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|                                                                                                                                             |  |                                                    |  |
|---------------------------------------------------------------------------------------------------------------------------------------------|--|----------------------------------------------------|--|
| <b>UTILITY<br/>PATENT APPLICATION<br/>TRANSMITTAL</b><br><br><small>(Only for new nonprovisional applications under 37 CFR 1.53(b))</small> |  | Attorney Docket No. <b>4123.0460003</b>            |  |
|                                                                                                                                             |  | First Named Inventor <b>Zhenyu LU</b>              |  |
|                                                                                                                                             |  | Title <b>STAIRCASE STRUCTURE FOR MEMORY DEVICE</b> |  |
|                                                                                                                                             |  | Priority Mail Express® Label No.                   |  |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>APPLICATION ELEMENTS</b><br><small>See MPEP chapter 600 concerning utility patent application contents.</small>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>ADDRESS TO:</b><br>Commissioner for Patents<br>P.O. Box 1450<br>Alexandria, VA 22313-1450                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 1. <input type="checkbox"/> <b>Fee Transmittal Form</b><br><small>(PTO/SB/17 or equivalent)</small><br>2. <input type="checkbox"/> <b>Applicant asserts small entity status.</b><br><small>See 37 CFR 1.27</small><br>3. <input type="checkbox"/> <b>Applicant certifies micro entity status.</b> See 37 CFR 1.29.<br><small>Applicant must attach form PTO/SB/15A or B or equivalent.</small><br>4. <input checked="" type="checkbox"/> <b>Specification</b> [Total Pages <u>24</u> ]<br><small>Both the claims and abstract must start on a new page.<br/>         (See MPEP § 608.01(a) for information on the preferred arrangement)</small><br>5. <input checked="" type="checkbox"/> <b>Drawing(s)</b> (35 U.S.C. 113) [Total Sheets <u>10</u> ]<br>6. <input checked="" type="checkbox"/> <b>Inventor's Oath or Declaration</b> [Total Pages <u>5</u> ]<br><small>(including substitute statements under 37 CFR 1.64 and assignments<br/>         serving as an oath or declaration under 37 CFR 1.63(e))</small><br>a. <input type="checkbox"/> Newly executed (original or copy)<br>b. <input checked="" type="checkbox"/> A copy from a prior application (37 CFR 1.63(d))<br>7. <input checked="" type="checkbox"/> <b>Application Data Sheet</b> * See note below.<br><small>See 37 CFR 1.76 (PTO/AIA/14 or equivalent)</small><br>8. <b>CD-ROM or CD-R</b><br><small>in duplicate, large table, or Computer Program (Appendix)</small><br><input type="checkbox"/> Landscape Table on CD<br>9. <b>Nucleotide and/or Amino Acid Sequence Submission</b><br><small>(if applicable, items a. – c. are required)</small><br>a. <input type="checkbox"/> Computer Readable Form (CRF)<br>b. <input type="checkbox"/> Specification Sequence Listing on:<br>i. <input type="checkbox"/> CD-ROM or CD-R (2 copies); or<br>ii. <input type="checkbox"/> Paper<br>c. <input type="checkbox"/> Statements verifying identity of above copies | <b>ACCOMPANYING APPLICATION PAPERS</b><br>10. <input type="checkbox"/> <b>Assignment Papers</b><br><small>(cover sheet &amp; document(s))</small><br><small>Name of Assignee _____</small><br><small>Yangtze Memory Technologies Co., Ltd.</small><br>11. <input type="checkbox"/> <b>37 CFR 3.73(c) Statement</b> <input checked="" type="checkbox"/> <b>Power of Attorney</b><br><small>(when there is an assignee)</small><br>12. <input type="checkbox"/> <b>English Translation Document</b><br><small>(if applicable)</small><br>13. <input checked="" type="checkbox"/> <b>Information Disclosure Statement</b><br><small>(PTO/SB/08 or PTO-1449)</small><br><input type="checkbox"/> Copies of citations attached<br>14. <input type="checkbox"/> <b>Preliminary Amendment</b><br>15. <input type="checkbox"/> <b>Return Receipt Postcard</b><br><small>(MPEP § 503) (Should be specifically itemized)</small><br>16. <input type="checkbox"/> <b>Certified Copy of Priority Document(s)</b><br><small>(if foreign priority is claimed)</small><br>17. <input type="checkbox"/> <b>Nonpublication Request</b><br><small>Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35<br/>         or equivalent.</small><br>18. <input checked="" type="checkbox"/> <b>Other:</b> Authorization to Treat a Reply as Incorporating an<br>Extension of Time Under 37 C.F.R. § 1.136(a)(3) |

**\*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>26111</u> OR <input type="checkbox"/> Correspondence address below |                                 |                                                 |  |
| Name _____                                                                                                                                             |                                 |                                                 |  |
| Address _____                                                                                                                                          |                                 |                                                 |  |
| City _____                                                                                                                                             | State _____                     | Zip Code _____                                  |  |
| Country _____                                                                                                                                          | Telephone <u>(202) 371-2600</u> | Email _____                                     |  |
| Signature <u>/Donald J. Featherstone/</u>                                                                                                              |                                 | Date <u>5/28/2020</u>                           |  |
| Name (Print/Type) <u>DONALD J. FEATHERSTONE</u>                                                                                                        |                                 | Registration No. (Attorney/Agent) <u>33,876</u> |  |

This collection of information is required by 37 CFR 1.53(b). 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 12 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.*

DONALD J. FEATHERSTONE  
DIRECTOR  
(202) 772-8629  
DONF@STERNEKESSLER.COM

May 28, 2020

Commissioner for Patents  
PO Box 1450  
Alexandria, VA 22313-1450

Re: U.S. Non-Provisional Patent Application under 37 C.F.R. § 1.53(b)  
(Continuation of Appl. No. 16/126,956; Filed: September 10, 2018)  
Appl. No. To Be Assigned; Filed: Herewith  
For: **STAIRCASE STRUCTURE FOR MEMORY DEVICE**  
Inventors: LU *et al.*  
Our Ref: 4123.0460003

Commissioner:

The following documents are transmitted herewith for appropriate action by the U.S. Patent and Trademark Office:

1. Payment made electronically for **\$1,720.00** to cover the Patent Application fees (including basic filing, search, and examination fees);
2. Utility Patent Application Transmittal Form (PTO/AIA/15);
3. Authorization to Treat a Reply As Incorporating An Extension of Time Under 37 C.F.R. § 1.136(a)(3);
4. U.S. Utility Patent Application entitled:

**STAIRCASE STRUCTURE FOR MEMORY DEVICE**

and naming as inventors:

**Zhenyu LU**  
**Jun CHEN**  
**Xiaowang DAI**  
**Jifeng ZHU**  
**Qian TAO**  
**Yu Ru HUANG**  
**Si Ping HU**  
**Lan YAO**  
**Li Hong XIAO**  
**A Man ZHENG**

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Sterne, Kessler, Goldstein & Fox P.L.L.C. | 1100 New York Avenue, NW | Washington, D.C. 20005  
P 202.371.2500 | F 202.371.2540 | [sternekessler.com](http://sternekessler.com)

**Kun BAO**  
**Haohao YANG**

the application consisting of:

- a. An Application Data Sheet (37 C.F.R. § 1.76) (PTO/AIA/14);
- b. A copy of the signed Inventors' Declarations, as originally filed in prior U.S. Appl. No. 16/126,956;
- c. A specification containing:
  - i. 19 pages of description prior to the claims;
  - ii. 4 pages of claims (20 claims);
  - iii. a one (1) page abstract;
- d. 10 sheets of drawings: (*Figures 1, 2A-2B and 3-9*);
5. An executed Power of Attorney by Applicant form (PTO/AIA/82B) and the Transmittal for Power of Attorney form (PTO/AIA/82A);
6. An Information Disclosure Statement (IDS); and
7. Form PTO/SB/08a (1 sheet) listing 18 documents (**US1-US15** and **FP1-FP3**);
8. Form PTO/SB/08b (1 sheet) listing 1 document (**NPL1**).

*The above-listed documents are filed electronically.*

Commissioner for Patents  
May 28, 2020  
Page 3

Fee payment is provided via electronic filing. The U.S. Patent and Trademark Office is hereby authorized to charge any fee deficiency, or credit any overpayment, to our Deposit Account No. 19-0036.

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.

/Donald J. Featherstone/

Donald J. Featherstone  
Attorney for Applicant  
Registration No. 33,876

DJF/KTS/tas  
Enclosures

15080666\_1.docx

| Electronic Patent Application Fee Transmittal |          |                                       |        |                      |
|-----------------------------------------------|----------|---------------------------------------|--------|----------------------|
| Application Number:                           |          |                                       |        |                      |
| Filing Date:                                  |          |                                       |        |                      |
| Title of Invention:                           |          | STAIRCASE STRUCTURE FOR MEMORY DEVICE |        |                      |
| First Named Inventor/Applicant Name:          |          | Zhenyu LU                             |        |                      |
| Filer:                                        |          | Donald J. Featherstone/Tonyia Skinner |        |                      |
| Attorney Docket Number:                       |          | 4123.0460003                          |        |                      |
| Filed as Large Entity                         |          |                                       |        |                      |
| Filing Fees for Utility under 35 USC 111(a)   |          |                                       |        |                      |
| Description                                   | Fee Code | Quantity                              | Amount | Sub-Total in USD(\$) |
| Basic Filing:                                 |          |                                       |        |                      |
| UTILITY APPLICATION FILING                    | 1011     | 1                                     | 300    | 300                  |
| UTILITY SEARCH FEE                            | 1111     | 1                                     | 660    | 660                  |
| UTILITY EXAMINATION FEE                       | 1311     | 1                                     | 760    | 760                  |
| Pages:                                        |          |                                       |        |                      |
| Claims:                                       |          |                                       |        |                      |
| Miscellaneous-Filing:                         |          |                                       |        |                      |
| Petition:                                     |          |                                       |        |                      |
| Patent-Appeals-and-Interference:              |          |                                       |        |                      |

| Description                              | Fee Code | Quantity | Amount | Sub-Total in USD(\$) |
|------------------------------------------|----------|----------|--------|----------------------|
| <b>Post-Allowance-and-Post-Issuance:</b> |          |          |        |                      |
| <b>Extension-of-Time:</b>                |          |          |        |                      |
| <b>Miscellaneous:</b>                    |          |          |        |                      |
| <b>Total in USD (\$)</b>                 |          |          |        | <b>1720</b>          |

| Electronic Acknowledgement Receipt          |                                       |
|---------------------------------------------|---------------------------------------|
| <b>EFS ID:</b>                              | 39561657                              |
| <b>Application Number:</b>                  | 16885858                              |
| <b>International Application Number:</b>    |                                       |
| <b>Confirmation Number:</b>                 | 1041                                  |
| <b>Title of Invention:</b>                  | STAIRCASE STRUCTURE FOR MEMORY DEVICE |
| <b>First Named Inventor/Applicant Name:</b> | Zhenyu LU                             |
| <b>Customer Number:</b>                     | 26111                                 |
| <b>Filer:</b>                               | Donald J. Featherstone/Tonyia Skinner |
| <b>Filer Authorized By:</b>                 | Donald J. Featherstone                |
| <b>Attorney Docket Number:</b>              | 4123.0460003                          |
| <b>Receipt Date:</b>                        | 28-MAY-2020                           |
| <b>Filing Date:</b>                         |                                       |
| <b>Time Stamp:</b>                          | 14:49:32                              |
| <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                                                                       | \$ 1720          |
| RAM confirmation Number                                                                                        | E20205RE50276593 |
| 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               |                                                     | 2020-05-28-Filing-Bundle-4123-0460003.pdf | 5359975                                  | yes              | 66               |
|                 |                                                     |                                           | 209dc8a95e551d407386fd1120cd333ba584f87  |                  |                  |
|                 | Multipart Description/PDF files in .zip description |                                           |                                          |                  |                  |
|                 | Document Description                                |                                           | Start                                    | End              |                  |
|                 | Power of Attorney                                   |                                           | 65                                       | 66               |                  |
|                 | Information Disclosure Statement (IDS) Form (SB08)  |                                           | 63                                       | 64               |                  |
|                 | Transmittal Letter                                  |                                           | 57                                       | 62               |                  |
|                 | Drawings-only black and white line drawings         |                                           | 47                                       | 56               |                  |
|                 | Abstract                                            |                                           | 46                                       | 46               |                  |
|                 | Claims                                              |                                           | 42                                       | 45               |                  |
|                 | Specification                                       |                                           | 23                                       | 41               |                  |
|                 | Oath or Declaration filed                           |                                           | 18                                       | 22               |                  |
|                 | Application Data Sheet                              |                                           | 6                                        | 17               |                  |
|                 | Authorization for Extension of Time all replies     |                                           | 5                                        | 5                |                  |
|                 | Transmittal of New Application                      |                                           | 4                                        | 4                |                  |
|                 | Transmittal Letter                                  |                                           | 1                                        | 3                |                  |
|                 | Warnings:                                           |                                           |                                          |                  |                  |
| Information:    |                                                     |                                           |                                          |                  |                  |
| 2               | Fee Worksheet (SB06)                                | fee-info.pdf                              | 34652                                    | no               | 2                |
|                 |                                                     |                                           | 8d36efe1320978f3553b453e0d60ec6967c88cf8 |                  |                  |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |         |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |         |
| <b>Total Files Size (in bytes):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 5394627 |
| <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> |         |

## TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA/82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

|                        |                                       |
|------------------------|---------------------------------------|
| Application Number     | To Be Assigned                        |
| Filing Date            | Herewith                              |
| First Named Inventor   | Zhenyu LU                             |
| Title                  | STAIRCASE STRUCTURE FOR MEMORY DEVICE |
| Art Unit               | To Be Assigned                        |
| Examiner Name          | To Be Assigned                        |
| Attorney Docket Number | 4123.0460003                          |

### SIGNATURE of Applicant or Patent Practitioner

|                                                    |                                       |                     |        |
|----------------------------------------------------|---------------------------------------|---------------------|--------|
| Signature                                          | /Donald J. Featherstone/              | Date (Optional)     |        |
| Name                                               | DONALD J. FEATHERSTONE                | Registration Number | 33,876 |
| Title (if Applicant is a juristic entity)          | Attorney for Applicant                |                     |        |
| Applicant Name (if Applicant is a juristic entity) | Yangtze Memory Technologies Co., Ltd. |                     |        |

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



\*Total of **one (1)** 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.**

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Doc Code: PA..

Document Description: Power of Attorney

PTO/AIA/82B (07-13)

Approved for use through 01/31/2018, OMB 0651-0035  
U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

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**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:

26111

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:

26111

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):

Yangtze Memory Technologies Co., Ltd.

- ☐ 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

Simon Shi-Ning Yang

Title

CEO

**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.

|                                                                                                      |   |    |   |                          |                |
|------------------------------------------------------------------------------------------------------|---|----|---|--------------------------|----------------|
| <b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br><i>(Use as many sheets as necessary)</i> |   |    |   | <b>Complete if Known</b> |                |
|                                                                                                      |   |    |   | Application Number       | To Be Assigned |
|                                                                                                      |   |    |   | Filing Date              | Herewith       |
|                                                                                                      |   |    |   | First Named Inventor     | Zhenyu LU      |
|                                                                                                      |   |    |   | Art Unit                 | To Be Assigned |
|                                                                                                      |   |    |   | Examiner Name            | To Be Assigned |
| Sheet                                                                                                | 1 | of | 1 | Attorney Docket Number   | 4123.0460003   |

| U.S. PATENT DOCUMENTS |                       |                                          |                                |                                                    |                                                                              |
|-----------------------|-----------------------|------------------------------------------|--------------------------------|----------------------------------------------------|------------------------------------------------------------------------------|
| Examiner initials*    | Cite No. <sup>1</sup> | Document Number                          | Publication Date<br>MM-DD-YYYY | Name of Patentee or<br>Applicant of Cited Document | Pages, Columns, Lines, Where<br>Relevant Passages or Relevant Figures Appear |
|                       |                       | Number-Kind Code <sup>2</sup> (if known) |                                |                                                    |                                                                              |
|                       | US1                   | 2015/0255385 A1                          | 09-10-2015                     | Lee et al.                                         |                                                                              |
|                       | US2                   | 2019/0081070 A1                          | 03-14-2019                     | Lu et al.                                          |                                                                              |
|                       | US3                   | 9,419,013 B1                             | 08-16-2016                     | Lee et al.                                         |                                                                              |
|                       | US4                   | 9,741,563 B2                             | 08-22-2017                     | Xiang et al.                                       |                                                                              |
|                       | US5                   | 2017/0084532 A1                          | 03-23-2017                     | Son et al.                                         |                                                                              |
|                       | US6                   | 10,403,641 B2                            | 09-03-2019                     | Kim et al.                                         |                                                                              |
|                       | US7                   | 10,002,880 B1                            | 06-19-2018                     | Nagashiima                                         |                                                                              |
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|                       | US17                  |                                          |                                |                                                    |                                                                              |
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|                       | US19                  |                                          |                                |                                                    |                                                                              |
|                       | US20                  |                                          |                                |                                                    |                                                                              |

| FOREIGN PATENT DOCUMENTS |                       |                                                                                       |                                |                                                    |                                                                              |                |
|--------------------------|-----------------------|---------------------------------------------------------------------------------------|--------------------------------|----------------------------------------------------|------------------------------------------------------------------------------|----------------|
| Examiner initials*       | Cite No. <sup>1</sup> | Foreign Patent Document                                                               | Publication Date<br>MM-DD-YYYY | Name of Patentee or<br>Applicant of Cited Document | Pages, Columns, Lines, Where Relevant Passages or<br>Relevant Figures Appear | T <sup>6</sup> |
|                          |                       | Country Code <sup>3</sup> -Number <sup>4</sup> -<br>Kind Code <sup>5</sup> (if known) |                                |                                                    |                                                                              |                |
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|                          | FP7                   |                                                                                       |                                |                                                    |                                                                              |                |
|                          | FP8                   |                                                                                       |                                |                                                    |                                                                              |                |

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| 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 applicant. <sup>1</sup> Applicant's unique citation designation number (optional). <sup>2</sup> See Kinds Codes of USPTO Patent Documents at [www.uspto.gov](http://www.uspto.gov) or MPEP 901.04. <sup>3</sup> Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). <sup>4</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>5</sup> Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. <sup>6</sup> Applicant is to place a check mark here if English language Translation is attached.

|                                                                                                      |   |    |   |                          |                |
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| Substitute for form 1449/PTO                                                                         |   |    |   | <b>Complete if Known</b> |                |
| <b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br><i>(Use as many sheets as necessary)</i> |   |    |   | Application Number       | To Be Assigned |
|                                                                                                      |   |    |   | Filing Date              | Herewith       |
|                                                                                                      |   |    |   | First Named Inventor     | Zhenyu LU      |
|                                                                                                      |   |    |   | Art Unit                 | To Be Assigned |
|                                                                                                      |   |    |   | Examiner Name            | To Be Assigned |
|                                                                                                      |   |    |   | Attorney Docket Number   | 4123.0460003   |
| Sheet                                                                                                | 1 | of | 1 |                          |                |

| NON PATENT LITERATURE DOCUMENTS |                          |                                                                                                                                                                                                                                                                |                |
|---------------------------------|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Examiner<br>Initials*           | Cite<br>No. <sup>1</sup> | 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, page(s), volume-issue number(s), publisher, city and/or country where published | T <sup>2</sup> |
|                                 | NPL1                     | International Search Report and Written Opinion of the International Searching Authority directed to related International Patent Application No. PCT/CN2018/098962, mailed November 7, 2018; 8 pages.                                                         |                |
|                                 | NPL2                     |                                                                                                                                                                                                                                                                |                |
|                                 | NPL3                     |                                                                                                                                                                                                                                                                |                |
|                                 | NPL4                     |                                                                                                                                                                                                                                                                |                |
|                                 | NPL5                     |                                                                                                                                                                                                                                                                |                |
|                                 | NPL6                     |                                                                                                                                                                                                                                                                |                |
|                                 | NPL7                     |                                                                                                                                                                                                                                                                |                |
|                                 | NPL8                     |                                                                                                                                                                                                                                                                |                |
|                                 | NPL9                     |                                                                                                                                                                                                                                                                |                |
|                                 | NPL10                    |                                                                                                                                                                                                                                                                |                |

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| Examiner<br>Signature |  | Date<br>Considered |  |
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\*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 applicant.

<sup>1</sup> Applicant's unique citation designation number (optional). <sup>2</sup> Applicant is to place a check mark here if English language Translation is attached.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventors: LU *et al.*

Applicant: Yangtze Memory Technologies  
Co., Ltd.

Application No.: *To Be Assigned*

(*Continuation of Appl. No. 16/126,956; Filed:  
September 10, 2018*)

Filing Date: *Herewith*

Confirmation No.: *To Be Assigned*

Art Unit: *To Be Assigned*

Examiner: *To Be Assigned*

Atty. Docket: 4123.0460003

Title: **STAIRCASE STRUCTURE FOR MEMORY DEVICE**

**Information Disclosure Statement**

*Mail Stop Amendment*

Commissioner for Patents  
PO Box 1450  
Alexandria, VA 22313-1450

Commissioner:

Listed on accompanying IDS Forms PTO/SB/08a equivalent and/or PTO/SB/08b equivalent are documents that may be considered material to the patentability of this application as defined in 37 C.F.R. §1.56, and in compliance with the duty of disclosure requirements of 37 C.F.R. §§ 1.97 and 1.98.

Where the publication date of a listed document does not provide a month of publication, the year of publication of the listed document is sufficiently earlier than the effective U.S. filing date and any foreign priority date so that the month of publication is not in issue. Applicant has listed publication dates on the attached IDS Forms based on information presently available to the undersigned. However, the listed publication dates should not be construed as an admission that the information was actually published on the date indicated.

Applicant reserves the right to establish the patentability of the claimed invention over any of the information provided herewith, and/or to prove that this information may not be prior art, and/or to prove that this information may not be enabling for the teachings purportedly offered.

This statement should not be construed as a representation that a search has been made, or that information more material to the examination of the present patent application does not exist. The Examiner is specifically requested not to rely solely on the material submitted herewith.

Applicant has checked the appropriate boxes below.

- ☐ 1. Statement under 37 C.F.R. 1.704(d). Each item of information contained in this Information Disclosure Statement: (i) was first cited in any communication from a patent office in a counterpart<sup>1</sup> foreign or international application or from the Office; and this communication was not received by any individual designated in Sec. 1.56(c) more than thirty days prior to the filing of this information disclosure statement; OR (ii) is a communication that was issued by a patent office in a counterpart foreign or international application or by the Office, and this communication was not received by any individual designated in Sec. 1.56(c) more than thirty days prior to the filing of the information disclosure statement.
- ☒ 2. Filing under 37 C.F.R. § 1.97(b). This Information Disclosure Statement is being filed within three months of the date of filing of a national application other than a continued prosecution application (CPA), OR within three months of the date of entry of the national

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<sup>1</sup> The term counterpart foreign patent application means that a claim for priority has been made in either the U.S. application or a foreign application based on the other, or that the disclosures of the U.S. and foreign patent applications are substantively identical (e.g., an application filed in the European Patent Office claiming the same U.K. priority as claimed in the U.S. application).

stage as set forth in 37 C.F.R. § 1.491 in an international application, OR before the mailing date of a first Office Action on the merits OR before the mailing of a first Office Action after the filing of a request for continued examination under 37 C.F.R. § 1.114. No statement or fee is required.

- ☐ 3. Filing under 37 C.F.R. § 1.97(c). This Information Disclosure Statement is being filed more than three months after the U.S. filing date AND after the mailing date of the first Office Action on the merits, but before the mailing date of a Final Rejection, or Notice of Allowance, or an action that otherwise closes prosecution in the application.
- ☐ a. Statement under 37 C.F.R. § 1.97(e)(1). I hereby state that each item of information contained in this 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 this Information Disclosure Statement. 37 C.F.R. § 1.97(e)(1).
- ☐ b. Statement under 37 C.F.R. § 1.97(e)(2). I hereby state that no item of information in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application and, to my knowledge after making reasonable inquiry, was known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of this Information Disclosure Statement. 37 C.F.R. § 1.97(e)(2).
- ☐ c. The required fee is provided through online credit card payment authorization in the amount of \$240.00 in payment of the fee under 37 C.F.R. § 1.17(p).

