                     |
|------------------------------|------------------------|---------------------|
| <b>Notice of Abandonment</b> | <b>Application No.</b> | <b>Applicant(s)</b> |
|                              | 18/232,576             | YUASA, Shinji       |
|                              | <b>Examiner</b>        | <b>Art Unit</b>     |
|                              | ALONZO CHAMBLISS       | 2897                |

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--**

This application is abandoned in view of:

1. ☒ Applicant's failure to timely file a proper reply to the Office letter mailed on 26 June 2024.

(a) ☐ A reply was received on \_\_\_\_\_ (with a Certificate of Mailing or Transmission dated \_\_\_\_\_), which is after the expiration of the period for reply (including a total extension of time of \_\_\_\_\_ month(s)) which expired on \_\_\_\_\_.

(b) ☐ A proposed reply was received on \_\_\_\_\_, but it does not constitute a proper reply under 37 CFR 1.113 to the final rejection. (A proper reply under 37 CFR 1.113 to a final rejection consists only of: (1) a timely filed amendment which places the application in condition for allowance; (2) a timely filed Notice of Appeal (with appeal fee); or (3) if this is utility or plant application, a timely filed Request for Continued Examination (RCE) in compliance with 37 CFR 1.114. Note that RCEs are not permitted in design applications.)

(c) ☐ A reply was received on \_\_\_\_\_ but it does not constitute a proper reply, or a *bona fide* attempt at a proper reply, to the non-final rejection. See 37 CFR 1.85(a) and 1.111. (See explanation in box 8 below).

(d) ☒ No reply has been received.

2. ☐ Applicant's failure to timely pay the required issue fee and publication fee, if applicable, within the statutory period of three months from the mailing date of the Notice of Allowance (PTOL-85).

(a) ☐ The issue fee and publication fee, if applicable, was received on \_\_\_\_\_ (with a Certificate of Mailing or Transmission dated \_\_\_\_\_), which is after the expiration of the statutory period for payment of the issue fee (and publication fee) set in the Notice of Allowance (PTOL-85).

(b) ☐ The submitted fee of \$ \_\_\_\_\_ is insufficient. A balance of \$ \_\_\_\_\_ is due.  
The issue fee required by 37CFR 1.18 is \$ \_\_\_\_\_. The publication fee, if required by 37 CFR 1.18(d), is \$ \_\_\_\_\_.

(c) ☐ The issue fee and publication fee, if applicable, has not been received.

3. ☐ Applicant's failure to timely file corrected drawings as required by, and within the three-month period set in, the Notice of Allowability (PTO-37).

(a) ☐ Proposed corrected drawings were received on \_\_\_\_\_ (with a Certificate of Mailing or Transmission dated \_\_\_\_\_), which is after the expiration of the period for reply.

(b) ☐ No corrected drawings have been received.

4. ☐ The letter of express abandonment which is signed by the attorney or agent of record or other party authorized under 37 CFR 1.33 (b). See 37 CFR 1.138(b).

5. ☐ The letter of express abandonment which is signed by an attorney or agent (acting in a representative capacity under 37 CFR 1.34) upon the filing of a continuing application.

6. ☐ The decision by the Patent Trial and Appeal Board rendered on \_\_\_\_\_ and because the period for seeking court review of the decision has expired and there are no allowed claims.

7. ☐ The dismissal of the appeal in an application having no allowed claims. (When an appeal is dismissed in an application having no allowed claims the application stands abandoned. See MPEP 1215.04 subsections I-V for an explanation of the reasons why an appeal is dismissed.)

8. ☒ The reason(s) below:

The attorney of record (Andrzej Malarz informed the examiner on 1/3/2024 that the case has gone abandon.

/ALONZO CHAMBLISS/  
Primary Examiner, Art Unit 2897

Petitions to revive under 37 CFR 1.137, or requests to withdraw the holding of abandonment under 37 CFR 1.181, should be promptly filed to minimize any negative effects on patent term.