Atty. Dkt. No. 4123.0460003

- ☐ 4. Filing under 37 C.F.R. § 1.97(d) This Information Disclosure Statement is being filed more than three months after the U.S. filing date and after the mailing date of a Final Rejection or Notice of Allowance, but on or before payment of the Issue Fee. The required fee is provided through online credit card payment authorization in the amount of \$240.00 in payment of the fee under 37 C.F.R. § 1.17(p); in addition:
- ☐ a. Statement under 37 C.F.R. § 1.97(e)(1). I hereby state that each item of information contained in this 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 this Information Disclosure Statement. 37 C.F.R. § 1.97(e)(1).
- ☐ b. Statement under 37 C.F.R. § 1.97(e)(2). I hereby state that no item of information in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application and, to my knowledge after making reasonable inquiry, was known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of this Information Disclosure Statement. 37 C.F.R. § 1.97(e)(2).
- ☐ 5. The patent family for one or more foreign language documents submitted herewith includes a United States patent, and other patent, in the English language. Copies of both the particular foreign patent(s) or published foreign patent applications cited in the foreign patent office communication, and that are not already of record in this application, are enclosed. Copies of the related United States or other English language patent or published

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application from the family list, if not already of record, are listed on the accompanying SB/08A form. For the purposes of a statement under 37 CFR 1.97(e)(1), the United States or other English language patent or published application are to be construed as being cited by the foreign patent office. MPEP 609.04(b)(V).

- ☐ 6. The document(s) was/were cited in a search report by a foreign patent office in a counterpart foreign application. Submission of an English language version of the search report that indicates the degree of relevance found by the foreign office is provided in satisfaction of the requirement for a concise explanation of relevance. MPEP 609.04(a)(III).
- ☐ 7. A concise explanation of the relevance of the non-English language document(s) appears below in accordance with 37 C.F.R. § 1.98(a)(3).
- ☐ 8. Copies of documents FP1-FP3 and NPL1 are submitted. However, in accordance with 37 C.F.R. § 1.98(a)(2)(ii), no copies of U.S. patents and patent application publications cited as documents US1-US15 on the attached IDS Forms are submitted.
- ☒ 9. Copies of the **US1-US15**, **FP1-FP3** and **NPL1** documents were cited by or submitted to the Office in an IDS that complies with 37 C.F.R. § 1.98(a)-(c) in Application No. 16/126,956, filed September 10, 2018, which is relied upon for an earlier filing date under 35 U.S.C. § 120. Thus, copies of these documents are not attached. 37 C.F.R. § 1.98(d).
- ☒ 10. It is expected that the examiner will review the prosecution and cited art in the parent Application No. 16/126,956 in accordance with MPEP 2001.06(b), and indicate in the next communication from the office that the art cited in the earlier prosecution history has been reviewed in connection with the present application.

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☐ 11. In accordance with the Federal Circuit decision in *Dayco Prods., Inc. v. Total Containment, Inc.* 329 F.3d 1358 (Fed. Cir. 2003), Applicants submit herewith Office Actions from the co-pending U.S. Patent Application No. \_\_\_\_\_, filed \_\_\_\_\_, as documents \_\_\_\_\_ to \_\_\_\_\_. The identification of these Office Actions is not to be construed as a waiver of secrecy as to those applications now or upon issuance of the present application as a patent. The Examiner is respectfully requested to consider the cited applications and the art cited therein during examination.

It is respectfully requested that the Examiner initial and return a copy of the enclosed IDS Forms, and indicate in the official file wrapper of this patent application that the documents have been considered.

The U.S. Patent and Trademark Office is hereby authorized to charge any fee deficiency, or credit any overpayment, to our Deposit Account No. 19-0036.

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.

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Registration No. 33,876

Date: 5/28/2020

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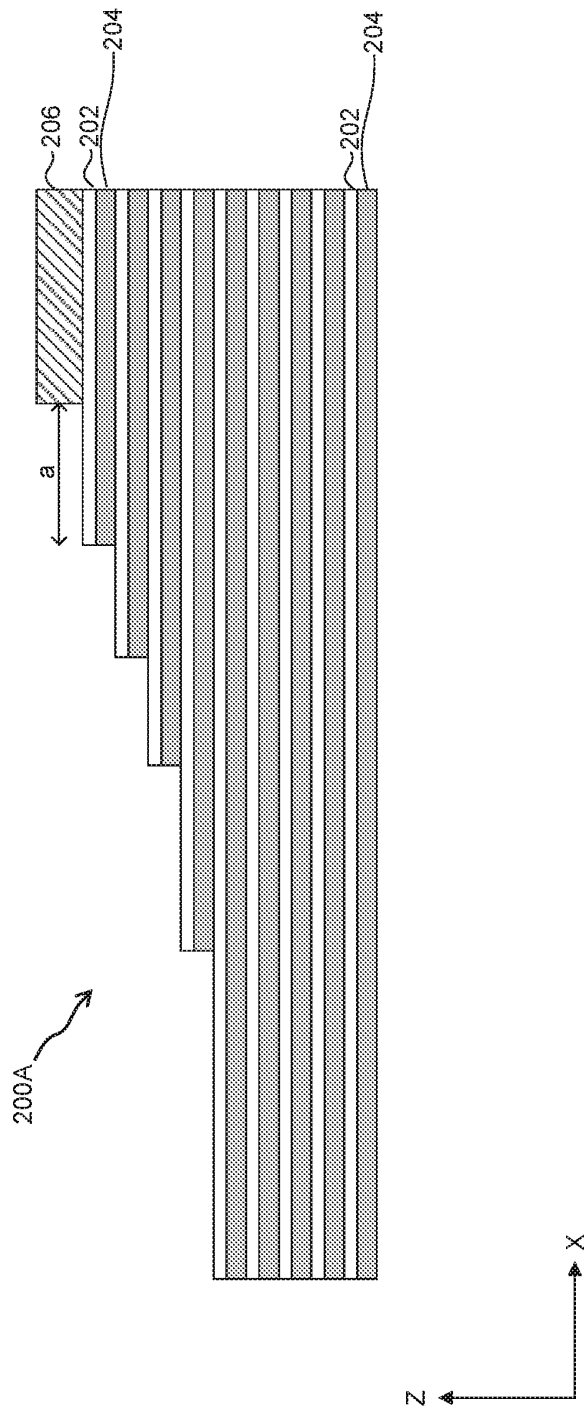


FIG. 2A

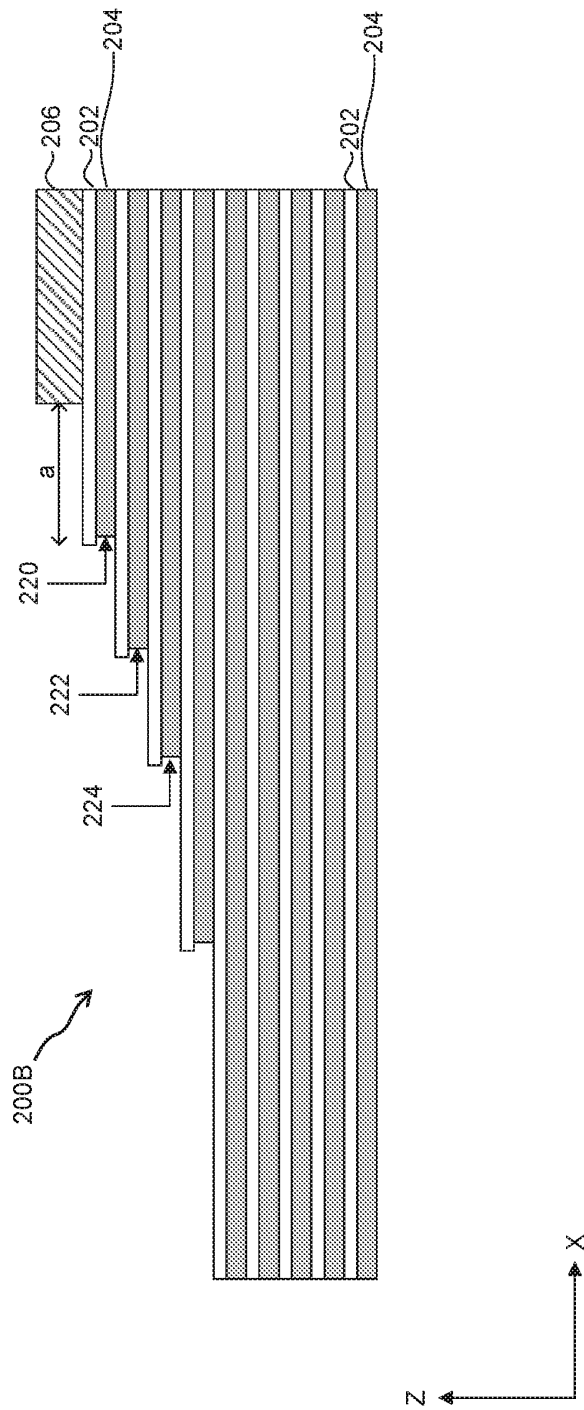


FIG. 2B

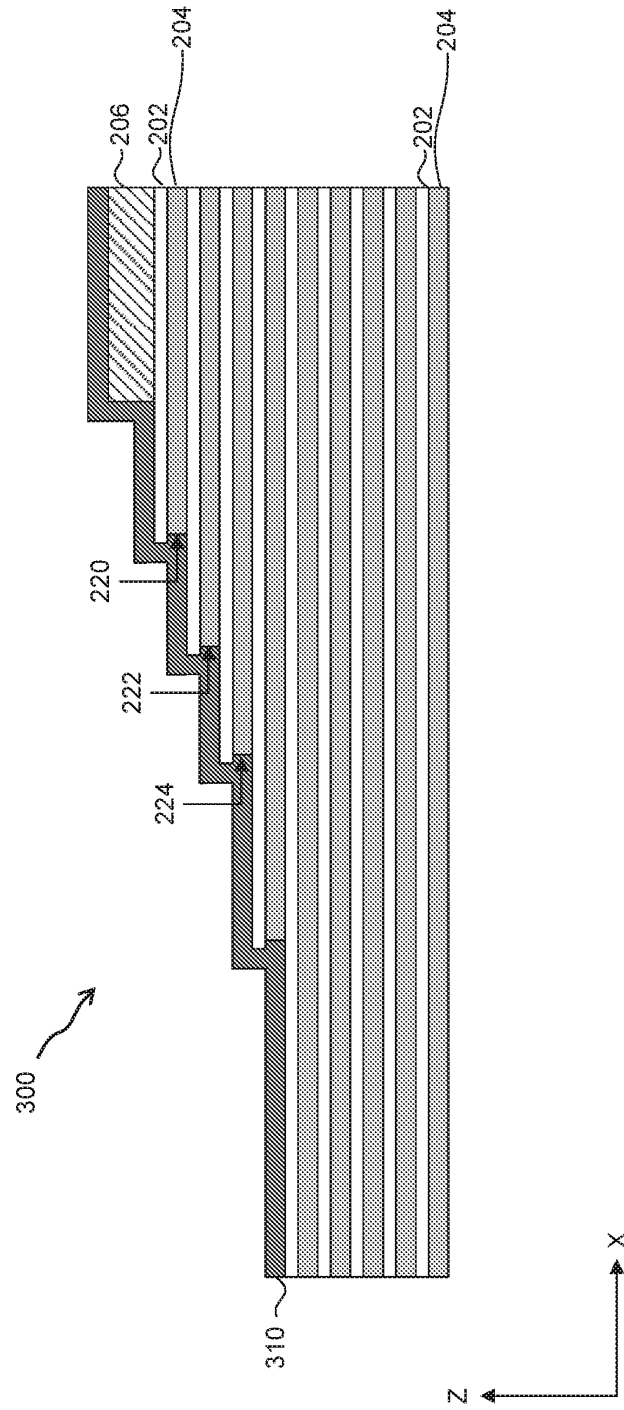


FIG. 3

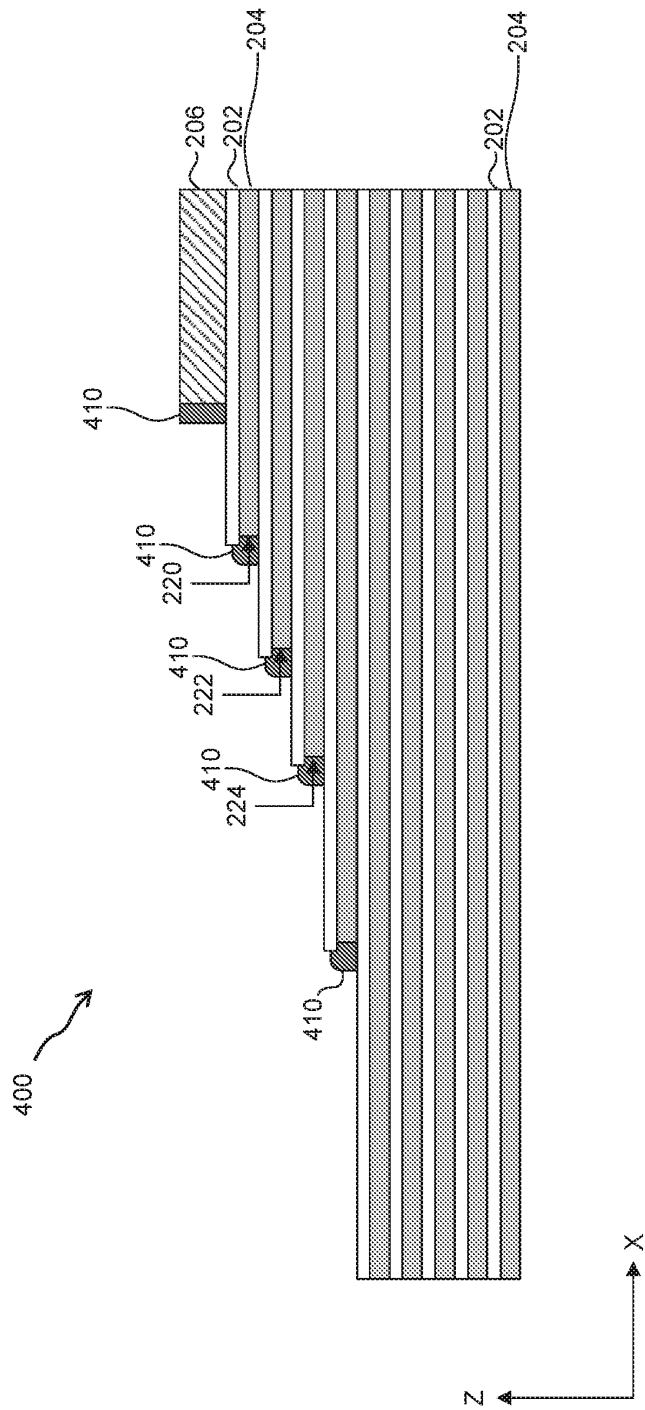


FIG. 4

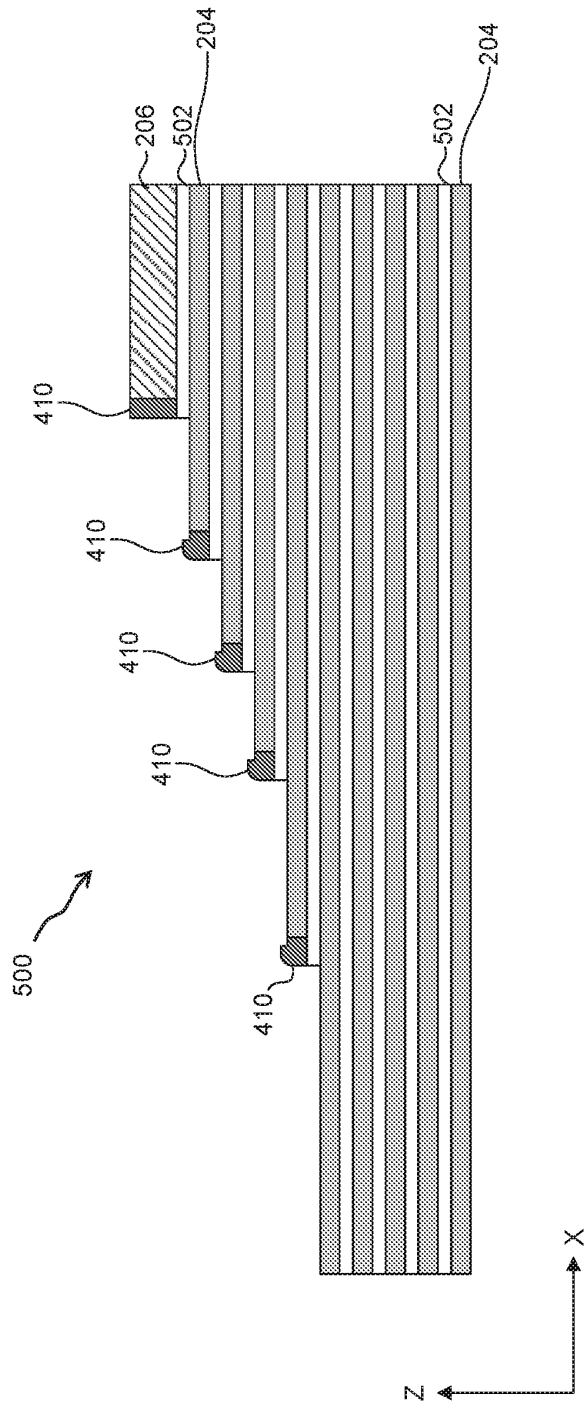


FIG. 5



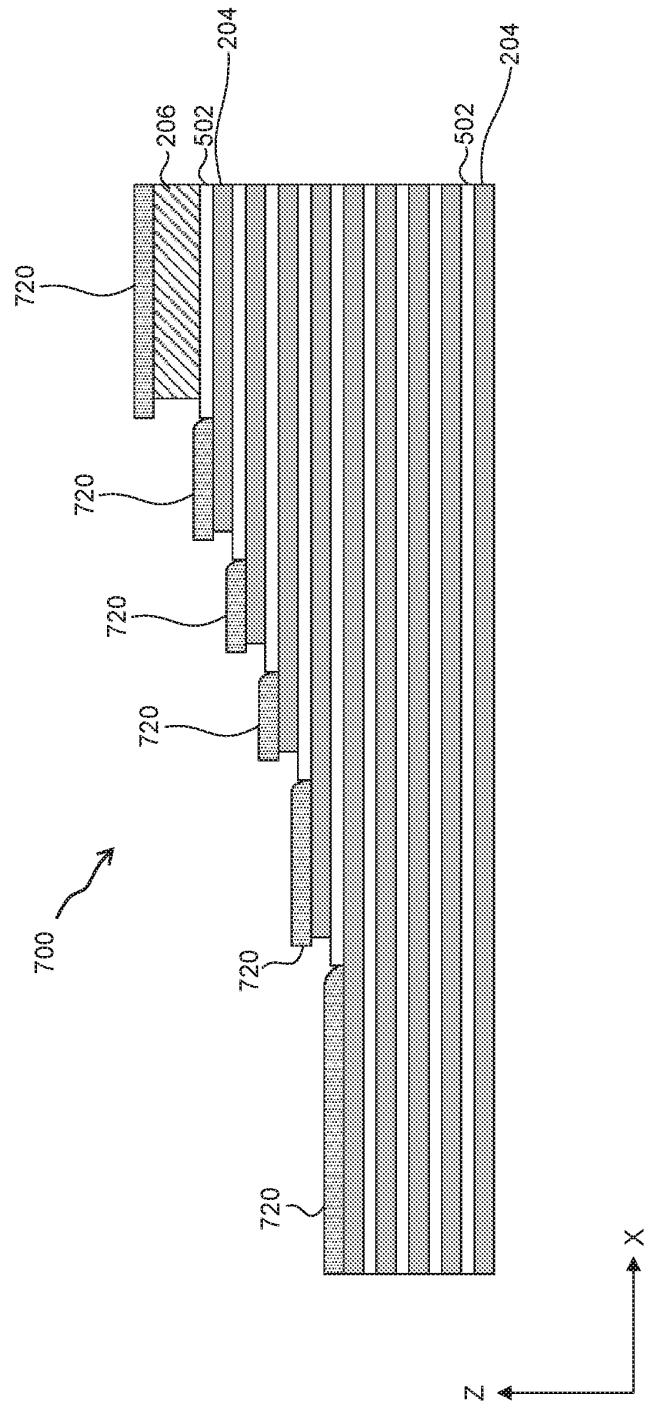


FIG. 7

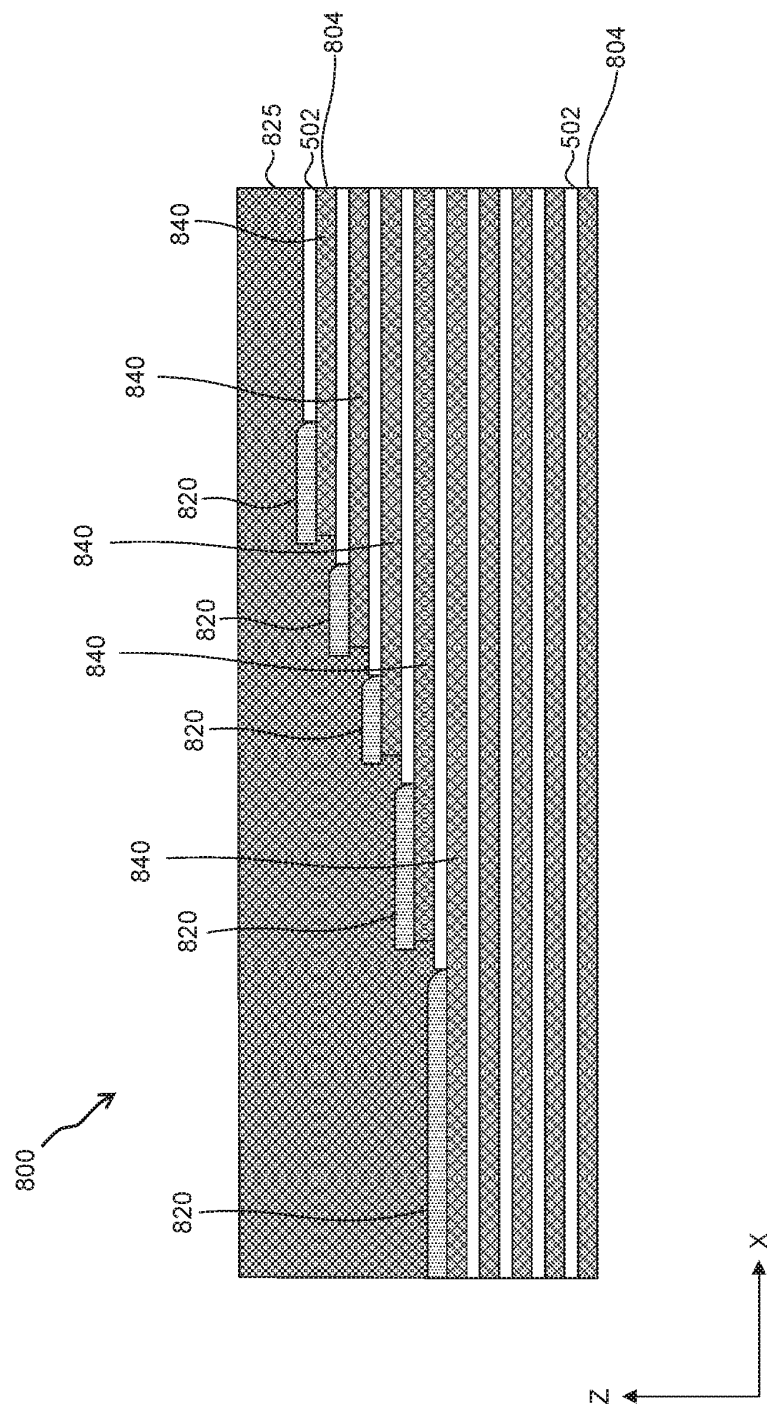


FIG. 8

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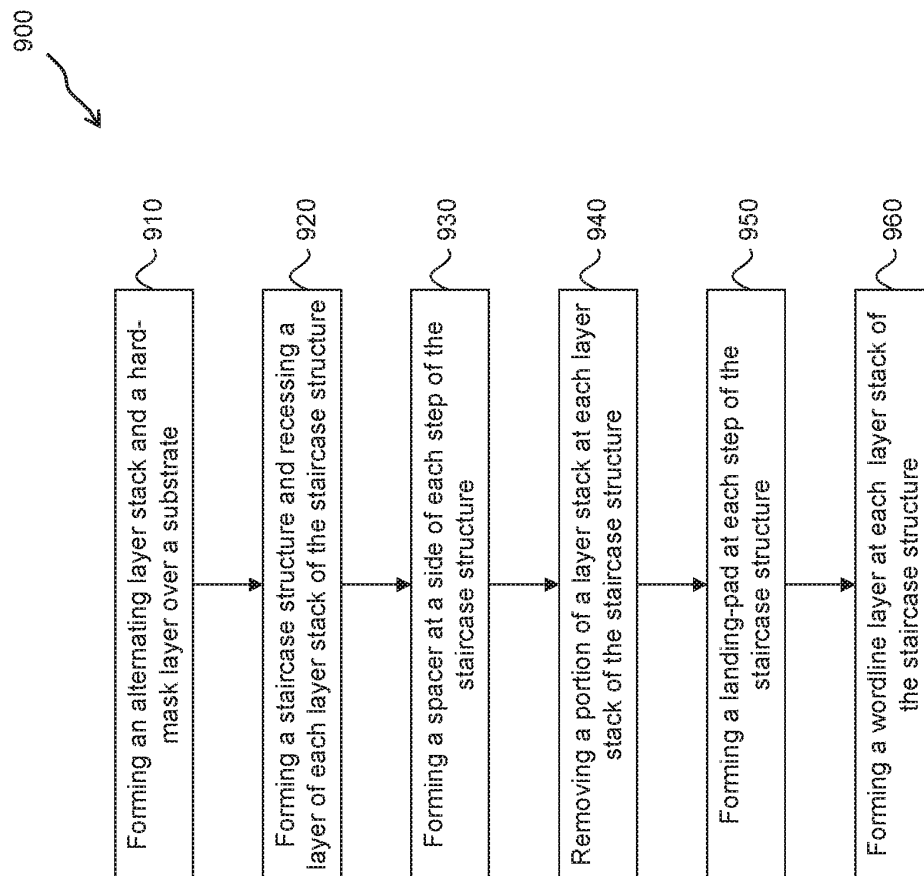


**FIG. 9**

# ABSTRACT

A semiconductor structure is disclosed. The semiconductor structure includes a staircase structure disposed over a substrate. The staircase structure includes a plurality of layer stacks, where each layer stack is made of a first material layer over a portion of a second material layer. The staircase structure further includes a plurality of landing pads, where each landing pad is disposed over another portion of the second material layer of a respective layer stack.

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WHAT IS CLAIMED IS:

1. A semiconductor structure, comprising:  
a substrate; and  
a staircase structure disposed over the substrate, wherein the staircase structure comprises:  
a plurality of layer stacks, each layer stack comprising a first material layer and a second material layer, wherein the first material layer is disposed over a first portion of the second material layer; and  
a plurality of landing pads respectively disposed on the plurality of layer stacks, wherein each landing pad is disposed over a second portion of the second material layer of a respective layer stack of the plurality of layer stacks, and wherein the each landing pad comprises a bottom surface substantially coplanar with another bottom surface of the first material layer of the respective layer stack.
2. The semiconductor structure of claim 1, wherein each of the plurality of landing pads comprises a first side surface and a second side surface, wherein the first side surface is in contact with the first material layer of the respective layer stack, and wherein the second side surface is laterally displaced from a third side surface of the second portion of the second material layer of the respective layer stack.
3. The semiconductor structure of claim 1, wherein each of the plurality of landing pads further comprises a top surface opposite to the bottom surface, wherein the top surface is laterally displaced and vertically above another top surface of the first material layer of the respective layer stack.
4. The semiconductor structure of claim 1, wherein the second material layer comprises a first conductive material, and wherein each of the plurality of landing pads comprises a second conductive material.
5. The semiconductor structure of claim 1, wherein a top surface of the each landing pad comprises a conductive material, and wherein the first material layer comprises an insulating material.

6. The semiconductor structure of claim 5, wherein the conductive material comprises tungsten, silicide, nickel, titanium, platinum, aluminum, titanium nitride, tantalum nitride, tungsten nitride, or a combination thereof.
7. The semiconductor structure of claim 1, wherein the second material layer of a layer stack of the plurality of layer stacks is disposed over a first portion of the first material layer of an adjacent layer stack of the plurality of layer stacks, wherein a side surface of a second portion of the first material layer of the adjacent layer stack is laterally displaced from another side surface of the each landing pad.
8. The semiconductor structure of claim 1, wherein the each landing pad is thicker than the first material layer of the respective layer stack of the plurality of layer stacks.
9. A semiconductor structure, comprising:  
a substrate; and  
a staircase structure disposed over the substrate, wherein the staircase structure comprises:  
a plurality of layer stacks, each layer stack comprising a first material layer and a second material layer, wherein the first material layer is disposed over a first portion of the second material layer; and  
a plurality of landing pads respectively disposed on the plurality of layer stacks, wherein each landing pad is disposed over a second portion of the second material layer of a respective layer stack of the plurality of layer stacks, and wherein the each landing pad comprises a curved side surface and a substantially straight side surface, wherein the substantially straight side surface is laterally displaced from a side surface of the second portion of the second material layer.
10. The semiconductor structure of claim 9, wherein a lateral distance between an upper portion of the curved side surface and another side surface of the first material layer of the respective layer stack is greater than another lateral distance between a lower portion of the curved side surface and the other side surface of the first material layer of the respective layer stack.

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11. The semiconductor structure of claim 9, wherein the curve side surface is laterally displaced from a top surface of the first portion of the second material layer and vertically above another top surface of the second portion of the second material layer.
12. The semiconductor structure of claim 9, wherein the second material layer comprises a first conductive material, and wherein each of the plurality of landing pads comprises a second conductive material.
13. The semiconductor structure of claim 9, wherein a top surface of the each landing pad comprises a conductive material.
14. The semiconductor structure of claim 13, wherein the conductive material comprises tungsten, silicide, nickel, titanium, platinum, aluminum, titanium nitride, tantalum nitride, tungsten nitride, or a combination thereof.
15. The semiconductor structure of claim 9, wherein the second material layer of a layer stack of the plurality of layer stacks is disposed over a first portion of the first material layer of an adjacent layer stack of the plurality of layer stacks, wherein a side surface of a second portion of the first material layer of the adjacent layer stack is laterally displaced from another side surface of the each landing pad.
16. The semiconductor structure of claim 9, wherein the each landing pad is thicker than the first material layer of the respective layer stack of the plurality of layer stacks.
17. A memory device, comprising:
  - a substrate, wherein the substrate comprises a top surface;
  - a memory string disposed over the substrate; and
  - a staircase structure disposed adjacent to the memory string, wherein the staircase structure comprises:
    - a plurality of layer stacks, each layer stack comprising an insulating layer disposed over a first portion of a conductive layer, wherein a second portion of the conductive layer comprises a curved side surface in contact with a side surface of the insulating layer.

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18. The memory device of claim 18, wherein an upper portion of the curved side surface is separated from the side surface of the insulating layer, and wherein a lower portion of the curved side surface is in contact with the side surface of the insulating layer.
19. The memory device of claim 17, wherein the conductive layer of a layer stack of the plurality of layer stacks is disposed over a first portion of the insulating layer of an adjacent layer stack of the plurality of layer stacks, wherein a second portion of the insulating layer of the adjacent layer stack is laterally displaced from the conductive layer of the layer stack.
20. The memory device of claim 17, wherein the conductive layer comprises a first conductive material, and wherein the curved side surface comprises a second conductive material.

## STAIRCASE STRUCTURE FOR MEMORY DEVICE

### CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. Non-provisional Patent Application No. 16/126,956, titled “Staircase Structure for Memory Device,” filed on September 10, 2018, which claims priority to PCT Application No. PCT/CN2018/098962 filed on August 6, 2018, which claims priority to Chinese Patent Application No. 201710750398.4 filed on August 28, 2017, the entire contents of which are incorporated herein by reference.

### BACKGROUND

[0002] Planar memory cells are scaled to smaller sizes by improving process technology, circuit design, programming algorithm, and fabrication process. However, as feature sizes of the memory cells approach a lower limit, planar process and fabrication techniques become challenging and costly. As a result, memory density for planar memory cells approaches an upper limit.

[0003] A three-dimensional (3D) memory architecture can address the density limitation in planar memory cells. The 3D memory architecture includes a memory array and peripheral devices for controlling signals to and from the memory array. The 3D memory architecture also includes a stack of word lines horizontally arranged over a substrate, with vertical semiconductor channels that intersect the word lines. The intersection of a word line and a vertical semiconductor channel forms a memory cell.

### BRIEF SUMMARY

[0004] Embodiments of the present disclosure are directed to a staircase structure for a memory device (e.g., 3D memory device). The disclosed embodiments provide numerous benefits including, but not limiting to, yield and manufacturing cost improvements.

[0005] In some embodiments, a semiconductor structure includes a staircase structure disposed over a substrate. The staircase structure includes a plurality of layer stacks, where each layer stack includes a first material layer disposed over a first portion of a second material layer. The staircase structure further includes a plurality of landing pads

respectively disposed on the plurality of layer stacks, where each landing pad is disposed over a second portion of the second material layer of a respective layer stack. Each of the landing pads is adjacent to a respective side of the first material layer and extends over a respective top surface of the second material layer. The first material layer is made of an insulating material, including silicon oxide, aluminum oxide or a combination thereof. The second material layer is made of a first conductive material. The plurality of landing pads are made of a second conductive material. The first conductive material can be the same or different from the second material. Each of the first and the second conductive materials includes tungsten, silicide, nickel, titanium, platinum, aluminum, titanium nitride, tantalum nitride, tungsten nitride, or a combination thereof. The second material layer of each layer stack is disposed over a portion of the first material layer of an adjacent layer stack. One of the plurality of landing pads is thicker than the first material layer of a corresponding layer stack and is insulated from another landing pad disposed on an adjacent layer stack.

[0006] In some embodiments, a method for forming a semiconductor structure includes forming a plurality of layer stacks over a substrate, where each layer stack includes a first material layer over a portion of a second material layer. The method further includes forming a hard mask layer over the plurality of layer stacks, forming a staircase structure on the plurality of layer stacks to expose a portion of the first material layer of each layer stack, forming a landing pad over a portion of the second material layer of the each layer stack, and removing the portion of the hard mask layer. The method further includes removing the landing pad and the second material layer of the each layer stack to form a recess in each layer stack, disposing a conductive material in the recess of each layer stack, and forming a dielectric layer over the staircase structure. The formation of the landing pad includes removing a portion of the second material layer from a side of each layer stack to form a recess, disposing a material layer over the staircase structure to fill the recess in each layer stack and removing a portion of the material layer to form a spacer at the side of each layer stack and a side of the portion of the hard mask layer. The formation of the landing pad further includes removing a portion of the first material layer of each layer stack using the spacer and the portion of the hard mask layer as a mask, disposing a dielectric layer over the staircase structure and removing the spacer and a portion of the dielectric layer. The disposing of the dielectric layer over the staircase

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structure includes disposing the dielectric layer over a portion of the second material layer, a portion of a side of the first material layer and a portion of a side of the spacer. The removing of the portion of the hard mask and the portion of the top layer stack in the plurality of layer stacks includes using dry etching, wet etching or a combination thereof. The trimming the mask stack include etching the mask stack incrementally and inwardly from a boundary of the mask stack. The removing of the portion of the hard mask includes using a wet etch process with tetramethylammonium hydroxide (TMAH), potassium hydroxide (KOH), a base, or a combination thereof. The formation of each layer stack and the hard mask layer includes deposition techniques using chemical vapor deposition (CVD), physical vapor deposition (PVD), plasma-enhanced CVD (PECVD), low pressure CVD (LPCVD), sputtering, metal-organic chemical vapor deposition (MOCVD), atomic layer deposition (ALD), or a combination thereof.

[0007] In some embodiments, a memory device includes a memory string disposed over the substrate and a staircase structure disposed adjacent to the memory string. The staircase structure includes a plurality of layer stacks, where each layer stack of the plurality of layer stacks includes an insulating layer disposed over a first portion of the a conductive layer, where a second portion of the conductive layer is in contact with a side surface of the insulating layer. The conductive layer of the each layer stack is disposed over a portion of the insulating layer of an adjacent layer stack. The second portion of the conductive layer is thicker than the first portion of the conductive material layer.

[0008] Other aspects of the present disclosure can be understood by those skilled in the art in light of the description, the claims, and the drawings of the present disclosure.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The accompanying drawings, which are incorporated herein and form a part of the specification, illustrate embodiments of the present disclosure and, together with the description, further serve to explain the principles of the present disclosure and to enable a person skilled in the art to make and use the present disclosure.

[0010] FIG. 1 illustrates a cross-sectional view of a hard mask layer and a plurality of dielectric layer pairs over a substrate, according to some embodiments.

[0011] FIG. 2A illustrates a cross-sectional view of a staircase structure, according to some embodiments.

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- [0012] FIG. 2B illustrates a cross-sectional view of a staircase structure, according to some embodiments.
- [0013] FIG. 3 illustrates a cross-sectional view of a staircase structure with a material layer disposed therein, according to some embodiments.
- [0014] FIG. 4 illustrates a cross-sectional view of a staircase structure with spacers, according to some embodiments.
- [0015] FIG. 5 illustrates a cross-sectional view of a staircase structure after removal of an insulating layer, according to some embodiments.
- [0016] FIG. 6 illustrates a cross-sectional view of a staircase structure with a dielectric layer disposed thereon, according to some embodiments.
- [0017] FIG. 7 illustrates a cross-sectional view of a staircase structure with landing pads, according to some embodiments.
- [0018] FIG. 8 illustrates a cross-sectional view of a staircase structure with a dielectric layer disposed thereon, according to some embodiments.
- [0019] FIG. 9 is a flowchart of a method for forming a memory device, according to some embodiments.

## DETAILED DESCRIPTION

- [0020] Although specific configurations and arrangements are discussed, it should be understood that this is done for illustrative purposes only. A person skilled in the art will recognize that other configurations and arrangements can be used without departing from the spirit and scope of the present disclosure. It will be apparent to a person skilled in the art that the present disclosure can also be employed in a variety of other applications.
- [0021] It is noted that references in the specification to “one embodiment,” “an embodiment,” “an example embodiment,” “some embodiments,” etc., indicate that the embodiment described can include a particular feature, structure, or characteristic, but every embodiment can not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases do not necessarily refer to the same embodiment. Further, when a particular feature, structure or characteristic is described in connection with an embodiment, it would be within the knowledge of a person skilled in the art to affect such feature, structure or characteristic in connection with other embodiments whether or not explicitly described.

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- [0022] In general, terminology can be understood at least in part from usage in context. For example, the term “one or more” as used herein, depending at least in part upon context, can be used to describe any feature, structure, or characteristic in a singular sense or can be used to describe combinations of features, structures or characteristics in a plural sense. Similarly, terms, such as “a,” “an,” or “the,” again, can be understood to convey a singular usage or to convey a plural usage, depending at least in part upon context. In addition, the term “based on” can be understood as not necessarily intended to convey an exclusive set of factors and may, instead, allow for existence of additional factors not necessarily expressly described, again, depending at least in part on context.
- [0023] The meaning of “on,” “above,” and “over” in the present disclosure should be interpreted in the broadest manner such that “on” not only means “directly on” something, but also includes the meaning of “on” something with an intermediate feature or a layer therebetween. Moreover, “above” or “over” not only means “above” or “over” something, but can also include the meaning it is “above” or “over” something with no intermediate feature or layer therebetween (i.e., directly on something).
- [0024] Further, spatially relative terms, such as “beneath,” “below,” “lower,” “above,” “upper,” and the like, can be used herein for ease of description to describe one element or feature’s relationship to another element(s) or feature(s) as illustrated in the figures. The spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. The apparatus can be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein can likewise be interpreted accordingly.
- [0025] As used herein, the term “substrate” refers to a material onto which subsequent material layers are added. The substrate includes a top surface and a bottom surface. The top surface of the substrate is where a semiconductor device is formed, and therefore the semiconductor device is formed at a top side of the substrate. The bottom surface is opposite to the top surface and therefore a bottom side of the substrate is opposite to the top side of the substrate. The substrate itself can be patterned. Materials added on top of the substrate can be patterned or can remain unpatterned. Furthermore, the substrate can include a wide array of semiconductor materials, such as silicon, germanium, gallium arsenide, indium phosphide, etc. Alternatively, the substrate can be made from an electrically non-conductive material, such as a glass, a plastic, or a sapphire wafer.

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[0026] As used herein, the term “layer” refers to a material portion including a region with a thickness. A layer has a top side and a bottom side where the bottom side of the layer is relatively close to the substrate and the top side is relatively away from the substrate. A layer can extend over the entirety of an underlying or overlying structure, or can have an extent less than the extent of an underlying or overlying structure. Further, a layer can be a region of a homogeneous or inhomogeneous continuous structure that has a thickness less than the thickness of the continuous structure. For example, a layer can be located between any set of horizontal planes between, or at, a top surface and a bottom surface of the continuous structure. A layer can extend horizontally, vertically, and/or along a tapered surface. A substrate can be a layer, can include one or more layers therein, and/or can have one or more layer thereupon, thereabove, and/or therebelow. A layer can include multiple layers. For example, an interconnect layer can include one or more conductor and contact layers (in which contacts, interconnect lines, and/or vias are formed) and one or more dielectric layers.

[0027] As used herein, the term “nominal/nominally” refers to a desired, or target, value of a characteristic or parameter for a component or a process operation, set during the design phase of a product or a process, together with a range of values above and/or below the desired value. The range of values can be due to slight variations in manufacturing processes or tolerances. As used herein, the term “about” indicates the value of a given quantity that can vary based on a particular technology node associated with the subject semiconductor device. Based on the particular technology node, the term “about” can indicate a value of a given quantity that varies within, for example, 10–30% of the value (e.g.,  $\pm 10\%$ ,  $\pm 20\%$ , or  $\pm 30\%$  of the value).

[0028] In the present disclosure, the term “horizontal/horizontally/lateral/laterally” means nominally parallel to a lateral surface of a substrate.

[0029] As used herein, the term “3D memory device” refers to a semiconductor device with vertically oriented strings of memory cell transistors (referred to herein as “memory strings,” such as NAND strings) on a laterally-oriented substrate so that the memory strings extend in the vertical direction with respect to the substrate. As used herein, the term “vertical/vertically” means nominally perpendicular to the lateral surface of a substrate.

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[0030] In some embodiments, a NAND string or a 3D memory device includes a semiconductor channel (e.g., a silicon channel) that extends vertically through a plurality of conductor/dielectric layer pairs, where the semiconductor channel is surrounded by a dielectric stack. The plurality of conductor/dielectric layer pairs are also referred to herein as an “alternating conductor/dielectric stack.” The conductor layer of the alternating conductor/dielectric stack can be used as a word line (e.g., to electrically connect one or more control gates). An intersection of a word line and the semiconductor channel forms a memory cell. Vertically-oriented memory strings require an electrical connection between a word line and an access line (e.g., back end of line (BEOL) interconnection) to select a memory cell along the memory string for read and write functions, where the electrical connection is provided by forming a staircase structure at the plurality of conductor/dielectric pairs.

[0031] The 3D memory device can include a plurality of staircase structures disposed adjacent to a plurality of memory strings for word line fan-out, according to some embodiments. As the demand for higher storage capacity continues to increase, the number of vertical levels of the staircase structures also increases. As a result, when applying a BEOL process to form interconnects on the staircase structures, an upper portion of the staircase structures is exposed to the BEOL process for a longer period of time than a lower portion of the staircase structures. This differential in BEOL exposure time increases the process variation of the final 3D memory device, thus introducing challenges in balancing manufacturing yield and process complexity/cost.

[0032] In the present disclosure, a staircase structure refers to a set of surfaces that include at least two horizontal surfaces (e.g., along an x-y plane) and at least two vertical surfaces (e.g., along a z-axis). Each horizontal surface is adjoined to a first vertical surface that extends upward from a first edge of the horizontal surface, and is also adjoined to a second vertical surface that extends downward from a second edge of the horizontal surface. Each of the horizontal surfaces is referred to as a “step” or “stair” of the staircase structure. A horizontal direction can refer to a direction (e.g., the x-axis or the y-axis) parallel with a top surface of the substrate (e.g., the substrate that provides the fabrication platform for formation of structures over it). A vertical direction can refer to a direction (e.g., the z-axis) perpendicular to the top surface of the structure.

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- [0033] The staircase structure can be formed from a plurality of layer stacks by repetitively etching and trimming the each layer stack using a mask layer, where each layer stack is also referred to as a “staircase layer” (or “SC layer”) of the staircase structure in the present disclosure. A step of the staircase structure exposes a portion of a top surface of a layer stack (e.g. a SC layer) of the plurality of layer stacks. In some embodiments, the staircase structure includes a plurality of layer stacks.
- [0034] FIG. 1 illustrates a structure 100 with an alternating layer stack formed over a substrate 101 and a hard mask layer 106 formed over the alternating layer stack. A layer stack within the alternating layer stack can include a dielectric layer pair with an insulating layer 102 over a sacrificial layer 104. In some embodiments, sacrificial layer 104 can be disposed over insulating layer 102. Insulating layer 102 can include silicon oxide. Sacrificial layer 104 can include silicon nitride. In some embodiments, a thickness of insulating layer 102 or sacrificial layer 104 is between 10 nm and 200 nm. In some embodiments, a thickness of hard mask layer 106 is between 10 nm and 200 nm. In some embodiments, the layers in the alternating layer stack can be different thicknesses.
- [0035] In some embodiments, substrate 101 includes any suitable material for supporting a memory structure (e.g., 3D memory structure). For example, substrate 101 can include silicon, silicon germanium, silicon carbide, silicon on insulator (SOI), germanium on insulator (GOI), glass, gallium nitride, gallium arsenide, any suitable III-V compounds, any other suitable material, or combinations thereof.
- [0036] In some embodiments, sacrificial layer 104 can include any suitable material different from insulating layer 102. For example, sacrificial layer 104 can include poly-crystalline silicon, silicon nitride, poly-crystalline germanium, poly-crystalline germanium-silicon, any other suitable materials, or combinations thereof. In some embodiments, sacrificial layer 104 can include silicon nitride.
- [0037] Insulating layer 102 can include any suitable insulating materials, such as silicon oxide or aluminum oxide.
- [0038] In some embodiments, sacrificial layer 104 can be a conductive material layer. The conductive material layer can include any suitable conductive material. In some embodiments, the conductive material layer can include poly-crystalline silicon, tungsten, silicide, nickel, titanium, platinum, aluminum, titanium nitride, tantalum nitride, tungsten nitride, any other suitable material, or combinations thereof.

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[0039] In some embodiments, hard mask layer 106 can be a poly-crystalline semiconductor layer including poly-crystalline silicon, poly-crystalline germanium, poly-crystalline germanium-silicon, any other suitable material, or combinations thereof. In some embodiments, hard mask layer 106 can be a metal layer, including cobalt, nickel, tungsten, copper, or silver. In some embodiments, hard mask layer 106 can be a metal silicide layer, including  $\text{CoSi}_x$ ,  $\text{NiSi}_x$ , or  $\text{WSi}_x$ . In some embodiments, hard mask layer 106 can be an organic material layer formed by spin-coating or self-assembling of organic molecules.

[0040] The formation of insulating layer 102, sacrificial layer 104, and hard mask layer 106 can include any suitable deposition methods such as, for example, chemical vapor deposition (CVD), physical vapor deposition (PVD), plasma-enhanced CVD (PECVD), low pressure chemical vapor deposition (LPCVD), sputtering, metal-organic chemical vapor deposition (MOCVD), atomic layer deposition (ALD), sputtering, thermal evaporation, e-beam evaporation, molecular beam-epitaxy (MBE), any other suitable deposition method, or combinations thereof. In some embodiments, insulating layer 102, sacrificial layer 104, the conductive material layer, and hard mask layer 106 are each formed by CVD. In some embodiments, the formation of hard mask layer 106 further includes applying a thermal anneal process to form a silicide layer.

[0041] FIGs. 2A-2B illustrate a cross-sectional view of staircase structures 200A and 200B, according to some embodiments. Staircase structure 200A includes a hard mask 206 and a plurality of layer stacks 202/204. Each layer stack 202/204 is also referred to herein as an “SC layer.” The steps in staircase structure 200A is formed by repeating an etch-trim process on structure 100 using a mask stack (not shown). After the formation of the steps, the mask stack is removed. In some embodiments, a step exposes a portion of a top surface of an SC layer. In some embodiments, a step exposes a side of a SC layer. In some embodiments, after repeating the etch-trim process, a portion of a top-most SC layer of staircase structure 200A is exposed and another portion of the top-most SC layer is covered by hard mask layer 206. An etch process is also applied to laterally etch a portion of sacrificial layer 204 of each SC layer. As a result, each step of staircase structure 200B has a recess (e.g. recess 220, 222, 224, ..., etc.). In some embodiments, a lateral dimension of each recess is between 10 nm and 300 nm. In some embodiments, a lateral dimension “a” of each step is between 100 nm and 1500 nm.

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- [0042] In some embodiments, the mask stack (not shown in FIG. 2A) can include a photoresist or carbon-based polymer material. In some embodiments, the mask stack is removed after forming staircase structure 200A. The etch-trim process includes an etch process and a trim process. In some embodiments, the etch process includes using any suitable etchants (e.g., wet etch and/or dry etch) to sequentially remove a portion of hard mask layer 106 and a portion of the layer stack, including a portion of insulating layer 102 and a portion of sacrificial layer 104. For example, as shown in FIG. 2A, hard mask layer 206, insulating layer 202, and sacrificial layer 204 are formed after removing a portion of hard mask layer 106, a portion of insulating layer 102, and a portion of sacrificial layer 104.
- [0043] In the etch process, an etchant for insulating layer 102 has a higher etching selectivity over sacrificial layer 104, and/or vice versa. In some embodiments, the etchant for hard mask layer 106 has a higher etching selectivity over insulating layer 102 and sacrificial layer 104, and/or vice versa. Accordingly, an underlying layer stack can function as an etch-stop layer so that a single layer stack is patterned/etched, according to some embodiments. In some embodiments, insulating layer 102 and sacrificial layer 104 are etched using an anisotropic etch process, such as reactive ion etch (RIE) or other dry etch process. In some embodiments, the etchant includes carbon-fluorine (CF<sub>4</sub>) based gases or hexafluoroethane (C<sub>2</sub>F<sub>6</sub>) based gases. In some embodiments, an etchant includes phosphoric acid and can be used to remove both insulating layer 102 and sacrificial layer 104. The methods and etchants to remove the layer stack described herein are exemplary. Other methods and etchants are within the spirit and scope of the present disclosure.
- [0044] The trim process includes applying a suitable etch process (e.g., an isotropic dry etch or a wet etch) on the mask stack at directions parallel to a surface of the substrate. The mask stack is etched incrementally and inwardly from a boundary of the mask stack. The amount of trimmed mask stack can be related to the lateral dimension “a” of each steps of staircase structure 200A.
- [0045] The process for forming the recess structure (e.g. recess 220, 222, 224..., etc.) uses an etch process similar to the etching techniques for removing sacrificial layer 104 as described above. In some embodiments, the process etches sacrificial layer 204 at a higher etching rate than that of insulating layer 202 or hard mask layer 206.

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[0046] FIG. 3 illustrates a cross-sectional view of a staircase structure 300 with a material layer 310 disposed thereon, according to some embodiments. Material layer 310 is conformally disposed on staircase structure 200B, including on a top surface of hard mask layer 206, a side of hard mask layer 206, a top surface of each SC layer (e.g. each step) of staircase structure 200B, and a recess of the each SC layer. In some embodiments, material layer 310 fills each recesses of staircase structure 200B. Material layer 310 can be made of similar material as hard mask layer 106, where the formation of material layer 310 can be similar to that of hard mask layer 106. In some embodiments, a thickness of material layer 310 is thicker than that of sacrificial layer 204. In some embodiments, a thickness of material layer 310 is thinner than that of the SC layer.

[0047] FIG. 4 illustrates a cross-sectional view of a staircase structure 400 with spacers 410, according to some embodiments. Each of spacers 410 is formed at a side of each SC layer of staircase structure 300. In some embodiments, spacer 410 is formed at a side of hard mask layer 206. Spacer 410 is formed by removing a portion of material layer 310 from staircase structure 300 using similar techniques as removing hard mask layer 106. In some embodiments, material layer 310 is removed from a top surface of staircase structure 300 and a top surface of hard mask layer 206. In some embodiments, spacer 410 fills a recess (e.g. recess 220, 222, or 224) of each SC layer of staircase structure 300. In some embodiments, spacer 410 covers a side of sacrificial layer 204 of each SC layer of staircase structure 300. In some embodiments, spacer 410 covers a portion of a side of insulating layer 202 of each SC layer of staircase structure 300. In some embodiments, spacer 410 and hard mask layer 106 are made of the same material.

[0048] FIG. 5 illustrates a cross-sectional view of a staircase structure 500 after removal of a portion of insulating layer 202, according to some embodiments. In FIG. 5, the portion of insulating layer 202 of each SC layer of staircase structure 400 is removed using spacers 410 and hard mask layer 206 as masks. Insulating layer 502 is formed after removing the portion of insulating layer 202 using similar techniques as removing insulating layer 102. As illustrated in FIG. 5, each SC layer of staircase structure 500 exposes a portion of a top surface of sacrificial layer 204 and spacer 410 of each SC layer. In some embodiments, a side of insulating layer 502 of each SC layer of staircase structure 500 is exposed.

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[0049] FIG. 6 illustrates a cross-sectional view of a staircase structure 600 with a dielectric layer 620 disposed thereon, according to some embodiments. Dielectric layer 620 covers a top surface of staircase structure 500 and a portion of a side of staircase structure 500. In some embodiments, dielectric layer 620 covers a portion of each spacer 410 of staircase structure 500. In some embodiments, dielectric layer 620 covers a top surface of hard mask layer 206, a portion of a top surface of sacrificial layer 204, and a portion of a side of insulating layers 502 of each SC layer of staircase structure 500. In some embodiments, dielectric layer 620 has poor step-coverage on staircase structure 500. For example, the poor step-coverage includes a thickness of dielectric layer 620 that is substantially thinner at a side of staircase structure 600 than that at a top surface of staircase structure 600. In some embodiments, dielectric layer 620 is discontinuous between each SC layer of staircase structure 600. In some embodiments, a portion of spacer 410 or a portion of a side of insulating layer 502 of each SC layer of staircase structure 600 is exposed.

[0050] In some embodiments, dielectric layer 620 can be a nitride layer, including silicon nitride, silicon oxynitride, any suitable materials, or combinations thereof. In some embodiments, dielectric layer 620 and each sacrificial layer 204 of staircase structure 600 are made of the same material. In some embodiments, a thickness of dielectric layer 620 at a top surface of staircase structure 600 is thinner than that of insulating layer 502 of each SC layer of staircase structure 600. Dielectric layer 620 can be formed using deposition techniques including, but not limiting to plasma-enhanced CVD (PECVD), low pressure CVD (LPCVD), physical vapor deposition (PVD), high density plasma (HDP), atomic layer deposition (ALD), any suitable deposition techniques, or combinations thereof.

[0051] FIG. 7 illustrates a cross-sectional view of a staircase structure 700 with landing pads 720, according to some embodiments. In FIG. 7, spacers 410 and a portion of dielectric layer 620 are removed from staircase structure 600. After removing spacers 410 and the portion of dielectric layer 620, a landing pad 720 is formed over each SC layer of staircase structure 700. As shown in FIG. 7, landing pad 720 is in contact with sacrificial layer 204 of each SC layer of staircase structure 700. Both landing pad 720 and sacrificial layer 204 of the SC layer are disposed over a portion of insulating layer 502 of another vertically adjacent SC layer. In some embodiments, landing pad 720 is formed over hard

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mask layer 206. In some embodiments, landing pad 720 of a SC layer is thicker than insulating layer 502 of the SC layer. Landing pad 720 can also be discontinuous from another landing pad 720 disposed on another vertically adjacent SC layer. In some embodiments, landing pad 720, dielectric layer 620 and sacrificial layer 204 are made of the same material.

[0052] Removal of spacers 410 and the portion of dielectric layer 620 can use an etch process similar to that which removes hard mask layer 106 and sacrificial layer 104, where the etch process has high etching selectivity to insulating layers 502 as described above. In some embodiments, more than two etch processes are applied to etch dielectric layer 620 and spacers 410, in which the etch processes have high etching selectivity to insulating layers.

[0053] FIG. 8 illustrates a cross-sectional view of a staircase structure 800 with a dielectric layer 825 disposed thereon, according to some embodiments. Staircase structure 800 is formed by removing hard mask layer 206 from staircase structure 700. Further, a wordline layer 804 for each SC layer of staircase structure 800 is formed by replacing landing pad 720 and sacrificial layer 204 of each step of staircase structure 700 with one or more conducting material layers, including poly-crystalline silicon, tungsten, silicide, nickel, tungsten, titanium, platinum, aluminum, titanium nitride, tantalum nitride, tungsten nitride, any other suitable material, or combinations thereof. As shown in FIG. 8, wordline layer 804 includes landing pad 820 and conductive layer 840. Wordline layer 804 of an SC layer is disposed over a portion of insulating layer 502 of another vertically adjacent SC layer. In some embodiments, a length of wordline layer 804 is shorter in a horizontal direction (e.g., x-direction) than that of insulating layer 502 of another vertically adjacent SC layer. In some embodiments, landing pad 820 is thicker than insulating layer 502 and is insulated from another landing pad 820 disposed on another vertically adjacent SC layer. A dielectric layer 825 is disposed on staircase structure 700. Each wordline layer 804, including landing pad 820 and a conductive layer 840, of staircase structure 800 can control a portion of a memory string in the stacked storage region of a memory device (e.g., 3D memory device). In some embodiments, each wordline layer 804 of staircase structure 800 is a wordline of the memory device, where conductive layer 840 contacts a portion of a memory string of a memory device, and landing pad 820 contacts a portion of a side of insulating layer 502. In some

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embodiments, a thickness of landing pad structure 820 of word line 804 is thicker than that of conductive layer 840 of wordline layer 804. In some embodiments, an edge of wordline layer 804 of each step of staircase structure 800 has landing pad structure 820, where landing pad 820 is made of the same or different conductive material as conductive layer 840.

[0054] In some embodiments, hard mask layer 206 of staircase structure 700 is removed using a wet etch process. In some embodiments, an etchant used in the wet etch process includes tetramethylammonium hydroxide (TMAH). In some embodiments, a landing pad 720 over hard mask layer 206 is lifted-off after the wet etch process. In some embodiments, hard mask layer 206 is removed using similar techniques as removing hard mask layer 106.

[0055] In some embodiments, replacement of landing pad 720 and sacrificial layer 204 of each SC layer with the conductive material includes formation of one or more recesses in each SC layer by removing landing pad 720 and sacrificial layer 204 from each SC layer, followed by filling the one or more conductive material layers in the one or more recesses. The removal of landing pad 720 or sacrificial layer 204 can be similar to the techniques of removing sacrificial layer 104. In some embodiments, the removal of landing pad 720 uses different techniques from the removal of sacrificial layer 204. The filling of the conductive material can be similar to the techniques of depositing metallic hard mask layer 106. In some embodiments, the filling of a recess formed by the removal of landing pad 720 uses different techniques and/or conductive material from the filling of another recess formed by the removal of sacrificial layer 204.

[0056] In some embodiments, the formation of dielectric layer 825 uses similar techniques as forming insulating layer 102 or sacrificial layer 104. In some embodiments, the formation of dielectric layer 825 uses a spin-coating process. In some embodiments, dielectric layer 825 includes any suitable dielectric materials, such as silicon oxide or a spin-on-dielectric material. In some embodiments, the formation of dielectric layer 825 further includes a planarization process, such as chemical-mechanical planarization (CMP). In some embodiments, dielectric layer 825 is made of the same material as insulating layer 102 or sacrificial layer 104. In some embodiments, dielectric layer 825 is disposed on each step of staircase structure 800.

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[0057] FIG. 9 is a flowchart of a method 900 for forming a memory device (e.g., 3D memory device), according to some embodiments. The operations of method 900 can be used to form memory device structures illustrated in FIGs. 1-8. The operations shown in method 900 are not exhaustive and that other operations can be performed as well before, after, or between any of the illustrated operations. In some embodiments, some operations of exemplary method 900 can be omitted or include other operations that are not described here for simplicity. In some embodiments, operations of method 900 can be performed in a different order and/or vary.

[0058] In operation 910, an alternating stack and a hard-mask layer are formed over a substrate. The substrate can include any suitable material for forming a memory structure—e.g., a 3D memory device. For example, the substrate can include silicon, silicon germanium, silicon carbide, SOI, GOI, glass, gallium nitride, gallium arsenide, plastic sheet, and/or other suitable III-V compound.

[0059] In operation 910, a layer stack in the alternating layer stack can include a dielectric layer pair with a first material layer and a second material layer. In some embodiments, the first material layer can be an insulating layer. The second material layer can be a sacrificial layer or a conductive material layer. The sacrificial layer can include materials such as silicon nitride, poly-crystalline silicon, poly-crystalline germanium, poly-crystalline germanium-silicon, any other suitable material, or combinations thereof. The insulating layer can include silicon oxide, aluminum oxide, or other suitable materials. The conductive material layer can include tungsten, titanium nitride, tantalum nitride, tungsten nitride, any other suitable material, or combinations thereof. Each of the insulating, sacrificial, and conductive material layers can include materials formed by one or more thin film deposition processes including, but not limiting to, CVD, PVD, ALD, or any combinations thereof.

[0060] The hard mask layer can be a poly-crystalline semiconductor layer, including poly-crystalline silicon. In some embodiments, the hard mask layer can be a metal layer, such as cobalt, nickel, tungsten, copper, or silver. In some embodiments, the hard mask layer can be a silicide layer, including  $\text{CoSi}_x$ ,  $\text{NiSi}_x$ , or  $\text{WSi}_x$ . In some embodiments, the hard mask layer can be an organic material layer. The hard mask layer can be formed using similar techniques as forming the alternating layer stack. In some embodiments, the formation of the hard mask layer includes a thermal anneal process.

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[0061] In operation 920, a staircase structure is formed, where a layer of each layer stack in the staircase structure is recessed. Each step of the staircase structure can be formed by repeating an etch-trim process using a mask stack. In some embodiments, the mask stack can include a photoresist or carbon-based polymer material. The etch-trim process includes an etch process and a trim process. In some embodiments, the etch process etches a portion of the hard mask layer and a portion of the layer stack. In some embodiments, the etch process etches a portion of the hard mask layer and a portion of a plurality of layer stacks. In some embodiments, one or more etchants are used in the etch process, and each of the etchants etches the first material layer at a higher etch rate than the second material layer or the hard mask layer. In some embodiments, the one or more etchants etches one of the first material layer, the second material layer and the hard mask layer at a higher etch rate than the other two of the first material layer, the second material layer and the hard mask layer. In some embodiments, the etch process can control the formation of steps of the staircase structure because high etching selectivity between the first and the second material layer allows the etch process to stop on a surface of a layer stack of the alternating layer stack.

[0062] The trim process includes a suitable etch (e.g., an isotropic dry etch or a wet etch) of the mask stack and is performed at a direction parallel to a surface of the substrate. The amount of trimmed mask stack can be related to the lateral dimensions of the staircase structure. After the repetitive etch-trim process, the resulting staircase structure includes a plurality of layer stacks (or plurality of SC layers). In some embodiments, the staircase structure includes a plurality of steps, where each of the steps exposes a side and a portion of a top surface of each SC layer. In some embodiments, the height of each of the steps is one level, which is equal to the thickness of a SC layer.

[0063] Further, in operation 920, a layer of each SC layer is recessed. The recess process uses similar techniques as etching the alternating layer stack. In some embodiments, a sacrificial layer of each SC layer is recessed using the recess process. In some embodiments, the recess process etches a sacrificial layer of each SC layer and has higher etching selectivity to an insulating layer of each SC layer and the hard mask layer. As a result, the staircase structure includes a plurality of steps, where a SC layer exposed by a step has a lateral recess structure. The formation of the staircase structure is described above with respect to FIGs. 2A-2B.

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- [0064] In operation 930, a spacer is formed at a side of each step of the staircase structure. A material layer is disposed on the staircase structure. In some embodiments, the material layer fills a recess in each of the SC layers. In some embodiments, the material layer is conformally disposed on the staircase structure. In some embodiments, the material layer is made of a similar material as the hard mask layer. In some embodiments, formation of the material layer uses similar techniques as forming the hard mask layer.
- [0065] Further, in operation 930, a portion of the material layer is removed to form a spacer at a side of each of the SC layers. The removal of the material layer uses similar techniques as removing the hard mask layer. In some embodiments, the material layer is completely removed from a top of each of the SC layers. In some embodiments, the material layer is completely removed from a top of the hard mask layer. In some embodiments, the spacer fills in the recess of each of the SC layers. The spacer and the hard mask layer can be made of the same material. The formation of the spacers is described above with respect to FIGs. 3-4.
- [0066] In operation 940, a portion of a layer of each of the SC layers is removed using the spacers and hard mask layer as a mask. In some embodiments, a portion of an insulating layer of each of the SC layers is removed. The removal of the portion of the layer of each of the SC layers uses similar techniques as removing the alternating layer stack. An example of operation 940 is described above with respect to FIG. 5.
- [0067] In operation 950, a landing pad is formed at each layer stack of the staircase structure. A dielectric layer is disposed to cover a top surface and a portion of a side of the staircase structure, including a portion of a side of each spacer and a side of an insulating layer of each of the SC layers. The dielectric layer is substantially thinner at a side of the staircase structure than at a top surface of the staircase structure. In some embodiments, the dielectric layer is discontinuous between steps of the staircase structure. The dielectric layer can be a nitride layer. In some embodiments, the dielectric layer and the sacrificial layer are made of the same material, where forming the dielectric layer uses similar techniques as forming the sacrificial layer.
- [0068] Operation 950 further includes removing a portion of the dielectric layer and the spacer to form a landing pad on each of the SC layers. The removal of the spacer and the dielectric layer uses an etch process similar to that for forming the staircase structure from

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the alternating layer stack and the hard mask layer. In some embodiments, the dielectric layer is completely removed from a side of each of the SC layers. In some embodiments, after removing the spacer and the portion of the dielectric layer, the dielectric layer remaining on each of the SC layer forms the landing pad. The landing pad and the sacrificial layer can be made of the same material. The formation of landing pads is described above with respect to FIGs 6-7.

[0069] In operation 960, a wordline layer at each layer of the staircase structure is formed. For example, the hard mask layer on a top surface of the staircase structure can be removed using an etch process. The etch process can include a wet etch process using tetramethylammonium hydroxide (TMAH). In some embodiments, the etch process lifts-off a landing pad at a top of the hard mask layer. Operation 960 further includes forming word lines of the memory device (e.g., 3D memory device) by replacing each of the landing pads and the insulating layers of each of the SC layers with one or more conductive material. This replacement starts from forming a recess at each SC layer of the staircase by removing the landing pad and the insulating layer of each SC layer. The one or more conductive material is disposed in the recess of each SC layer to form a word line in the staircase structure. After forming the word lines, a dielectric layer is disposed over the staircase structure for the BEOL interconnect process.

[0070] The foregoing description of the specific embodiments will so fully reveal the general nature of the present disclosure that others can, by applying knowledge within the skill of the art, readily modify and/or adapt for various applications such specific embodiments, without undue experimentation, without departing from the general concept of the present disclosure. Therefore, such adaptations and modifications are intended to be within the meaning and range of equivalents of the disclosed embodiments, based on the disclosure and guidance presented herein. It is to be understood that the phraseology or terminology herein is for the purpose of description and not of limitation, such that the terminology or phraseology of the present specification is to be interpreted by the skilled artisan in light of the disclosure and guidance.

[0071] Embodiments of the present disclosure have been described above with the aid of functional building blocks illustrating the implementation of specified functions and relationships thereof. The boundaries of these functional building blocks have been arbitrarily defined herein for the convenience of the description. Alternate boundaries can

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be defined so long as the specified functions and relationships thereof are appropriately performed.

[0072] The Summary and Abstract sections can set forth one or more but not all exemplary embodiments of the present disclosure and thus are not intended to limit the present disclosure and the appended claims.

[0073] The breadth and scope of the present disclosure should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

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## COMBINED DECLARATION AND ASSIGNMENT

### DECLARATION

As the below named inventors, I hereby declare that:

This declaration is directed to:

- ☐ The attached application, or
- ☒ United States application or PCT international application number 16/126,956  
filed on September 10, 2018

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 five (5) years, or both.

### ASSIGNMENT

In consideration of the sum of One Dollar (\$1.00) or equivalent and other good and valuable consideration paid to each of the below named inventors, each of the below named inventors, hereby sell and assign to **Yangtze Memory Technologies Co., Ltd.**, a corporation formed under the laws of China, whose mailing address is 18 Gaoxin 4th Road, East Lake High-Tech Development Zone, Wuhan, Hubei, China (hereafter referred to as the Assignee), his/her entire right, title and interest, including the right to sue for past infringement and to collect for all past, present and future damages, for the United States of America (as defined in 35 U.S.C. § 100) and throughout the world,

(a) in the invention(s) known as **STAIRCASE STRUCTURE FOR MEMORY DEVICE** for which application(s) for patent in the United States of America is identified above, in any and all applications thereon, in any and all Letters Patent(s) therefor, and

(b) in any and all applications that claim the benefit of the patent application identified above in part (a), including non-provisional applications, continuing (continuation, divisional, or continuation-in-part) applications, reissues, extensions, renewals and reexaminations of the patent application or Letters Patent therefor listed above in part (a), to the full extent of the term or terms for which Letters Patents issue, and

(c) in any and all inventions described in the patent application identified above in part (a), and in any and all forms of intellectual and industrial property protection derivable from such patent application, and that are derivable from any and all continuing applications, reissues, extensions, renewals and reexaminations of such patent application, including, without limitation, patents, applications, utility models, inventor's certificates, and designs together with the right to file applications therefor; and including the right to claim the same priority rights from any previously filed applications under the International Agreement for the Protection of Industrial Property, or any other international agreement, or the domestic laws of the country in which any such application is filed, as may be applicable;

all such rights, title and interest to be held and enjoyed by the above-named Assignee, its successors, legal representatives and assigns to the same extent as all such rights, title and interest would have been held and enjoyed by the Assignor had this assignment and sale not been made.

The below named inventors agree to execute all papers necessary in connection with the application(s) and any non-provisional, continuing (continuation, divisional, or continuation-in-part), reissue, reexamination or corresponding application(s) thereof and also to execute separate assignments in connection with such application(s) as the Assignee may deem necessary or expedient.

The below named inventors agree to execute all papers necessary in connection with any patent enforcement action (judicial or otherwise) related to the application(s) or any non-provisional, continuing (continuation, divisional, or continuation-in-part), reissue or reexamination application(s) thereof and to cooperate with the Assignee in every way possible in obtaining evidence and going forward with such patent enforcement action.

The below named inventors hereby represent that he/she has full right to convey the entire interest herein assigned, and that he/she has not executed, and will not execute, any agreement in conflict therewith.

The below named inventors hereby represent that he/she understands that the patent practitioners associated with **CUSTOMER NUMBER 26111** are the legal representatives of, and attorneys for, the assignee, and are NOT the legal representatives of, and attorneys for, the inventors.

IN WITNESS WHEREOF, executed by the below named inventors on the date opposite his/her name.

LEGAL NAME OF INVENTOR

Inventor: Zhenyu LU Date: 2018.10.23

Signature of Inventor: Zhenyu Lu

LEGAL NAME OF INVENTOR

Inventor: Jun CHEN Date: 2018.10.23

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Inventor: Xiaowang DAI Date: 2018.11.3

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LEGAL NAME OF INVENTOR

Inventor: Jifeng ZHU Date: 2018.10.22

Signature of Inventor: Jifeng ZHU

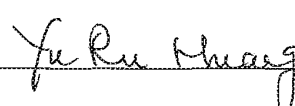
LEGAL NAME OF INVENTOR

Inventor: Qian TAO Date: 2018.11.3

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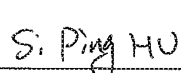
LEGAL NAME OF INVENTOR

Inventor: Yu Ru HUANG Date: 2018.11.5

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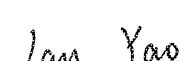
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Inventor: Haohao YANG Date: 2018/10/22

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                       |                        |              |
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| <b>Application Data Sheet 37 CFR 1.76</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                       | Attorney Docket Number | 4123.0460003 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                       | Application Number     |              |
| Title of Invention                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | STAIRCASE STRUCTURE FOR MEMORY DEVICE |                        |              |
| <p>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.</p> <p>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.</p> |                                       |                        |              |

**Secrecy Order 37 CFR 5.2:**

☐ 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:**

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| Inventor 1 <span style="float: right;">Remove</span>                                                                                                                     |              |                                                  |             |        |
| Legal Name                                                                                                                                                               |              |                                                  |             |        |
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|                                                                                                                                                                          | Xiaowang   |             | DAI         |        |
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| Inventor 4 | <a href="#">Remove</a> |
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|                                                                                                                                                                          | Jifeng     |             | ZHU         |        |
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|                                                                                                                                                                          | Qian       |             | TAO         |        |
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|                                           |                                       | Application Number     |              |
| Title of Invention                        | STAIRCASE STRUCTURE FOR MEMORY DEVICE |                        |              |

|                                                                                                                                                                                 |                   |                                                  |                             |               |                        |
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| <b>Inventor 6</b>                                                                                                                                                               |                   |                                                  |                             |               | <a href="#">Remove</a> |
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|                                                                                                                                                                                 | Yu Ru             |                                                  | HUANG                       |               |                        |
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| <b>Inventor 7</b>                                                                                                                                                               |                   |                                                  |                             |               | <a href="#">Remove</a> |
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|                                                                                                                                                                                 | Si Ping           |                                                  | HU                          |               |                        |
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| <b>Inventor 8</b>                                                                                                                                                               |                   |                                                  |                             |               | <a href="#">Remove</a> |
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|                                                                                                                                                                                 | Lan               |                                                  | YAO                         |               |                        |
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|                                                                                                                                                                          |              | Application Number                               |                        |                |                        |
| Title of Invention                                                                                                                                                       |              | STAIRCASE STRUCTURE FOR MEMORY DEVICE            |                        |                |                        |
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| Inventor 9                                                                                                                                                               |              |                                                  |                        |                | <a href="#">Remove</a> |
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|                                                                                                                                                                          | Li Hong      |                                                  |                        | XIAO           |                        |
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|                                                                                                                                                                          | A Man        |                                                  |                        | ZHENG          |                        |
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| Prefix                                                                                                                                                                         | Given Name   | Middle Name                                      | Family Name                           |
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| 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                                                                                                                       | 26111                                                                                |
| Email Address                                                                                                                         | <input type="button" value="Add Email"/> <input type="button" value="Remove Email"/> |

**Application Information:**

|                                         |                                       |                                           |                          |
|-----------------------------------------|---------------------------------------|-------------------------------------------|--------------------------|
| Title of the Invention                  | STAIRCASE STRUCTURE FOR MEMORY DEVICE |                                           |                          |
| Attorney Docket Number                  | 4123.0460003                          | 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) |                          |

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>Application Data Sheet 37 CFR 1.76</b> |                                       | Attorney Docket Number | 4123.0460003 |
|                                           |                                       | Application Number     |              |
| Title of Invention                        | STAIRCASE STRUCTURE FOR MEMORY DEVICE |                        |              |

**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    | 26111                                            |                                              |                                                         |

**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         | <a href="#">Remove</a>   |                                    |
| Application Number       | Continuity Type | Prior Application Number | Filing or 371(c) Date (YYYY-MM-DD) |
|                          | Continuation of | 16126956                 | 2018-09-10                         |

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>Application Data Sheet 37 CFR 1.76</b>                                                                             |                                       | Attorney Docket Number   | 4123.0460003                       |
|                                                                                                                       |                                       | Application Number       |                                    |
| Title of Invention                                                                                                    | STAIRCASE STRUCTURE FOR MEMORY DEVICE |                          |                                    |
| Prior Application Status                                                                                              | Pending                               | <a href="#">Remove</a>   |                                    |
| Application Number                                                                                                    | Continuity Type                       | Prior Application Number | Filing or 371(c) Date (YYYY-MM-DD) |
| 16126956                                                                                                              | Continuation of                       | PCT/CN2018/098962        | 2018-08-06                         |
| Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the <b>Add</b> button. |                                       |                          |                                    |

### 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).

|                                                                                                        |                      |                          |                                          |
|--------------------------------------------------------------------------------------------------------|----------------------|--------------------------|------------------------------------------|
| Application Number                                                                                     | Country <sup>i</sup> | Filing Date (YYYY-MM-DD) | <a href="#">Remove</a>                   |
| 201710750398.4                                                                                         | CN                   | 2017-08-28               | Access Code <sup>j</sup> (if applicable) |
| Additional Foreign Priority Data may be generated within this form by selecting the <b>Add</b> button. |                      |                          |                                          |

### 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.

|                                           |                                       |                        |              |
|-------------------------------------------|---------------------------------------|------------------------|--------------|
| <b>Application Data Sheet 37 CFR 1.76</b> |                                       | Attorney Docket Number | 4123.0460003 |
|                                           |                                       | Application Number     |              |
| Title of Invention                        | STAIRCASE STRUCTURE FOR MEMORY DEVICE |                        |              |

## 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.

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>Application Data Sheet 37 CFR 1.76</b> |                                       | Attorney Docket Number | 4123.0460003 |
|                                           |                                       | Application Number     |              |
| Title of Invention                        | STAIRCASE STRUCTURE FOR MEMORY DEVICE |                        |              |

## 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 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                |                                                                        |  |
| <p>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.</p> |                                                                |                                                                        |  |
| <input type="button" value="Clear"/>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                |                                                                        |  |
| <input checked="" type="radio"/> Assignee                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <input type="radio"/> Legal Representative under 35 U.S.C. 117 | <input type="radio"/> Joint Inventor                                   |  |
| <input type="radio"/> Person to whom the inventor is obligated to assign.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                | <input type="radio"/> Person who shows sufficient proprietary interest |  |
| If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                |                                                                        |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                |                                                                        |  |
| Name of the Deceased or Legally Incapacitated Inventor: <input type="text"/>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                |                                                                        |  |
| If the Applicant is an Organization check here. <input checked="" type="checkbox"/>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                |                                                                        |  |
| Organization Name                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Yangtze Memory Technologies Co., Ltd.                          |                                                                        |  |
| <b>Mailing Address Information For Applicant:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                |                                                                        |  |
| Address 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 18 Gaoxin 4th Road                                             |                                                                        |  |
| Address 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | East Lake High-Tech Development Zone                           |                                                                        |  |
| City                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Wuhan, Hubei                                                   | State/Province                                                         |  |
| Country                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | CN                                                             | Postal Code                                                            |  |
| Phone Number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                | Fax Number                                                             |  |
| Email Address                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                |                                                                        |  |
| Additional Applicant Data may be generated within this form by selecting the Add button.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                |                                                                        |  |

## 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. |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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|                                           |                                       |                        |              |
|-------------------------------------------|---------------------------------------|------------------------|--------------|
| <b>Application Data Sheet 37 CFR 1.76</b> |                                       | Attorney Docket Number | 4123.0460003 |
|                                           |                                       | Application Number     |              |
| Title of Invention                        | STAIRCASE STRUCTURE FOR MEMORY DEVICE |                        |              |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                       |                |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|----------------|--|
| <b>Assignee 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                       |                |  |
| 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. |                                       |                |  |
| If the Assignee or Non-Applicant Assignee is an Organization check here. <input checked="" type="checkbox"/>                                                                                                                                                                                                                                                                                                                                           |                                       |                |  |
| Organization Name                                                                                                                                                                                                                                                                                                                                                                                                                                      | Yangtze Memory Technologies Co., Ltd. |                |  |
| <b>Mailing Address Information For Assignee including Non-Applicant Assignee:</b>                                                                                                                                                                                                                                                                                                                                                                      |                                       |                |  |
| Address 1                                                                                                                                                                                                                                                                                                                                                                                                                                              | 18 Gaoxin 4th Road                    |                |  |
| Address 2                                                                                                                                                                                                                                                                                                                                                                                                                                              | East Lake High-Tech Development Zone  |                |  |
| City                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Wuhan, Hubei                          | State/Province |  |
| Country <sup>i</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                   | CN                                    | Postal Code    |  |
| Phone Number                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                       | Fax Number     |  |
| Email Address                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                       |                |  |
| Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.                                                                                                                                                                                                                                                                                                                                      |                                       |                |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                       |                |  |

**Signature:**

**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                                                                           | /Donald J. Featherstone/ |           | Date (YYYY-MM-DD) | 2020-05-28          |        |
| First Name                                                                          | Donald                   | Last Name | Featherstone      | Registration Number | 33,876 |
| Additional Signature may be generated within this form by selecting the Add button. |                          |           |                   |                     |        |

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|                                           |                                       |                        |              |
|-------------------------------------------|---------------------------------------|------------------------|--------------|
| <b>Application Data Sheet 37 CFR 1.76</b> |                                       | Attorney Docket Number | 4123.0460003 |
|                                           |                                       | Application Number     |              |
| Title of Invention                        | STAIRCASE STRUCTURE FOR MEMORY DEVICE |                        |              |

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventors: LU *et al.*

Applicant: Yangtze Memory Technologies  
Co., Ltd.

Application No.: *To Be Assigned*

(*Continuation of Appl. No. 16/126,956; Filed:  
September 10, 2018*)

Filed: *Herewith*

Confirmation No.: *To Be Assigned*

Art Unit: *To Be Assigned*

Examiner: *To Be Assigned*

Atty. Docket: 4123.0460003

Title: **STAIRCASE STRUCTURE FOR MEMORY DEVICE**

**Authorization to Treat a Reply as Incorporating an  
Extension of Time Under 37 C.F.R. § 1.136(a)(3)**

Commissioner for Patents  
PO Box 1450  
Alexandria, VA 22313-1450

Commissioner:

The U.S. Patent and Trademark Office is hereby authorized to treat any concurrent or future reply that requires a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. The U.S. Patent and Trademark Office is hereby authorized to charge all required extension of time fees to our Deposit Account No. 19-0036, if such fees are not otherwise provided for in such reply.

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.

/Donald J. Featherstone/

Donald J. Featherstone  
Attorney for Applicant  
Registration No. 33,876

Date: 5/28/2020

1100 New York Avenue, N.W.  
Washington, D.C. 20005-3934  
(202) 371-2600  
15080953\_1.docx

## SCORE Placeholder Sheet for IFW Content

Application Number: 16885858

Document Date: 05/28/2020

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

- Drawing

At the time of document entry (noted above):

- USPTO employees may access SCORE content via DAV or via the SCORE web page.
- External customers may access SCORE content via PAIR using the Supplemental Content tab.

Form Revision Date: March 1, 2019

## PATENT ASSIGNMENT COVER SHEET

Electronic Version v1.1  
 Stylesheet Version v1.2

EPAS ID: PAT6127021

|                                                                                                                                                                                                 |                                                            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| <b>SUBMISSION TYPE:</b>                                                                                                                                                                         | NEW ASSIGNMENT                                             |
| <b>NATURE OF CONVEYANCE:</b>                                                                                                                                                                    | ASSIGNMENT                                                 |
| <b>CONVEYING PARTY DATA</b>                                                                                                                                                                     |                                                            |
| <b>Name</b>                                                                                                                                                                                     | <b>Execution Date</b>                                      |
| ZHENYU LU                                                                                                                                                                                       | 10/23/2018                                                 |
| JUN CHEN                                                                                                                                                                                        | 10/23/2018                                                 |
| XIAOWANG DAI                                                                                                                                                                                    | 11/03/2018                                                 |
| JIFENG ZHU                                                                                                                                                                                      | 10/22/2018                                                 |
| QIAN TAO                                                                                                                                                                                        | 11/03/2018                                                 |
| YU RU HUANG                                                                                                                                                                                     | 11/05/2018                                                 |
| SI PING HU                                                                                                                                                                                      | 11/05/2018                                                 |
| LAN YAO                                                                                                                                                                                         | 10/22/2018                                                 |
| LI HONG XIAO                                                                                                                                                                                    | 10/22/2018                                                 |
| A MAN ZHENG                                                                                                                                                                                     | 10/22/2018                                                 |
| KUN BAO                                                                                                                                                                                         | 10/22/2018                                                 |
| HAOHAO YANG                                                                                                                                                                                     | 10/22/2018                                                 |
| <b>RECEIVING PARTY DATA</b>                                                                                                                                                                     |                                                            |
| <b>Name:</b>                                                                                                                                                                                    | YANGTZE MEMORY TECHNOLOGIES CO., LTD.                      |
| <b>Street Address:</b>                                                                                                                                                                          | 18 GAOXIN 4TH ROAD, EAST LAKE HIGH-TECH DEVELOPMENT ZONE   |
| <b>City:</b>                                                                                                                                                                                    | WUHAN, HUBEI                                               |
| <b>State/Country:</b>                                                                                                                                                                           | CHINA                                                      |
| <b>PROPERTY NUMBERS Total: 1</b>                                                                                                                                                                |                                                            |
| <b>Property Type</b>                                                                                                                                                                            | <b>Number</b>                                              |
| Application Number:                                                                                                                                                                             | 16885858                                                   |
| <b>CORRESPONDENCE DATA</b>                                                                                                                                                                      |                                                            |
| <b>Fax Number:</b>                                                                                                                                                                              | (202)371-2540                                              |
| <i>Correspondence will be sent to the e-mail address first; if that is unsuccessful, it will be sent using a fax number, if provided; if that is unsuccessful, it will be sent via US Mail.</i> |                                                            |
| <b>Phone:</b>                                                                                                                                                                                   | (202) 371-2600                                             |
| <b>Email:</b>                                                                                                                                                                                   | KShiu@sternekessler.com, TTOPSSecretary1@sternekessler.com |
| <b>Correspondent Name:</b>                                                                                                                                                                      | STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C                   |
| <b>Address Line 1:</b>                                                                                                                                                                          | 1100 NEW YORK AVENUE, N.W.                                 |
| <b>Address Line 4:</b>                                                                                                                                                                          | WASHINGTON, D.C. 20005                                     |

|                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| <b>ATTORNEY DOCKET NUMBER:</b>                                                                                                                                                                                                                                                                                                                                                                                          | 4123.0460003                                               |
| <b>NAME OF SUBMITTER:</b>                                                                                                                                                                                                                                                                                                                                                                                               | DONALD J. FEATHERSTONE                                     |
| <b>SIGNATURE:</b>                                                                                                                                                                                                                                                                                                                                                                                                       | /DONALD J. FEATHERSTONE/                                   |
| <b>DATE SIGNED:</b>                                                                                                                                                                                                                                                                                                                                                                                                     | 05/28/2020                                                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                         | This document serves as an Oath/Declaration (37 CFR 1.63). |
| <b>Total Attachments: 5</b><br>source=2020-05-28-Combined-Declaration-Assignment-4123-0460003#page1.tif<br>source=2020-05-28-Combined-Declaration-Assignment-4123-0460003#page2.tif<br>source=2020-05-28-Combined-Declaration-Assignment-4123-0460003#page3.tif<br>source=2020-05-28-Combined-Declaration-Assignment-4123-0460003#page4.tif<br>source=2020-05-28-Combined-Declaration-Assignment-4123-0460003#page5.tif |                                                            |

## COMBINED DECLARATION AND ASSIGNMENT

### DECLARATION

As the below named inventors, I hereby declare that:

This declaration is directed to:

- ☐ The attached application, or
- ☒ United States application or PCT international application number 16/126,956  
filed on September 10, 2018

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 five (5) years, or both.

### ASSIGNMENT

In consideration of the sum of One Dollar (\$1.00) or equivalent and other good and valuable consideration paid to each of the below named inventors, each of the below named inventors, hereby sell and assign to **Yangtze Memory Technologies Co., Ltd.**, a corporation formed under the laws of China, whose mailing address is 18 Gaoxin 4th Road, East Lake High-Tech Development Zone, Wuhan, Hubei, China (hereafter referred to as the Assignee), his/her entire right, title and interest, including the right to sue for past infringement and to collect for all past, present and future damages, for the United States of America (as defined in 35 U.S.C. § 100) and throughout the world,

(a) in the invention(s) known as **STAIRCASE STRUCTURE FOR MEMORY DEVICE** for which application(s) for patent in the United States of America is identified above, in any and all applications thereon, in any and all Letters Patent(s) therefor, and

(b) in any and all applications that claim the benefit of the patent application identified above in part (a), including non-provisional applications, continuing (continuation, divisional, or continuation-in-part) applications, reissues, extensions, renewals and reexaminations of the patent application or Letters Patent therefor listed above in part (a), to the full extent of the term or terms for which Letters Patents issue, and

(c) in any and all inventions described in the patent application identified above in part (a), and in any and all forms of intellectual and industrial property protection derivable from such patent application, and that are derivable from any and all continuing applications, reissues, extensions, renewals and reexaminations of such patent application, including, without limitation, patents, applications, utility models, inventor's certificates, and designs together with the right to file applications therefor; and including the right to claim the same priority rights from any previously filed applications under the International Agreement for the Protection of Industrial Property, or any other international agreement, or the domestic laws of the country in which any such application is filed, as may be applicable;

all such rights, title and interest to be held and enjoyed by the above-named Assignee, its successors, legal representatives and assigns to the same extent as all such rights, title and interest would have been held and enjoyed by the Assignor had this assignment and sale not been made.

The below named inventors agree to execute all papers necessary in connection with the application(s) and any non-provisional, continuing (continuation, divisional, or continuation-in-part), reissue, reexamination or corresponding application(s) thereof and also to execute separate assignments in connection with such application(s) as the Assignee may deem necessary or expedient.

The below named inventors agree to execute all papers necessary in connection with any patent enforcement action (judicial or otherwise) related to the application(s) or any non-provisional, continuing (continuation, divisional, or continuation-in-part), reissue or reexamination application(s) thereof and to cooperate with the Assignee in every way possible in obtaining evidence and going forward with such patent enforcement action.

The below named inventors hereby represent that he/she has full right to convey the entire interest herein assigned, and that he/she has not executed, and will not execute, any agreement in conflict therewith.

The below named inventors hereby represent that he/she understands that the patent practitioners associated with **CUSTOMER NUMBER 26111** are the legal representatives of, and attorneys for, the assignee, and are NOT the legal representatives of, and attorneys for, the inventors.

IN WITNESS WHEREOF, executed by the below named inventors on the date opposite his/her name.

LEGAL NAME OF INVENTOR

Inventor: Zhenyu LU Date: 2018.10.23

Signature of Inventor: Zhenyu Lu

LEGAL NAME OF INVENTOR

Inventor: Jun CHEN Date: 2018.10.23

Signature of Inventor: Jun CHEN

LEGAL NAME OF INVENTOR

Inventor: Xiaowang DAI Date: 2018.11.3

Signature of Inventor: Xiaowang DAI

LEGAL NAME OF INVENTOR

Inventor: Jifeng ZHU Date: 2018.10.22

Signature of Inventor: Jifeng ZHU

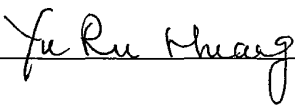
LEGAL NAME OF INVENTOR

Inventor: Qian TAO Date: 2018.11.3

Signature of Inventor: 

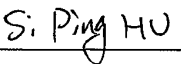
LEGAL NAME OF INVENTOR

Inventor: Yu Ru HUANG Date: 2018.11.5

Signature of Inventor: 

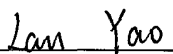
LEGAL NAME OF INVENTOR

Inventor: Si Ping HU Date: 2018.11.05

Signature of Inventor: 

LEGAL NAME OF INVENTOR

Inventor: Lan YAO Date: 2018.10.22

Signature of Inventor: 

LEGAL NAME OF INVENTOR

Inventor: Li Hong XIAO Date: 2018.10.22

Signature of Inventor: 

LEGAL NAME OF INVENTOR

Inventor: A Man ZHENG Date: 2018/10/22

Signature of Inventor: A Man ZHENG

LEGAL NAME OF INVENTOR

Inventor: Kun BAO Date: 2018/10/22

Signature of Inventor: Kun BAO

LEGAL NAME OF INVENTOR

Inventor: Haohao YANG Date: 2018/10/22

Signature of Inventor: Haohao YANG

10202577\_1.docx

| <b>PATENT APPLICATION FEE DETERMINATION RECORD</b><br>Substitute for Form PTO-875                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                               |                                    |                 |              |                    | Application or Docket Number<br>16/885,858 |          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|-----------------|--------------|--------------------|--------------------------------------------|----------|
| <b>APPLICATION AS FILED - PART I</b>                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                               |                                    |                 |              |                    |                                            |          |
| (Column 1)                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                               | (Column 2)                         |                 | SMALL ENTITY |                    | 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                                        | 300      |
| SEARCH FEE<br>(37 CFR 1.16(k), (l), or (m))                                                                                                                                                                                                                                                                                                                                                                | N/A                                                                                                                                                                                                                           | N/A                                | N/A             |              |                    | N/A                                        | 660      |
| EXAMINATION FEE<br>(37 CFR 1.16(o), (p), or (q))                                                                                                                                                                                                                                                                                                                                                           | N/A                                                                                                                                                                                                                           | N/A                                | N/A             |              |                    | N/A                                        | 760      |
| TOTAL CLAIMS<br>(37 CFR 1.16(i))                                                                                                                                                                                                                                                                                                                                                                           | 20                                                                                                                                                                                                                            | minus 20 = *                       |                 |              |                    | x 100 =                                    | 0.00     |
| INDEPENDENT CLAIMS<br>(37 CFR 1.16(h))                                                                                                                                                                                                                                                                                                                                                                     | 3                                                                                                                                                                                                                             | minus 3 = *                        |                 |              |                    | x 460 =                                    | 0.00     |
| 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). |                                    |                 |              |                    |                                            | 0.00     |
| MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                               |                                    |                 |              |                    |                                            | 0.00     |
| * If the difference in column 1 is less than zero, enter "0" in column 2.                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                               |                                    | TOTAL           |              |                    | TOTAL                                      | 1720     |
| <b>APPLICATION AS AMENDED - PART II</b>                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                               |                                    |                 |              |                    |                                            |          |
| (Column 1)                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                               | (Column 2)                         |                 | (Column 3)   |                    | SMALL ENTITY                               |          |
| AMENDMENT A                                                                                                                                                                                                                                                                                                                                                                                                | CLAIMS REMAINING AFTER AMENDMENT                                                                                                                                                                                              | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA   | RATE(\$)     | ADDITIONAL FEE(\$) |                                            | RATE(\$) |
|                                                                                                                                                                                                                                                                                                                                                                                                            | Total<br>(37 CFR 1.16(i))                                                                                                                                                                                                     | *                                  | Minus **        | =            | x =                |                                            | x =      |
|                                                                                                                                                                                                                                                                                                                                                                                                            | Independent<br>(37 CFR 1.16(h))                                                                                                                                                                                               | *                                  | Minus ***       | =            | x =                |                                            | x =      |
|                                                                                                                                                                                                                                                                                                                                                                                                            | Application Size Fee (37 CFR 1.16(s))                                                                                                                                                                                         |                                    |                 |              |                    |                                            |          |
|                                                                                                                                                                                                                                                                                                                                                                                                            | FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))                                                                                                                                                               |                                    |                 |              |                    |                                            |          |
|                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                               |                                    | TOTAL ADD'L FEE |              |                    | TOTAL ADD'L FEE                            |          |
| (Column 1)                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                               | (Column 2)                         |                 | (Column 3)   |                    | SMALL ENTITY                               |          |
| AMENDMENT B                                                                                                                                                                                                                                                                                                                                                                                                | CLAIMS REMAINING AFTER AMENDMENT                                                                                                                                                                                              | HIGHEST NUMBER PREVIOUSLY PAID FOR | PRESENT EXTRA   | RATE(\$)     | ADDITIONAL FEE(\$) |                                            | RATE(\$) |
|                                                                                                                                                                                                                                                                                                                                                                                                            | Total<br>(37 CFR 1.16(i))                                                                                                                                                                                                     | *                                  | Minus **        | =            | x =                |                                            | x =      |
|                                                                                                                                                                                                                                                                                                                                                                                                            | Independent<br>(37 CFR 1.16(h))                                                                                                                                                                                               | *                                  | Minus ***       | =            | x =                |                                            | x =      |
|                                                                                                                                                                                                                                                                                                                                                                                                            | Application Size Fee (37 CFR 1.16(s))                                                                                                                                                                                         |                                    |                 |              |                    |                                            |          |
|                                                                                                                                                                                                                                                                                                                                                                                                            | FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))                                                                                                                                                               |                                    |                 |              |                    |                                            |          |
|                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                               |                                    | TOTAL ADD'L FEE |              |                    | TOTAL ADD'L FEE                            |          |
| * If the entry in column 1 is less than the entry in column 2, write "0" in column 3.<br>** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".<br>*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".<br>The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1. |                                                                                                                                                                                                                               |                                    |                 |              |                    |                                            |          |



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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 |
|-----------------------|--------------------------|-----------------|---------------|------------------|------------|------------|
| 16/885,858            | 05/28/2020               | 2811            | 1720          | 4123.0460003     | 20         | 3          |

CONFIRMATION NO. 1041

26111

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.  
1100 NEW YORK AVENUE, N.W.  
WASHINGTON, DC 20005

FILING RECEIPT



0000000117523030

Date Mailed: 06/08/2020

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)**

Zhenyu LU, Wuhan, CHINA;  
Jun Chen, Wuhan, CHINA;  
Xiaowang Dai, Wuhan, CHINA;  
Jifeng Zhu, Wuhan, CHINA;  
Qian Tao, Wuhan, CHINA;  
Yu Ru Huang, Wuhan, CHINA;  
Si Ping Hu, Wuhan, CHINA;  
Lan Yao, Wuhan, CHINA;  
Li Hong Xiao, Wuhan, CHINA;  
A Man Zheng, Wuhan, CHINA;  
Kun Bao, Wuhan, CHINA;  
Haohao Yang, Wuhan, CHINA;

**Applicant(s)**

Yangtze Memory Technologies Co., Ltd., Wuhan, CHINA;

**Assignment For Published Patent Application**

Yangtze Memory Technologies Co., Ltd., Wuhan, CHINA

**Power of Attorney:** The patent practitioners associated with Customer Number 26111

**Domestic Priority data as claimed by applicant**

This application is a CON of 16/126,956 09/10/2018 PAT 10680003  
which is a CON of PCT/CN2018/098962 08/06/2018

**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.)  
CHINA 201710750398.4 08/28/2017 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:** 06/05/2020

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/885,858**

**Projected Publication Date:** 09/17/2020

**Non-Publication Request:** No

**Early Publication Request:** No

**Title**

STAIRCASE STRUCTURE FOR MEMORY DEVICE

**Preliminary Class**

257

**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.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventors: LU *et al.*

Applicant: Yangtze Memory Technologies  
Co., Ltd.

Application No.: 16/885,858

Filing Date: May 28, 2020

Confirmation No.: 1041

Art Unit: 2812

Examiner: GEYER, Scott B.

Atty. Docket: 4123.0460003

Title: **STAIRCASE STRUCTURE FOR MEMORY DEVICE**

**Request for Corrected Official Filing Receipt**

Commissioner for Patents  
PO Box 1450  
Alexandria, VA 22313-1450

*Mail Stop Missing Parts*

Commissioner:

Applicant hereby requests that a corrected Official Filing Receipt be issued and sent to the undersigned representative. Specifically, the following corrections to the Official Filing Receipt are requested:

**In the "Assignment For Published Patent Application" section, please change  
"Technologies Co.," to --Technologies Co.,--.**

In support of the above request, a marked-up copy of the instant Official Filing Receipt is enclosed to show the corrections. It is requested that a corrected Official Filing Receipt be issued, and sent to the undersigned at the earliest possible time.

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.

/Donald J. Featherstone/

Donald J. Featherstone  
Attorney for Applicant  
Registration No. 33,876

Date: 6/10/2020

1100 New York Avenue, N.W.  
Washington, D.C. 20005-3934  
(202) 371-2600  
15149114\_1



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
**United States Patent and Trademark Office**  
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| APPLICATION<br>NUMBER | FILING or<br>371(c) DATE | GRP ART<br>UNIT | FIL FEE REC'D | ATTY. DOCKET NO. | TOT CLAIMS | IND CLAIMS |
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**CONFIRMATION NO. 1041**

26111

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.  
 1100 NEW YORK AVENUE, N.W.  
 WASHINGTON, DC 20005

## FILING RECEIPT



CC000000117525030

Date Mailed: 06/08/2020

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### Inventor(s)

Zhenyu LU, Wuhan, CHINA;  
 Jun Chen, Wuhan, CHINA;  
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 Haohao Yang, Wuhan, CHINA;

### Applicant(s)

Yangtze Memory Technologies Co., Ltd., Wuhan, CHINA;

### Assignment For Published Patent Application

Yangtze Memory Technologies Co., Ltd., Wuhan, CHINA  
 Technologies Co.,

**Power of Attorney:** The patent practitioners associated with Customer Number 26111

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 which is a CON of PCT/CN2018/098962 08/06/2018

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CHINA 201710750398.4 08/28/2017 Access Code Provided

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

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**If Required, Foreign Filing License Granted:** 06/05/2020

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/885,858**

**Projected Publication Date:** 09/17/2020

**Non-Publication Request:** No

**Early Publication Request:** No

**Title**

STAIRCASE STRUCTURE FOR MEMORY DEVICE

**Preliminary Class**

257

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

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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).

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| Electronic Acknowledgement Receipt          |                                       |
|---------------------------------------------|---------------------------------------|
| <b>EFS ID:</b>                              | 39684465                              |
| <b>Application Number:</b>                  | 16885858                              |
| <b>International Application Number:</b>    |                                       |
| <b>Confirmation Number:</b>                 | 1041                                  |
| <b>Title of Invention:</b>                  | STAIRCASE STRUCTURE FOR MEMORY DEVICE |
| <b>First Named Inventor/Applicant Name:</b> | Zhenyu LU                             |
| <b>Customer Number:</b>                     | 26111                                 |
| <b>Filer:</b>                               | Donald J. Featherstone/Tonyia Skinner |
| <b>Filer Authorized By:</b>                 | Donald J. Featherstone                |
| <b>Attorney Docket Number:</b>              | 4123.0460003                          |
| <b>Receipt Date:</b>                        | 10-JUN-2020                           |
| <b>Filing Date:</b>                         | 28-MAY-2020                           |
| <b>Time Stamp:</b>                          | 17:50:23                              |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)           |

### Payment information:

| Submitted with Payment |                      | no                                      |                                          |                  |                  |
|------------------------|----------------------|-----------------------------------------|------------------------------------------|------------------|------------------|
| <b>File Listing:</b>   |                      |                                         |                                          |                  |                  |
| Document Number        | Document Description | File Name                               | File Size(Bytes)/<br>Message Digest      | Multi Part /.zip | Pages (if appl.) |
| 1                      | Transmittal Letter   | 2020-06-10-Cover-Sheet-4123-0460003.pdf | 324072                                   | no               | 1                |
|                        |                      |                                         | 6ce89b3abfe691768c98a69f3643e2973b50fe97 |                  |                  |
| <b>Warnings:</b>       |                      |                                         |                                          |                  |                  |

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| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                      |                                                       |                                              |        |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Request for Corrected Filing Receipt | 2020-06-10-Request-Corrected-<br>OFR-4123-0460003.pdf | 147046                                       | no     | 1 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                      |                                                       | 0587b06b7f9ef47297e24a38a6fd531604f3<br>a73d |        |   |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                      |                                                       |                                              |        |   |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                      |                                                       |                                              |        |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Request for Corrected Filing Receipt | 2020-06-10-Marked-Up-Copy-<br>OFR-4123-0460003.pdf    | 37780                                        | no     | 4 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                      |                                                       | c3f1649d833c9cd7ccaf6623a3c898bd92f1<br>cb0  |        |   |
| <b>Warnings:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                      |                                                       |                                              |        |   |
| <b>Information:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                      |                                                       |                                              |        |   |
| <b>Total Files Size (in bytes):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                      |                                                       |                                              | 508898 |   |
| <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> |                                      |                                                       |                                              |        |   |

DONALD J. FEATHERSTONE  
DIRECTOR  
(202) 772-8629  
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June 10, 2020

Commissioner for Patents  
PO Box 1450  
Alexandria, VA 22313-1450

**Confirmation No. 1041**  
**Art Unit 2812**

Re: U.S. Utility Patent Application  
Appl. No. 16/885,858; Filing Date: May 28, 2020  
For: **STAIRCASE STRUCTURE FOR MEMORY DEVICE**  
Inventors: LU *et al.*  
Our Ref: 4123.0460003

Commissioner:

Transmitted herewith for appropriate action are the following documents:

1. Request for Corrected Official Filing Receipt; and
2. Marked-Up Copy of Official Filing Receipt.

***The above-listed documents are filed electronically.***

In the event that extensions of time are necessary to prevent abandonment of this patent application, then such extensions of time are hereby petitioned.

The U.S. Patent and Trademark Office is hereby authorized to charge any fee deficiency and any additional fees required to continue prosecution or appeal of this application (including issue fee, fees for net addition of claims or forwarding to appeal) or credit any overpayment to our Deposit Account No. 19-0036.

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.

/Donald J. Featherstone/

Donald J. Featherstone  
Attorney for Applicant  
Registration No. 33,876

DJF/KTS/tas  
Enclosures

15149110\_1

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United States Patent and Trademark Office  
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| APPLICATION<br>NUMBER | FILING or<br>371(c) DATE | GRP ART<br>UNIT | FIL FEE REC'D | ATTY. DOCKET NO. | TOT CLAIMS | IND CLAIMS |
|-----------------------|--------------------------|-----------------|---------------|------------------|------------|------------|
| 16/885,858            | 05/28/2020               | 2812            | 1720          | 4123.0460003     | 20         | 3          |

**CONFIRMATION NO. 1041**  
**CORRECTED FILING RECEIPT**

26111

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.  
1100 NEW YORK AVENUE, N.W.  
WASHINGTON, DC 20005



0000000117688067

Date Mailed: 06/12/2020

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.

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**Inventor(s)**

Zhenyu LU, Wuhan, CHINA;  
Jun Chen, Wuhan, CHINA;  
Xiaowang Dai, Wuhan, CHINA;  
Jifeng Zhu, Wuhan, CHINA;  
Qian Tao, Wuhan, CHINA;  
Yu Ru Huang, Wuhan, CHINA;  
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Lan Yao, Wuhan, CHINA;  
Li Hong Xiao, Wuhan, CHINA;  
A Man Zheng, Wuhan, CHINA;  
Kun Bao, Wuhan, CHINA;  
Haohao Yang, Wuhan, CHINA;

**Applicant(s)**

Yangtze Memory Technologies Co., Ltd., Wuhan, CHINA;

**Assignment For Published Patent Application**

Yangtze Memory Technologies Co, Ltd., Wuhan, CHINA

**Power of Attorney:** The patent practitioners associated with Customer Number 26111

**Domestic Priority data as claimed by applicant**

This application is a CON of 16/126,956 09/10/2018 PAT 10680003  
which is a CON of PCT/CN2018/098962 08/06/2018

**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.)  
CHINA 201710750398.4 08/28/2017 Access Code Provided

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

**Permission to Access Search Results:** Yes

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**Projected Publication Date:** 09/17/2020

**Non-Publication Request:** No

**Early Publication Request:** No

**Title**

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**Preliminary Class**

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| APPLICATION<br>NUMBER | FILING or<br>371(c) DATE | GRP ART<br>UNIT | FIL FEE REC'D | ATTY. DOCKET NO. | TOT CLAIMS | IND CLAIMS |
|-----------------------|--------------------------|-----------------|---------------|------------------|------------|------------|
| 16/885,858            | 05/28/2020               | 2812            | 1720          | 4123.0460003     | 20         | 3          |

CONFIRMATION NO. 1041

CORRECTED FILING RECEIPT

26111

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WASHINGTON, DC 20005



CC000000117816355

Date Mailed: 06/18/2020

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Haohao Yang, Wuhan, CHINA;

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Yangtze Memory Technologies Co., Ltd., Wuhan, CHINA;

**Assignment For Published Patent Application**

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**Power of Attorney:** The patent practitioners associated with Customer Number 26111

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which is a CON of PCT/CN2018/098962 08/06/2018

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CHINA 201710750398.4 08/28/2017 Access Code Provided

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

**Permission to Access Search Results:** Yes

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**Projected Publication Date:** 09/17/2020

**Non-Publication Request:** No

**Early Publication Request:** No

**Title**

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**Preliminary Class**

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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>.

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| APPLICATION NUMBER | FILING OR 371(C) DATE | FIRST NAMED APPLICANT | ATTY. DOCKET NO./TITLE |
|--------------------|-----------------------|-----------------------|------------------------|
| 16/885,858         | 05/28/2020            | Zhenyu LU             | 4123.0460003           |

**CONFIRMATION NO. 1041**

26111

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.  
1100 NEW YORK AVENUE, N.W.  
WASHINGTON, DC 20005

## PUBLICATION NOTICE



\*OC000000119972480\*

**Title:**STAIRCASE STRUCTURE FOR MEMORY DEVICE

**Publication No.**US-2020-0295019-A1

**Publication Date:**09/17/2020

## 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/>.

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|                                                                                                                          |             |                      |                            |                  |
|--------------------------------------------------------------------------------------------------------------------------|-------------|----------------------|----------------------------|------------------|
| APPLICATION NO.                                                                                                          | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO.        | CONFIRMATION NO. |
| 16/885,858                                                                                                               | 05/28/2020  | Zhenyu LU            | 4123.0460003               | 1041             |
| 26111 7590 03/23/2021<br>STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.<br>1100 NEW YORK AVENUE, N.W.<br>WASHINGTON, DC 20005 |             |                      | EXAMINER<br>GEYER, SCOTT B |                  |
|                                                                                                                          |             |                      | ART UNIT                   | PAPER NUMBER     |
|                                                                                                                          |             |                      | 2812                       |                  |
|                                                                                                                          |             |                      | NOTIFICATION DATE          | DELIVERY MODE    |
|                                                                                                                          |             |                      | 03/23/2021                 | 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):

e-office@sternekessler.com



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## **DETAILED ACTION**

### **Priority**

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. 16/126,956, filed on September 10, 2018.

### **Information Disclosure Statement**

The references cited within the IDS document submitted on May 28, 2020 have been considered.

### **Claim Objections**

Claim 18 is objected to because of the following informalities:

In claim 18, line 1: change "claim 18" to - - claim 17 - -

Appropriate correction is required.

### **Double Patenting**

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

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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 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 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

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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/process/file/efs/guidance/eTD-info-I.jsp](http://www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp).

Claims 1, 2, and 4-8 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1 and 3-8 of U.S. Patent No. 10,680,003. Although the claims at issue are not identical, they are not patentably distinct from each other because all of the limitations within claims 1, 2, and 4-8 of the instant application are recited within claims 1 and 3-8 of the '003 patent.

Specifically, for claim 1 of the instant application, see claim 1 of the '003 patent;

For claim 2 of the instant application, see claims 1 and 3 of the '003 patent;

For claim 4 of the instant application, see claims 4 and 5 of the '003 patent;

For claim 5 of the instant application, see claim 4 of the '003 patent;

For claim 6 of the instant application, see claim 6 of the '003 patent;

For claim 7 of the instant application, see claim 7 of the '003 patent;

For claim 8 of the instant application, see claim 8 of the '003 patent.

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**Allowable Subject Matter**

Claim 3 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claims 9-20 are allowable. The following is an examiner's statement of reasons for allowability. The prior art of record does not teach or suggest the disclosed invention regarding:

A semiconductor structure, particularly characterized by having:

a plurality of landing pads respectively disposed on the plurality of layer stacks, wherein each landing pad is disposed over a second portion of the second material layer of a respective layer stack of the plurality of layer stacks, and wherein the each landing pad comprises a curved side surface and a substantially straight side surface, wherein the substantially straight side surface is laterally displaced from a side surface of the second portion of the second material layer, as recited within claim 9.

Claims 10-16 depend from claim 9.

A memory device, particularly characterized by having:

a staircase structure disposed adjacent to the memory string, wherein the staircase structure comprises:

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a plurality of layer stacks, each layer stack comprising an insulating layer disposed over a first portion of a conductive layer, wherein a second portion of the conductive layer comprises a curved side surface in contact with a side surface of the insulating layer, as recited within claim 17.

Claims 18-20 depend from claim 17.

### **Cited Prior Art**

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure: see the attached form PTO-892 for pertinent cited art.

### **Contact Information**

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Scott B. Geyer (telephone: 571-272-1958). The examiner can normally be reached on Monday to Friday, 10AM - 4PM. Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at: <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Charles D Garber (telephone: 571-272-2194). The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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/SCOTT B GEYER/  
Primary Examiner, Art Unit 2812

|                                   |                                       |  |                                                         |             |
|-----------------------------------|---------------------------------------|--|---------------------------------------------------------|-------------|
| <b>Notice of References Cited</b> | Application/Control No.<br>16/885,858 |  | Applicant(s)/Patent Under<br>Reexamination<br>LU et al. |             |
|                                   | Examiner<br>Scott B Geyer             |  | Art Unit<br>2812                                        | Page 1 of 1 |

#### U.S. PATENT DOCUMENTS

| * |   | Document Number<br>Country Code-Number-Kind Code | Date<br>MM-YYYY | Name              | CPC Classification | US Classification |
|---|---|--------------------------------------------------|-----------------|-------------------|--------------------|-------------------|
| * | A | US-20130056818-A1                                | 03-2013         | IINO; Hiromitsu   | H01L27/1157        | 257/324           |
| * | B | US-20170271256-A1                                | 09-2017         | INATSUKA; Takuya  | H01L21/31144       | 1/1               |
| * | C | US-20130043509-A1                                | 02-2013         | CHO; Sung Yoon    | H01L27/11575       | 257/208           |
| * | D | US-20180301460-A1                                | 10-2018         | Yoo; Tae Hee      | H01L27/11548       | 1/1               |
| * | E | US-20190006385-A1                                | 01-2019         | KIM; Sung-Gil     | H01L27/11575       | 1/1               |
| * | F | US-20180166380-A1                                | 06-2018         | Park; Jo-young    | H01L27/11575       | 1/1               |
| * | G | US-20190280001-A1                                | 09-2019         | TERASAWA; Yujin   | H01L27/11556       | 1/1               |
| * | H | US-10395982-B2                                   | 08-2019         | Nam; Phil Ouk     | H01L27/11524       | 1/1               |
| * | I | US-9941153-B1                                    | 04-2018         | Yang; Chin-Cheng  | H01L23/53257       | 1/1               |
| * | J | US-9520402-B1                                    | 12-2016         | Haller; Gordon A. | H01L27/11548       | 1/1               |
| * | K | US-9711603-B2                                    | 07-2017         | Lim; Tae-Wan      | H01L27/11575       | 1/1               |
|   | L |                                                  |                 |                   |                    |                   |
|   | M |                                                  |                 |                   |                    |                   |

#### FOREIGN PATENT DOCUMENTS

| * |   | Document Number<br>Country Code-Number-Kind Code | Date<br>MM-YYYY | Country | Name | CPC Classification |
|---|---|--------------------------------------------------|-----------------|---------|------|--------------------|
|   | N |                                                  |                 |         |      |                    |
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|   | 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 MM-YYYY format are publication dates. Classifications may be US or foreign.

|                                                                                                                 |                                              |                                                             |
|-----------------------------------------------------------------------------------------------------------------|----------------------------------------------|-------------------------------------------------------------|
| <b><i>Search Notes</i></b><br> | <b>Application/Control No.</b><br>16/885,858 | <b>Applicant(s)/Patent Under Reexamination</b><br>LU et al. |
|                                                                                                                 | <b>Examiner</b><br>Scott B Geyer             | <b>Art Unit</b><br>2812                                     |

| CPC - Searched*                                                                     |            |          |
|-------------------------------------------------------------------------------------|------------|----------|
| Symbol                                                                              | Date       | Examiner |
| H01L 27/11514, 27/11551, 27/11578, 27/11597                                         | 03/18/2021 | SBG      |
| H01L 27/11509, 27/11512, 27/11526, 27/11529, 27/11573, 27/11575, 27/11592, 27/11595 | 03/18/2021 | SBG      |

| 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 |
| Parent application (16/126,956) - references checked          | 03/18/2021 | SBG      |
| Consulted Examiner B. Paterson (AU 2812) on search strategies | 03/18/2021 | SBG      |
| PE2E-Search, details attached                                 | 03/18/2021 | SBG      |

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

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# PE2E SEARCH - Search History (Prior Art)

| Ref # | Hits  | Search Query                                                                                                                                                                                                                                                                                                                                                  | DBs                                                               | Default Operator | Plurals | British Equivalents | Time Stamp          |
|-------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|------------------|---------|---------------------|---------------------|
| L1    | 1     | "10680003".pn.                                                                                                                                                                                                                                                                                                                                                | (US-PGPUB ; USPAT)                                                | OR               | ON      | ON                  | 2021/03/16 04:03 PM |
| L2    | 15    | ("9006884"   "9331082"   "9343452"   "9373540"   "9419013"   "9478487"   "9741563"   "10002880"   "10403641"   "20110031630"   "20130270714"   "20150255385"   "20150255386"   "20170084532"   "20190081070").pn. OR ("10680003").urpn. AND (PGPB   USPT   USOC).dbnm.                                                                                        | (US-PGPUB ; USPAT ; USOCR)                                        | OR               | ON      | ON                  | 2021/03/16 05:03 PM |
| L5    | 74581 | (H01L27/11524 H01L21/0273 H01L21/31144 H01L27/11529 H01L27/1157 H01L27/11575 H01L27/11582).CPC.                                                                                                                                                                                                                                                               | (US-PGPUB ; USPAT ; USOCR ; FPRS ; EPO ; JPO ; DERWENT ; IBM_TDB) | OR               | ON      | ON                  | 2021/03/16 05:03 PM |
| L6    | 1772  | ((Yangtze WITH Memory).as. (Zhenyu WITH LU).in. (Jun WITH Chen).in. (Xiaowang WITH Dai).in. (Jifeng WITH Zhu).in. (Qian WITH Tao).in. (Yu WITH Huang).in. (Si WITH Hu).in. (Lan WITH Yao).in. (Li WITH Xiao).in. (Man WITH Zheng).in. (Kun WITH Bao).in. (Haohao Yang).in.) AND (stair-case staircase stair-step stairstep (stair ADJ case) (stair ADJ step)) | (US-PGPUB ; USPAT ; USOCR ; FPRS ; EPO ; JPO ; DERWENT ; IBM_TDB) | OR               | ON      | ON                  | 2021/03/16 05:03 PM |
| L9    | 525   | (H01L27/115-11597).CPC. AND (stair-case staircase stair-step stairstep (stair ADJ case) (stair ADJ step)) AND landing                                                                                                                                                                                                                                         | (US-PGPUB ; USPAT ; USOCR ; FPRS ; EPO ; JPO ; DERWENT ; IBM_TDB) | OR               | ON      | ON                  | 2021/03/16 05:03 PM |
| L10   | 1105  | (H01L27/115-11597).CPC. AND (stair-case staircase stair-step stairstep (stair ADJ case) (stair ADJ step)) AND (landing pad)                                                                                                                                                                                                                                   | (US-PGPUB ; USPAT ; USOCR ; FPRS ; EPO ; JPO ; DERWENT ; IBM_TDB) | OR               | ON      | ON                  | 2021/03/16 05:03 PM |
| L11   | 2383  | (stair-case staircase stair-step stairstep (stair ADJ case) (stair ADJ step)) WITH memory                                                                                                                                                                                                                                                                     | (US-PGPUB ; USPAT ; USOCR ; FPRS ; EPO ; JPO ; DERWENT ; IBM_TDB) | OR               | ON      | ON                  | 2021/03/16 05:03 PM |

|     |       |                                                                                                                                     |                                                                            |    |    |    |                        |
|-----|-------|-------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|----|----|----|------------------------|
| L12 | 10907 | (H01L27/11524<br>H01L27/11529<br>H01L27/1157).cpc. AND<br>(H01L27/11575<br>H01L27/11582).CPC.                                       | (US-PGPUB ; USPAT ;<br>USOCR ; FPRS ; EPO<br>; JPO ; DERWENT ;<br>IBM_TDB) | OR | ON | ON | 2021/03/16<br>05:03 PM |
| L13 | 1199  | 12 AND (stair-case<br>staircase stair-step<br>stairstep (stair ADJ<br>case) (stair ADJ step))                                       | (US-PGPUB ; USPAT ;<br>USOCR ; FPRS ; EPO<br>; JPO ; DERWENT ;<br>IBM_TDB) | OR | ON | ON | 2021/03/16<br>05:03 PM |
| L14 | 24999 | (H01L27/11524<br>H01L27/11529<br>H01L27/1157).cpc.                                                                                  | (US-PGPUB ; USPAT ;<br>USOCR ; FPRS ; EPO<br>; JPO ; DERWENT ;<br>IBM_TDB) | OR | ON | ON | 2021/03/16<br>05:03 PM |
| L15 | 1342  | 14 AND (stair-case<br>staircase stair-step<br>stairstep (stair ADJ<br>case) (stair ADJ step))                                       | (US-PGPUB ; USPAT ;<br>USOCR ; FPRS ; EPO<br>; JPO ; DERWENT ;<br>IBM_TDB) | OR | ON | ON | 2021/03/16<br>05:03 PM |
| L16 | 942   | 15 NOT ("2021" "2020"<br>"2019").ay.                                                                                                | (US-PGPUB ; USPAT ;<br>USOCR ; FPRS ; EPO<br>; JPO ; DERWENT ;<br>IBM_TDB) | OR | ON | ON | 2021/03/16<br>05:03 PM |
| L18 | 1902  | (H01L27/11524<br>H01L27/11529<br>H01L27/1157).cpc. AND<br>(H01L27/11551).CPC.                                                       | (US-PGPUB ; USPAT ;<br>USOCR ; FPRS ; EPO<br>; JPO ; DERWENT ;<br>IBM_TDB) | OR | ON | ON | 2021/03/16<br>05:03 PM |
| L19 | 1701  | 18 NOT ("2021" "2020"<br>"2019").ay.                                                                                                | (US-PGPUB ; USPAT ;<br>USOCR ; FPRS ; EPO<br>; JPO ; DERWENT ;<br>IBM_TDB) | OR | ON | ON | 2021/03/16<br>05:03 PM |
| L24 | 9433  | (H01L27/11514<br>H01L27/11551<br>H01L27/11578<br>H01L27/11597).CPC.                                                                 | (US-PGPUB ; USPAT ;<br>USOCR ; FPRS ; EPO<br>; JPO ; DERWENT ;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>01:03 PM |
| L25 | 3724  | 24 AND (stair-case<br>staircase stair-step<br>stairstep (stair ADJ<br>case) (stair ADJ step)<br>NAND)                               | (US-PGPUB ; USPAT ;<br>USOCR ; FPRS ; EPO<br>; JPO ; DERWENT ;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>01:03 PM |
| L26 | 3306  | 25 NOT ("2021" "2020"<br>"2019").ay.                                                                                                | (US-PGPUB ; USPAT ;<br>USOCR ; FPRS ; EPO<br>; JPO ; DERWENT ;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>01:03 PM |
| L27 | 25057 | (H01L27/11509<br>H01L27/11512<br>H01L27/11526<br>H01L27/11529<br>H01L27/11573<br>H01L27/11575<br>H01L27/11592<br>H01L27/11595).CPC. | (US-PGPUB ; USPAT ;<br>USOCR ; FPRS ; EPO<br>; JPO ; DERWENT ;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>01:03 PM |
| L28 | 7466  | 27 AND (stair-case<br>staircase stair-step<br>stairstep (stair ADJ<br>case) (stair ADJ step)<br>NAND)                               | (US-PGPUB ; USPAT ;<br>USOCR ; FPRS ; EPO<br>; JPO ; DERWENT ;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>01:03 PM |
| L29 | 6230  | 28 NOT ("2021" "2020"<br>"2019").ay.                                                                                                | (US-PGPUB ; USPAT ;<br>USOCR ; FPRS ; EPO<br>; JPO ; DERWENT ;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>01:03 PM |
| L30 | 722   | 24 AND (stair-case<br>staircase stair-step<br>stairstep (stair ADJ<br>case) (stair ADJ step))                                       | (US-PGPUB ; USPAT ;<br>USOCR ; FPRS ; EPO<br>; JPO ; DERWENT ;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>01:03 PM |

|     |      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                   |    |    |    |                     |
|-----|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|----|----|----|---------------------|
| L31 | 1935 | 27 AND (stair-case staircase stair-step stairstep (stair ADJ case) (stair ADJ step))                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | (US-PGPUB ; USPAT ; USOCR ; FPRS ; EPO ; JPO ; DERWENT ; IBM_TDB) | OR | ON | ON | 2021/03/17 01:03 PM |
| L32 | 2256 | 30 OR 31                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | (US-PGPUB ; USPAT ; USOCR ; FPRS ; EPO ; JPO ; DERWENT ; IBM_TDB) | OR | ON | ON | 2021/03/17 01:03 PM |
| L33 | 1653 | 32 NOT ("2021" "2020" "2019").ay.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | (US-PGPUB ; USPAT ; USOCR ; FPRS ; EPO ; JPO ; DERWENT ; IBM_TDB) | OR | ON | ON | 2021/03/17 01:03 PM |
| L34 | 18   | ("20070134817"   "20080121953"   "20090317978").pn. OR ("8304348").urpn. AND (PGPB   USPT   USOC).dbnm.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | (US-PGPUB ; USPAT ; USOCR)                                        | OR | ON | ON | 2021/03/17 01:03 PM |
| L35 | 36   | ("7799672"   "7847334"   "7910432"   "7989880"   "8304348"   "8822322"   "8890229"   "8912593"   "9362303"   "9633945"   "9911753"   "20070252201"   "20090230458"   "20090242968"   "20100059811"   "20100207240"   "20110031546"   "20120052674"   "20120112171"   "20120171861"   "20120184078"   "20120211821"   "20130062683"   "20130087846"   "20130130468"   "20130248965"   "20140054787"   "20140061776"   "20150061068"   "20150194441"   "20150200199"   "20150255484"   "20170098659"   "20170141122"   "20170207236").pn. OR ("10002880").urpn. AND (PGPB   USPT   USOC).dbnm. | (US-PGPUB ; USPAT ; USOCR)                                        | OR | ON | ON | 2021/03/17 01:03 PM |

|     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                              |                               |    |    |    |                        |
|-----|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|----|----|----|------------------------|
| L36 | 26 | ("5619071"   "6028363"<br>"6271083"   "6455412"<br>"6841442"   "7511349"<br>"7679133"   "8039828"<br>"8119503"   "8178917"<br>"8304348"   "8409977"<br>"8541831"   "8553466"<br>"8559235"   "8654587"<br>"9373540"   "9577085"<br>"9711603"<br>"10103236"<br>"20020070457"  <br>"20070210348"  <br>"20100009531"  <br>"20110233648"  <br>"20130043509"  <br>"20150155296").pn. OR<br>("10608091").urpn. AND<br>(PGPB   USPT  <br>USOC).dbnm. | (US-PGPUB ; USPAT ;<br>USOCR) | OR | ON | ON | 2021/03/17<br>01:03 PM |
| L37 | 13 | ("7875922"   "8304348"<br>"8314455"   "8324680"<br>"8378409"   "8461566"<br>"8659944"<br>"20120108048"  <br>"20120146122"  <br>"20120168858"  <br>"20130043509"  <br>"20130130468").pn. OR<br>("9362226").urpn. AND<br>(PGPB   USPT  <br>USOC).dbnm.                                                                                                                                                                                         | (US-PGPUB ; USPAT ;<br>USOCR) | OR | ON | ON | 2021/03/17<br>01:03 PM |
| L39 | 10 | ("8304348"  <br>"20110031630"  <br>"20130127011"  <br>"20150255386").pn. OR<br>("9373540").urpn. AND<br>(PGPB   USPT  <br>USOC).dbnm.                                                                                                                                                                                                                                                                                                        | (US-PGPUB ; USPAT ;<br>USOCR) | OR | ON | ON | 2021/03/17<br>02:03 PM |
| L40 | 27 | ("5619071"   "6271083"<br>"6455412"   "6841442"<br>"7511349"   "7679133"<br>"8039828"   "8119503"<br>"8409977"   "8553466"<br>"8559235"   "8654587"<br>"20020070457"  <br>"20100009531"  <br>"20110233648"  <br>"20130043509"  <br>"20150155296").pn. OR<br>("9711603").urpn. AND<br>(PGPB   USPT  <br>USOC).dbnm.                                                                                                                           | (US-PGPUB ; USPAT ;<br>USOCR) | OR | ON | ON | 2021/03/17<br>02:03 PM |
| L42 | 5  | ("8193571"   "8313998"<br>"9373540"  <br>"20130234232"  <br>"20140054789").pn. OR<br>("10707227").urpn. AND<br>(PGPB   USPT  <br>USOC).dbnm.                                                                                                                                                                                                                                                                                                 | (US-PGPUB ; USPAT ;<br>USOCR) | OR | ON | ON | 2021/03/17<br>02:03 PM |

|     |      |                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                            |    |    |    |                        |
|-----|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|----|----|----|------------------------|
| L43 | 13   | ("9202780"   "9343452"<br>"9355913"   "9373540"<br>"9640542"   "9768193"<br>"9831180"   "9871053"<br>"20110031630"  <br>"20150255385"  <br>"20170271256"  <br>"20180026046"  <br>"20180166380").pn. OR<br>("10763167").urpn. AND<br>(PGPB   USPT  <br>USOC).dbnm.                                                                                                                                        | (US-PGPUB ; USPAT ;<br>USOCR)                                              | OR | ON | ON | 2021/03/17<br>02:03 PM |
| L44 | 21   | ("6424044"   "6764901"<br>"7170126"   "7183222"<br>"7855457"   "7989880"<br>"8704288"   "9305830"<br>"9305935"   "9419013"<br>"9711603"  <br>"20120070944"  <br>"20130313627"  <br>"20140054789"  <br>"20150054170"  <br>"20150255484"  <br>"20160056165"  <br>"20160343821"  <br>"20170077026"  <br>"20170117222"  <br>"20170278859").pn. OR<br>("10395982").urpn. AND<br>(PGPB   USPT  <br>USOC).dbnm. | (US-PGPUB ; USPAT ;<br>USOCR)                                              | OR | ON | ON | 2021/03/17<br>02:03 PM |
| L47 | 1    | "10134672".pn.                                                                                                                                                                                                                                                                                                                                                                                           | (USPAT)                                                                    | OR | ON | ON | 2021/03/17<br>02:03 PM |
| L48 | 16   | ("7847334"   "8592890"<br>"9184177"   "9853048"<br>"20080073635"  <br>"20100207240"  <br>"20110156132"  <br>"20120077320"  <br>"20120119287"  <br>"20120322252"  <br>"20140264925"  <br>"20140377934"  <br>"20160071861"  <br>"20160133568"  <br>"20160204102"  <br>"20160268269").pn. OR<br>("10134672").urpn. AND<br>(PGPB   USPT  <br>USOC).dbnm.                                                     | (US-PGPUB ; USPAT ;<br>USOCR)                                              | OR | ON | ON | 2021/03/17<br>02:03 PM |
| L49 | 1    | "10297543".pn.                                                                                                                                                                                                                                                                                                                                                                                           | (USPAT)                                                                    | OR | ON | ON | 2021/03/17<br>02:03 PM |
| L50 | 3    | ("9202780"  <br>"20150255385"  <br>"20160079257").pn. OR<br>("10297543").urpn. AND<br>(PGPB   USPT  <br>USOC).dbnm.                                                                                                                                                                                                                                                                                      | (US-PGPUB ; USPAT ;<br>USOCR)                                              | OR | ON | ON | 2021/03/17<br>02:03 PM |
| L51 | 1264 | L24 AND (pad<br>(interlayer ADJ<br>conductor) landing)                                                                                                                                                                                                                                                                                                                                                   | (US-PGPUB ; USPAT ;<br>USOCR ; FPRS ; EPO<br>; JPO ; DERWENT ;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>02:03 PM |
| L52 | 4376 | L27 AND (pad<br>(interlayer ADJ<br>conductor) landing)                                                                                                                                                                                                                                                                                                                                                   | (US-PGPUB ; USPAT ;<br>USOCR ; FPRS ; EPO<br>; JPO ; DERWENT ;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>02:03 PM |

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|-----|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|----|----|----|---------------------|
| L53 | 952 | (51 OR 52) AND (stair-case staircase stair-step stairstep (stair ADJ case) (stair ADJ step))                                                                                                                                                                                                                                                                                                                                                                                                                                                    | (US-PGPUB ; USPAT ; USOCR ; FPRS ; EPO ; JPO ; DERWENT ; IBM_TDB) | OR | ON | ON | 2021/03/17 02:03 PM |
| L54 | 613 | 53 NOT ("2021" "2020" "2019").ay.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | (US-PGPUB ; USPAT ; USOCR ; FPRS ; EPO ; JPO ; DERWENT ; IBM_TDB) | OR | ON | ON | 2021/03/17 02:03 PM |
| L55 | 2   | ("20130234232"   "20150255385").pn. OR ("9941153").urpn. AND (PGPB   USPT   USOC).dbnm.                                                                                                                                                                                                                                                                                                                                                                                                                                                         | (US-PGPUB ; USPAT ; USOCR)                                        | OR | ON | ON | 2021/03/17 03:03 PM |
| L56 | 1   | "9941153".pn.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | (USPAT)                                                           | OR | ON | ON | 2021/03/17 03:03 PM |
| L57 | 31  | ("6258648"   "8975609"   "20050263824"   "20090100388"   "20090230449"   "20090242967"   "20100193861"   "20100207240"   "20100232224"   "20110031547"   "20110031630"   "20120001249"   "20120119283"   "20120119287"   "20120238093"   "20130005136"   "20130056818"   "20130161731"   "20130334589"   "20140054789"   "20140327093"   "20150221667"   "20160005759"   "20160064041"   "20160071861"   "20160071876"   "20160086964"   "20160111438"   "20160126248"   "20160133630").pn. OR ("9520402").urpn. AND (PGPB   USPT   USOC).dbnm. | (US-PGPUB ; USPAT ; USOCR)                                        | OR | ON | ON | 2021/03/17 03:03 PM |
| L58 | 3   | ("9716105"   "9960181"   "20160365352").pn. OR ("10608010").urpn. AND (PGPB   USPT   USOC).dbnm.                                                                                                                                                                                                                                                                                                                                                                                                                                                | (US-PGPUB ; USPAT ; USOCR)                                        | OR | ON | ON | 2021/03/17 03:03 PM |

|     |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                               |    |    |    |                        |
|-----|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|----|----|----|------------------------|
| L59 | 232 | ("3708728"<br>"4058430"<br>"4389973"<br>"4747367"<br>"4767494"<br>"4935661"<br>"5166092"<br>"5270247"<br>"5306666"<br>"5342652"<br>"5595784"<br>"5618395"<br>"5693139"<br>"5723384"<br>"5769950"<br>"5855680"<br>"5946598"<br>"5964943"<br>"5972430"<br>"6006763"<br>"6087257"<br>"6104074"<br>"6124158"<br>"6139700"<br>"6156382"<br>"6162501"<br>"6188134"<br>"6200389"<br>"6206967"<br>"6270572"<br>"6287965"<br>"6355561"<br>"6391785"<br>"6416577"<br>"6475276"<br>"6482733"<br>"6511539"<br>"6576053"<br>"6599572"<br>"6616982"<br>"6652924"<br>"6727169"<br>"6794287"<br>"6800383"<br>"6809026"<br>"6827978"<br>"6863727"<br>"6986914"<br>"7045406"<br>"7115534"<br>"7138336"<br>"7211508"<br>"7329590"<br>"7410666"<br>"7611751"<br>"7776396"<br>"7824492"<br>"9111746"<br>"9243324"<br>"9455138"<br>"9786491"<br>"10424477"<br>"10453675"<br>"20010004479"<br>"20010005546"<br>"20010024387"<br>"20010034097"<br>"20010041250"<br>"20020004293"<br>"20020104481" | "3925337"<br>"4282267"<br>"4565747"<br>"4761269"<br>"4851095"<br>"5071670"<br>"5221556"<br>"5281274"<br>"5316793"<br>"5482262"<br>"5603771"<br>"5691235"<br>"5711811"<br>"5744254"<br>"5789024"<br>"5916365"<br>"5947710"<br>"5965004"<br>"5973400"<br>"6015590"<br>"6099904"<br>"6113977"<br>"6139624"<br>"6144060"<br>"6159871"<br>"6174809"<br>"6194310"<br>"6203613"<br>"6234646"<br>"6284646"<br>"6342277"<br>"6380627"<br>"6410462"<br>"6464779"<br>"6482262"<br>"6482740"<br>"6534395"<br>"6583048"<br>"6613383"<br>"6632595"<br>"6706115"<br>"6780704"<br>"6797340"<br>"6800552"<br>"6821889"<br>"6833161"<br>"6902763"<br>"7015153"<br>"7074690"<br>"7115974"<br>"7211144"<br>"7268078"<br>"7405158"<br>"7416981"<br>"7749871"<br>"7794798"<br>"8217446"<br>"9171736"<br>"9425038"<br>"9784695"<br>"9786492" | (US-PGPUB ; USPAT ;<br>USOCR) | OR | ON | ON | 2021/03/17<br>04:03 PM |
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|  |  | "20030015764" |  |  |  |  |  |
|  |  | "20030026989" |  |  |  |  |  |
|  |  | "20030031793" |  |  |  |  |  |
|  |  | "20030049931" |  |  |  |  |  |
|  |  | "20030072975" |  |  |  |  |  |
|  |  | "20030082296" |  |  |  |  |  |
|  |  | "20030104126" |  |  |  |  |  |
|  |  | "20030119305" |  |  |  |  |  |
|  |  | "20030123216" |  |  |  |  |  |
|  |  | "20030127043" |  |  |  |  |  |
|  |  | "20030153181" |  |  |  |  |  |
|  |  | "20030157760" |  |  |  |  |  |
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|  |  | "20030203616" |  |  |  |  |  |
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|  |  | "20040238876" |  |  |  |  |  |
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|  |  | "20050271813" |  |  |  |  |  |
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|  |  | "20060079090" |  |  |  |  |  |
|  |  | "20060079099" |  |  |  |  |  |
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|  |  | "20060223300" |  |  |  |  |  |
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|  |  | "20070148350" |  |  |  |  |  |
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|  |  | "20070251444" |  |  |  |  |  |
|  |  | "20080102204" |  |  |  |  |  |
|  |  | "20080102613" |  |  |  |  |  |
|  |  | "20080113110" |  |  |  |  |  |
|  |  | "20080182411" |  |  |  |  |  |
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|  |  | "20090081868" |  |  |  |  |  |
|  |  | "20090104791" |  |  |  |  |  |
|  |  | "20090211526" |  |  |  |  |  |
|  |  | "20090315093" |  |  |  |  |  |
|  |  | "20100092781" |  |  |  |  |  |
|  |  | "20100148903" |  |  |  |  |  |
|  |  | "20100239742" |  |  |  |  |  |
|  |  | "20100297545" |  |  |  |  |  |
|  |  | "20110159202" |  |  |  |  |  |
|  |  | "20110262642" |  |  |  |  |  |
|  |  | "20110278533" |  |  |  |  |  |
|  |  | "20120003831" |  |  |  |  |  |
|  |  | "20120119283" |  |  |  |  |  |
|  |  | "20120141770" |  |  |  |  |  |
|  |  | "20120208347" |  |  |  |  |  |
|  |  | "20120269962" |  |  |  |  |  |
|  |  | "20130078454" |  |  |  |  |  |
|  |  | "20130112605" |  |  |  |  |  |
|  |  | "20130115763" |  |  |  |  |  |
|  |  | "20130134372" |  |  |  |  |  |
|  |  | "20130196082" |  |  |  |  |  |
|  |  | "20130330935" |  |  |  |  |  |
|  |  | "20140030432" |  |  |  |  |  |

|     |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                   |    |    |    |                     |
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|     |     | "20140048131"<br>"20140272194"<br>"20140295109"<br>"20140302267"<br>"20140349107"<br>"20140367764"<br>"20150087156"<br>"20150118865"<br>"20150214103"<br>"20150217240"<br>"20150217330"<br>"20150275355"<br>"20150303056"<br>"20150303101"<br>"20150376211"<br>"20160064281"<br>"20160093485"<br>"20160225616"<br>"20160336338"<br>"20170140924"<br>"20170213726"<br>"20170309476"<br>"20170323782"<br>"20170352680"<br>"20170365462"<br>"20180005814"<br>"20180013078"<br>"20180122742"<br>"20180151355"<br>"20180182618"<br>"20180350587").pn. OR<br>("10847529").urpn. AND<br>(PGPB   USPT  <br>USOC).dbnm. |                                                                   |    |    |    |                     |
| L61 | 122 | 59 AND (stair-case staircase stair-step stairstep (stair ADJ case) (stair ADJ step) nand memory)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | (US-PGPUB ; USPAT ; USOCR ; FPRS ; EPO ; JPO ; DERWENT ; IBM_TDB) | OR | ON | ON | 2021/03/17 04:03 PM |
| L62 | 7   | 61 AND (pad (interlayer ADJ conductor) landing)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | (US-PGPUB ; USPAT ; USOCR ; FPRS ; EPO ; JPO ; DERWENT ; IBM_TDB) | OR | ON | ON | 2021/03/17 04:03 PM |
| L63 | 24  | 59 AND (pad (interlayer ADJ conductor) landing)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | (US-PGPUB ; USPAT ; USOCR ; FPRS ; EPO ; JPO ; DERWENT ; IBM_TDB) | OR | ON | ON | 2021/03/17 04:03 PM |
| L64 | 710 | L26 AND (pad (interlayer ADJ conductor) landing)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | (US-PGPUB ; USPAT ; USOCR ; FPRS ; EPO ; JPO ; DERWENT ; IBM_TDB) | OR | ON | ON | 2021/03/17 04:03 PM |
| L65 | 16  | ("20110031630"<br>"10002880" "9343452"<br>"9362226"<br>"20130043509"<br>"9373540" "9711603"<br>"10395982"<br>"20170271256"<br>"20180166380"<br>"9941153" "9520402"<br>"20130056818"<br>"20190280001"<br>"20180301460"<br>"20190006385").PN.                                                                                                                                                                                                                                                                                                                                                                    | (US-PGPUB ; USPAT)                                                | OR | ON | ON | 2021/03/17 04:03 PM |

|     |    |                                                                                                                                                                          |                    |    |    |    |                        |
|-----|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|----|----|----|------------------------|
| L74 | 11 | ("20130043509"<br>"9711603" "10395982"<br>"20170271256"<br>"20180166380"<br>"9941153" "9520402"<br>"20130056818"<br>"20190280001"<br>"20180301460"<br>"20190006385").PN. | (US-PGPUB ; USPAT) | OR | ON | ON | 2021/03/18<br>02:03 PM |
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#### PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

Receipt date: 05/28/2020

16/885,858 - GAU: 2812

Equivalent of Form PTO/SB/08a (07-09)

|                                                                                                                                          |   |    |                          |                                       |              |
|------------------------------------------------------------------------------------------------------------------------------------------|---|----|--------------------------|---------------------------------------|--------------|
| Substitute for form 1449/PTO<br><br><b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br><i>(Use as many sheets as necessary)</i> |   |    | <b>Complete if Known</b> |                                       |              |
|                                                                                                                                          |   |    | Application Number       | <del>To Be Assigned</del>             |              |
|                                                                                                                                          |   |    | Filing Date              | Herewith                              |              |
|                                                                                                                                          |   |    | First Named Inventor     | Zhenyu LU                             |              |
|                                                                                                                                          |   |    | Art Unit                 | <del>To Be Assigned</del>             |              |
|                                                                                                                                          |   |    | Examiner Name            | <del>To Be Assigned</del> Scott Geyer |              |
| Sheet                                                                                                                                    | 1 | of | 1                        | Attorney Docket Number                | 4123.0460003 |

| U.S. PATENT DOCUMENTS |                       |                                          |                                |                                                    |                                                                              |
|-----------------------|-----------------------|------------------------------------------|--------------------------------|----------------------------------------------------|------------------------------------------------------------------------------|
| Examiner initials*    | Cite No. <sup>1</sup> | Document Number                          | Publication Date<br>MM-DD-YYYY | Name of Patentee or<br>Applicant of Cited Document | Pages, Columns, Lines, Where<br>Relevant Passages or Relevant Figures Appear |
|                       |                       | Number-Kind Code <sup>2</sup> (if known) |                                |                                                    |                                                                              |
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|                       | US17                  |                                          |                                |                                                    |                                                                              |
|                       | US18                  |                                          |                                |                                                    |                                                                              |
|                       | US19                  |                                          |                                |                                                    |                                                                              |
|                       | US20                  |                                          |                                |                                                    |                                                                              |

| FOREIGN PATENT DOCUMENTS |                       |                                                                                       |                                |                                                    |                                                                              |                |
|--------------------------|-----------------------|---------------------------------------------------------------------------------------|--------------------------------|----------------------------------------------------|------------------------------------------------------------------------------|----------------|
| Examiner initials*       | Cite No. <sup>1</sup> | Foreign Patent Document                                                               | Publication Date<br>MM-DD-YYYY | Name of Patentee or<br>Applicant of Cited Document | Pages, Columns, Lines, Where Relevant Passages or<br>Relevant Figures Appear | T <sup>6</sup> |
|                          |                       | Country Code <sup>3</sup> -Number <sup>4</sup> -<br>Kind Code <sup>5</sup> (if known) |                                |                                                    |                                                                              |                |
| /SG/                     | FP1                   | CN 106601746 A                                                                        | 04-26-2017                     | Samsung Electronics Co Ltd                         |                                                                              |                |
| /SG/                     | FP2                   | CN 107644876 A                                                                        | 01-30-2018                     | Yangtze Memory Tech Co Ltd                         |                                                                              |                |
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|                          | FP4                   |                                                                                       |                                |                                                    |                                                                              |                |
|                          | FP5                   |                                                                                       |                                |                                                    |                                                                              |                |
|                          | FP6                   |                                                                                       |                                |                                                    |                                                                              |                |
|                          | FP7                   |                                                                                       |                                |                                                    |                                                                              |                |
|                          | FP8                   |                                                                                       |                                |                                                    |                                                                              |                |

|                    |                 |                 |            |
|--------------------|-----------------|-----------------|------------|
| Examiner Signature | /SCOTT B GEYER/ | Date Considered | 03/16/2021 |
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Receipt date: 05/28/2020

16/885,858 - GAU: 2812

Equivalent of Form PTO/SB/08b (7-09)

|                                                                                                      |   |    |   |                          |                                       |
|------------------------------------------------------------------------------------------------------|---|----|---|--------------------------|---------------------------------------|
| Substitute for form 1449/PTO                                                                         |   |    |   | <b>Complete if Known</b> |                                       |
| <b>INFORMATION DISCLOSURE<br/>STATEMENT BY APPLICANT</b><br><i>(Use as many sheets as necessary)</i> |   |    |   | Application Number       | <del>To Be Assigned</del>             |
|                                                                                                      |   |    |   | Filing Date              | Herewith                              |
|                                                                                                      |   |    |   | First Named Inventor     | Zhenyu LU                             |
|                                                                                                      |   |    |   | Art Unit                 | <del>To Be Assigned</del>             |
|                                                                                                      |   |    |   | Examiner Name            | <del>To Be Assigned</del> Scott Geyer |
| Sheet                                                                                                | 1 | of | 1 | Attorney Docket Number   | 4123.0460003                          |

| NON PATENT LITERATURE DOCUMENTS |                       |                                                                                                                                                                                                                                                                |                |
|---------------------------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Examiner Initials*              | Cite No. <sup>1</sup> | 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, page(s), volume-issue number(s), publisher, city and/or country where published | T <sup>2</sup> |
| /SG/                            | NPL1                  | International Search Report and Written Opinion of the International Searching Authority directed to related International Patent Application No. PCT/CN2018/098962, mailed November 7, 2018; 8 pages.                                                         |                |
|                                 | NPL2                  |                                                                                                                                                                                                                                                                |                |
|                                 | NPL3                  |                                                                                                                                                                                                                                                                |                |
|                                 | NPL4                  |                                                                                                                                                                                                                                                                |                |
|                                 | NPL5                  |                                                                                                                                                                                                                                                                |                |
|                                 | NPL6                  |                                                                                                                                                                                                                                                                |                |
|                                 | NPL7                  |                                                                                                                                                                                                                                                                |                |
|                                 | NPL8                  |                                                                                                                                                                                                                                                                |                |
|                                 | NPL9                  |                                                                                                                                                                                                                                                                |                |
|                                 | NPL10                 |                                                                                                                                                                                                                                                                |                |

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|                    |                 |                 |            |
|--------------------|-----------------|-----------------|------------|
| Examiner Signature | /SCOTT B GEYER/ | Date Considered | 03/16/2021 |
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<sup>1</sup> Applicant's unique citation designation number (optional). <sup>2</sup> Applicant is to place a check mark here if English language Translation is attached.

## Bibliographic Data

Application No: 16/885,858

Foreign Priority claimed: ☒ Yes ☐ No

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

Verified and Acknowledged: /SCOTT B GEYER/

Examiner's Signature

Initials

Title:

STAIRCASE STRUCTURE FOR MEMORY DEVICE

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| FILING or 371(c) DATE | CLASS | GROUP ART UNIT | ATTORNEY DOCKET NO. |
|-----------------------|-------|----------------|---------------------|
| 05/28/2020            | 257   | 2812           | 4123.0460003        |
| RULE                  |       |                |                     |

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### CONTINUING DATA

This application is a CON of 16126956 09/10/2018 PAT 10680003

16126956 is a CON of PCT/CN2018/098962 08/06/2018

### FOREIGN APPLICATIONS

CHINA CN201710750398.4 08/28/2017

### IF REQUIRED, FOREIGN LICENSE GRANTED\*\*

06/05/2020

### STATE OR COUNTRY

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WASHINGTON, DC 20005  
UNITED STATES

**FILING FEE RECEIVED**

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| PATENT APPLICATION FEE DETERMINATION RECORD                                                                                     |                                                                                          |                                                                                                                                                                                                                               |                            | Application or Docket Number<br>16/885,858 |               | Filing Date<br>05/28/2020 |  | <input type="checkbox"/> To be Mailed |  |
|---------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|--------------------------------------------|---------------|---------------------------|--|---------------------------------------|--|
| Substitute for Form PTO-875                                                                                                     |                                                                                          |                                                                                                                                                                                                                               |                            |                                            |               |                           |  |                                       |  |
| ENTITY: <input checked="" type="checkbox"/> LARGE <input type="checkbox"/> SMALL <input type="checkbox"/> MICRO                 |                                                                                          |                                                                                                                                                                                                                               |                            |                                            |               |                           |  |                                       |  |
| APPLICATION AS FILED - PART I                                                                                                   |                                                                                          |                                                                                                                                                                                                                               |                            |                                            |               |                           |  |                                       |  |
| FOR                                                                                                                             |                                                                                          | (Column 1)<br>NUMBER FILED                                                                                                                                                                                                    | (Column 2)<br>NUMBER EXTRA |                                            |               | RATE (\$)                 |  | FEE (\$)                              |  |
| <input type="checkbox"/> BASIC FEE<br>(37 CFR 1.16(a), (b), or (c))                                                             |                                                                                          | N/A                                                                                                                                                                                                                           | N/A                        |                                            |               | N/A                       |  |                                       |  |
| <input type="checkbox"/> SEARCH FEE<br>(37 CFR 1.16(k), (l), or (m))                                                            |                                                                                          | N/A                                                                                                                                                                                                                           | N/A                        |                                            |               | N/A                       |  |                                       |  |
| <input type="checkbox"/> EXAMINATION FEE<br>(37 CFR 1.16(o), (p), or (q))                                                       |                                                                                          | N/A                                                                                                                                                                                                                           | N/A                        |                                            |               | N/A                       |  |                                       |  |
| TOTAL CLAIMS<br>(37 CFR 1.16(i))                                                                                                |                                                                                          | minus 20 =                                                                                                                                                                                                                    | *                          |                                            |               | x \$100 =                 |  |                                       |  |
| INDEPENDENT CLAIMS<br>(37 CFR 1.16(h))                                                                                          |                                                                                          | minus 3 =                                                                                                                                                                                                                     | *                          |                                            |               | x \$460 =                 |  |                                       |  |
| <input type="checkbox"/> APPLICATION SIZE FEE (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). |                            |                                            |               |                           |  |                                       |  |
| <input type="checkbox"/> MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))                                                      |                                                                                          |                                                                                                                                                                                                                               |                            |                                            |               |                           |  |                                       |  |
| * If the difference in column 1 is less than zero, enter "0" in column 2.                                                       |                                                                                          |                                                                                                                                                                                                                               |                            |                                            |               | TOTAL                     |  |                                       |  |
| APPLICATION AS AMENDED - PART II                                                                                                |                                                                                          |                                                                                                                                                                                                                               |                            |                                            |               |                           |  |                                       |  |
| AMENDMENT                                                                                                                       | 06/02/2021                                                                               | CLAIMS REMAINING AFTER AMENDMENT                                                                                                                                                                                              |                            | HIGHEST NUMBER PREVIOUSLY PAID FOR         | PRESENT EXTRA | RATE (\$)                 |  | ADDITIONAL FEE (\$)                   |  |
|                                                                                                                                 | Total<br>(37 CFR 1.16(i))                                                                | * 20                                                                                                                                                                                                                          | Minus                      | ** 20                                      | = 0           | x \$100 =                 |  | 0                                     |  |
|                                                                                                                                 | Independent<br>(37 CFR 1.16(h))                                                          | * 3                                                                                                                                                                                                                           | Minus                      | *** 3                                      | = 0           | x \$480 =                 |  | 0                                     |  |
|                                                                                                                                 | <input type="checkbox"/> Application Size Fee (37 CFR 1.16(s))                           |                                                                                                                                                                                                                               |                            |                                            |               |                           |  |                                       |  |
|                                                                                                                                 | <input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) |                                                                                                                                                                                                                               |                            |                                            |               |                           |  |                                       |  |
|                                                                                                                                 |                                                                                          |                                                                                                                                                                                                                               |                            |                                            |               | TOTAL ADD'L FEE           |  | 0                                     |  |
| AMENDMENT                                                                                                                       |                                                                                          | CLAIMS REMAINING AFTER AMENDMENT                                                                                                                                                                                              |                            | HIGHEST NUMBER PREVIOUSLY PAID FOR         | PRESENT EXTRA | RATE (\$)                 |  | ADDITIONAL FEE (\$)                   |  |
|                                                                                                                                 | Total<br>(37 CFR 1.16(i))                                                                | *                                                                                                                                                                                                                             | Minus                      | **                                         | =             | x \$0 =                   |  |                                       |  |
|                                                                                                                                 | Independent<br>(37 CFR 1.16(h))                                                          | *                                                                                                                                                                                                                             | Minus                      | ***                                        | =             | x \$0 =                   |  |                                       |  |
|                                                                                                                                 | <input type="checkbox"/> Application Size Fee (37 CFR 1.16(s))                           |                                                                                                                                                                                                                               |                            |                                            |               |                           |  |                                       |  |
|                                                                                                                                 | <input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j)) |                                                                                                                                                                                                                               |                            |                                            |               |                           |  |                                       |  |
|                                                                                                                                 |                                                                                          |                                                                                                                                                                                                                               |                            |                                            |               | TOTAL ADD'L FEE           |  |                                       |  |
| * If the entry in column 1 is less than the entry in column 2, write "0" in column 3.                                           |                                                                                          |                                                                                                                                                                                                                               |                            |                                            |               | LIE                       |  |                                       |  |
| ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".                                       |                                                                                          |                                                                                                                                                                                                                               |                            |                                            |               | /JERMAINE D MINOR/        |  |                                       |  |
| *** 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 number found in the appropriate box in column 1. |                                                                                          |                                                                                                                                                                                                                               |                            |                                            |               |                           |  |                                       |  |

This collection of information is required by 37 CFR 1.16. 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 12 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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor: Zhenyu LU

Applicant: Yangtze Memory Technologies  
Co., Ltd.

Application No.: 16/885,858

Filed: May 28, 2020

Title: **STAIRCASE STRUCTURE FOR MEMORY DEVICE**

Confirmation No.: 1041

Art Unit: 2812

Examiner: Scott B. Geyer

Atty. Docket: 4123.0460003

**Amendment and Reply Under 37 C.F.R. § 1.111**

**Mail Stop Amendment**

Commissioner for Patents  
PO Box 1450  
Alexandria, VA 22313-1450

Commissioner:

In reply to the Office Action dated March 23, 2021 (“Office Action”), Applicant submits the following Amendment and Remarks.

It is not believed that extensions of time are required beyond those that may otherwise be provided for in documents accompanying this paper. However, if additional extensions of time are necessary to prevent abandonment of this application, then such extensions of time are hereby petitioned under 37 C.F.R. § 1.136(a), and any additional fees required to continue prosecution or appeal of this application (including issue fee, fees for net addition of claims or forwarding to appeal) are hereby authorized to be charged to our Deposit Account No. 19-0036.

### Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application.

1. (Currently Amended) A semiconductor structure, comprising:  
a substrate; and  
a staircase structure disposed over the substrate, wherein the staircase structure comprises:  
a plurality of layer stacks, each layer stack comprising a first material layer and a second material layer, wherein the first material layer is disposed over a first portion of the second material layer; and  
a plurality of landing pads respectively disposed on the plurality of layer stacks, wherein each landing pad is disposed over a second portion of the second material layer of a respective layer stack of the plurality of layer stacks, and wherein the each landing pad comprises:  
a bottom surface ~~substantially coplanar with another bottom surface of the first material layer of the respective layer stack;~~ and  
a top surface opposite to the bottom surface, wherein the top surface is above an other top surface of the first material layer of the respective layer stack.
2. (Original) The semiconductor structure of claim 1, wherein each of the plurality of landing pads comprises a first side surface and a second side surface, wherein the first side surface is in contact with the first material layer of the respective layer stack, and wherein the second side surface is laterally displaced from a third side surface of the second portion of the second material layer of the respective layer stack.
3. (Currently Amended) The semiconductor structure of claim 1, ~~wherein each of the plurality of landing pads further comprises a top surface opposite to the bottom surface,~~ wherein the top surface is laterally displaced and vertically above ~~another~~ the other top surface of the first material layer of the respective layer stack.

Atty. Dkt. No. 4123.0460003

4. (Original) The semiconductor structure of claim 1, wherein the second material layer comprises a first conductive material, and wherein each of the plurality of landing pads comprises a second conductive material.
5. (Original) The semiconductor structure of claim 1, wherein a top surface of the each landing pad comprises a conductive material, and wherein the first material layer comprises an insulating material.
6. (Cancelled)
7. (Original) The semiconductor structure of claim 1, wherein the second material layer of a layer stack of the plurality of layer stacks is disposed over a first portion of the first material layer of an adjacent layer stack of the plurality of layer stacks, wherein a side surface of a second portion of the first material layer of the adjacent layer stack is laterally displaced from another side surface of the each landing pad.
8. (Original) The semiconductor structure of claim 1, wherein the each landing pad is thicker than the first material layer of the respective layer stack of the plurality of layer stacks.
9. (Original) A semiconductor structure, comprising:
  - a substrate; and
  - a staircase structure disposed over the substrate, wherein the staircase structure comprises:
    - a plurality of layer stacks, each layer stack comprising a first material layer and a second material layer, wherein the first material layer is disposed over a first portion of the second material layer; and
    - a plurality of landing pads respectively disposed on the plurality of layer stacks, wherein each landing pad is disposed over a second portion of the second material layer of a respective layer stack of the plurality of layer stacks, and wherein the each landing pad comprises a curved side surface and a substantially straight side surface, wherein the substantially straight side surface is laterally displaced from a side surface of the second portion of the second material layer.

10. (Original) The semiconductor structure of claim 9, wherein a lateral distance between an upper portion of the curved side surface and another side surface of the first material layer of the respective layer stack is greater than another lateral distance between a lower portion of the curved side surface and the other side surface of the first material layer of the respective layer stack.

11. (Original) The semiconductor structure of claim 9, wherein the curve side surface is laterally displaced from a top surface of the first portion of the second material layer and vertically above another top surface of the second portion of the second material layer.

12. (Original) The semiconductor structure of claim 9, wherein the second material layer comprises a first conductive material, and wherein each of the plurality of landing pads comprises a second conductive material.

13. (Original) The semiconductor structure of claim 9, wherein a top surface of the each landing pad comprises a conductive material.

14. (Original) The semiconductor structure of claim 13, wherein the conductive material comprises tungsten, silicide, nickel, titanium, platinum, aluminum, titanium nitride, tantalum nitride, tungsten nitride, or a combination thereof.

15. (Original) The semiconductor structure of claim 9, wherein the second material layer of a layer stack of the plurality of layer stacks is disposed over a first portion of the first material layer of an adjacent layer stack of the plurality of layer stacks, wherein a side surface of a second portion of the first material layer of the adjacent layer stack is laterally displaced from another side surface of the each landing pad.

16. (Original) The semiconductor structure of claim 9, wherein the each landing pad is thicker than the first material layer of the respective layer stack of the plurality of layer stacks.

17. (Original) A memory device, comprising:  
a substrate, wherein the substrate comprises a top surface;

a memory string disposed over the substrate; and  
a staircase structure disposed adjacent to the memory string, wherein the staircase structure comprises:

a plurality of layer stacks, each layer stack comprising an insulating layer disposed over a first portion of a conductive layer, wherein a second portion of the conductive layer comprises a curved side surface in contact with a side surface of the insulating layer.

18. (Currently Amended) The memory device of claim ~~[[18]]~~ 17, wherein an upper portion of the curved side surface is separated from the side surface of the insulating layer, and wherein a lower portion of the curved side surface is in contact with the side surface of the insulating layer.

19. (Original) The memory device of claim 17, wherein the conductive layer of a layer stack of the plurality of layer stacks is disposed over a first portion of the insulating layer of an adjacent layer stack of the plurality of layer stacks, wherein a second portion of the insulating layer of the adjacent layer stack is laterally displaced from the conductive layer of the layer stack.

20. (Original) The memory device of claim 17, wherein the conductive layer comprises a first conductive material, and wherein the curved side surface comprises a second conductive material.

21. (New) The semiconductor structure of claim 1, wherein the bottom surface is substantially coplanar with another bottom surface of the first material layer of the respective layer stack.

### **Remarks**

Reconsideration of this Application is respectfully requested.

Upon entry of the foregoing amendments, claims 1-5 and 7-21 are pending in the application, with claims 1, 9, and 17 being the independent claims. Claims 1, 3, and 18 are sought to be amended. Claim 6 is sought to be cancelled without prejudice to or disclaimer of the subject matter therein. New claim 21 is sought to be added. Exemplary support for the amended claims and the new claim can be found, *inter alia*, in Figs. 6-8 and ¶¶ [0049]-[0056] of the as-filed specification. These changes are believed to introduce no new matter, and their entry is respectfully requested.

Based on the following remarks, Applicant respectfully requests that the Examiner reconsider all outstanding objections and rejections and that they be withdrawn. Throughout the arguments, Applicant reminds the Examiner that the claims are given their broadest reasonable meaning in view of the specification, and any paraphrasing of the claim features is not to be interpreted as reading any features into, or characterizing of, the claims.

### **Claim Objection**

Claim 18 is objected to because of alleged informalities. Without acquiescing to the propriety of the objection, claim 18 has been amended to correct its dependency. Applicant respectfully requests that the objection be reconsidered and withdrawn.

### **Double Patenting**

Claims 1, 2, and 4-8 are rejected on the ground of nonstatutory double patenting as allegedly being unpatentable over claims 1 and 3-8 of U.S. Patent No. 10,680,003. Without acquiescing to the propriety of the rejection, claim 1 has been amended. Claims 2 and 4-8 depend from claim 1. Applicant respectfully requests that the rejection be reconsidered and withdrawn.

### **Objection to the Claim / Allowable Subject Matter**

Claim 3 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claims 9-20 are allowable.

Atty. Dkt. No. 4123.0460003

Applicant thanks the Examiner for indicating the allowable subject matter and the allowed claims.

As discussed above with regard to the double patenting rejection, claim 1 has been amended. Claim 3 depends from claim 1. Therefore, Applicant respectfully requests the objection of claim 3 be reconsidered and withdrawn.

Applicant notes the Examiner's statement of reasons for allowability presented on pages 5 and 6 of the Office Action. Applicant reserves the right to demonstrate claims 9-20 are allowable over the art made of record for further reasons related to any of their recited features. Applicant further contends that reservation of this right does not give rise to any implication regarding whether the Applicant agrees with or acquiesces in the reasoning provided by the Examiner.

**New Claim 21**

New claim 21 has been added. Claim 21 is allowable at least based on its dependency from claim 1 as well as for its own distinguishing features. Accordingly, Applicant respectfully requests that claim 21 be passed to allowance.

### Conclusion

All of the stated grounds of objection and rejection have been properly traversed, accommodated, or rendered moot. Applicant therefore respectfully requests that the Examiner reconsider all presently outstanding objections and rejections and that they be withdrawn. Applicant believes that a full and complete reply has been made to the outstanding Office Action and, as such, the present application is in condition for allowance. If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at the number provided.

Prompt and favorable consideration of this Amendment and Reply is respectfully requested.

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.

/Yuanfeng Gao/

Yuanfeng Gao  
Agent for Applicant  
Registration No. 79,573

Date: 2021/06/02

1100 New York Avenue, N.W.  
Washington, D.C. 20005-3934  
(202) 371-2600

16483811\_1

Atty. Dkt. No. 4123.0460003

| Electronic Acknowledgement Receipt          |                                       |
|---------------------------------------------|---------------------------------------|
| <b>EFS ID:</b>                              | 42871977                              |
| <b>Application Number:</b>                  | 16885858                              |
| <b>International Application Number:</b>    |                                       |
| <b>Confirmation Number:</b>                 | 1041                                  |
| <b>Title of Invention:</b>                  | STAIRCASE STRUCTURE FOR MEMORY DEVICE |
| <b>First Named Inventor/Applicant Name:</b> | Zhenyu LU                             |
| <b>Customer Number:</b>                     | 26111                                 |
| <b>Filer:</b>                               | Yuanfeng Gao/Catherine Saunders       |
| <b>Filer Authorized By:</b>                 | Yuanfeng Gao                          |
| <b>Attorney Docket Number:</b>              | 4123.0460003                          |
| <b>Receipt Date:</b>                        | 02-JUN-2021                           |
| <b>Filing Date:</b>                         | 28-MAY-2020                           |
| <b>Time Stamp:</b>                          | 13:48:32                              |
| <b>Application Type:</b>                    | Utility under 35 USC 111(a)           |

### Payment information:

| Submitted with Payment |                      | no                                        |                                          |                  |                  |
|------------------------|----------------------|-------------------------------------------|------------------------------------------|------------------|------------------|
| <b>File Listing:</b>   |                      |                                           |                                          |                  |                  |
| Document Number        | Document Description | File Name                                 | File Size(Bytes)/<br>Message Digest      | Multi Part /.zip | Pages (if appl.) |
| 1                      |                      | 2021-06-02-Filing-Bundle-4123-0460003.PDF | 225131                                   | yes              | 9                |
|                        |                      |                                           | 3523638de7b977a8d877b42a4b98cb0c02202a4e |                  |                  |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Multipart Description/PDF files in .zip description   |        |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|--------|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Document Description                                  | Start  | End |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Miscellaneous Incoming Letter                         | 1      | 1   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Amendment/Req. Reconsideration-After Non-Final Reject | 2      | 2   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Claims                                                | 3      | 6   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Applicant Arguments/Remarks Made in an Amendment      | 7      | 9   |
| Warnings:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                       |        |     |
| Information:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                       |        |     |
| Total Files Size (in bytes):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                       | 225131 |     |
| <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> |                                                       |        |     |

**YUANFENG GAO**  
PATENT AGENT  
202-772-8731  
YGAO@STERNEKESSLER.COM

June 2, 2021

Commissioner for Patents  
PO Box 1450  
Alexandria, VA 22313-1450

**Confirmation No. 1041**  
**Art Unit: 2812**  
**Mail Stop Amendment**

Re: U.S. Utility Patent Application  
Appl. No. 16/885,858; Filing Date: May 28, 2020  
For: **STAIRCASE STRUCTURE FOR MEMORY DEVICE**  
First Named Inventor: Zhenyu LU  
Our Ref.: 4123.0460003

Commissioner:

Transmitted herewith for appropriate action is a document entitled ***Amendment and Reply Under 37 C.F.R. § 1.111***, which is submitted electronically.

In the event that extensions of time are necessary to prevent abandonment of this patent application, then such extensions of time are hereby petitioned.

The U.S. Patent and Trademark Office hereby authorized to charge any fee deficiency and any additional fees required to continue prosecution or appeal of this application (including issue fees for net addition of claims or forwarding to appeal) or credit any overpayment to our Deposit Account No. 19-0036.

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.

/Yuanfeng Gao/

Yuanfeng Gao  
Agent for Applicant  
Registration No. 79,573

Y-G/cms  
Enclosure

16483898\_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

## NOTICE OF ALLOWANCE AND FEE(S) DUE

26111 7590 06/14/2021  
STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.  
1100 NEW YORK AVENUE, N.W.  
WASHINGTON, DC 20005

EXAMINER

GEYER, SCOTT B

ART UNIT PAPER NUMBER

2812

DATE MAILED: 06/14/2021

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 16/885,858      | 05/28/2020  | Zhenyu LU            | 4123.0460003        | 1041             |

TITLE OF INVENTION: STAIRCASE STRUCTURE FOR MEMORY 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           | 09/14/2021 |

**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 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity 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 and an extra copy of the form should be submitted. 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 including the Patent, advance orders and notification of maintenance fees 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.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

26111 7590 06/14/2021  
STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.  
1100 NEW YORK AVENUE, N.W.  
WASHINGTON, DC 20005

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. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 16/885,858      | 05/28/2020  | Zhenyu LU            | 4123.0460003        | 1041             |

TITLE OF INVENTION: STAIRCASE STRUCTURE FOR MEMORY 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           | 09/14/2021 |

| EXAMINER       | ART UNIT | CLASS-SUBCLASS |
|----------------|----------|----------------|
| GEYER, SCOTT B | 2812     | 257-324000     |

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/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 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, 1 \_\_\_\_\_
- (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. 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) ☐ Advance Order - # of Copies \_\_\_\_\_

4b. Method of Payment: (Please first reapply any previously paid fee shown above)

☐ Electronic Payment via 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  
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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. |
|--------------------------------------------------------------------------------------------------------------------------|-------------|----------------------|----------------------------|------------------|
| 16/885,858                                                                                                               | 05/28/2020  | Zhenyu LU            | 4123.0460003               | 1041             |
| 26111 7590 06/14/2021<br>STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.<br>1100 NEW YORK AVENUE, N.W.<br>WASHINGTON, DC 20005 |             |                      | EXAMINER<br>GEYER, SCOTT B |                  |
|                                                                                                                          |             |                      | ART UNIT<br>2812           | PAPER NUMBER     |
| DATE MAILED: 06/14/2021                                                                                                  |             |                      |                            |                  |

## 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>16/885,858 | <b>Applicant(s)</b><br>LU et al. |                                 |
|                               | <b>Examiner</b><br>Scott B Geyer     | <b>Art Unit</b><br>2812          | <b>AIA (FITF) Status</b><br>Yes |

**-- 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 papers filed by the applicant on June 2, 2021.  
☐ 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 1-5 and 7-21. 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. 16/126,956.  
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 checked="" 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 type="checkbox"/> Examiner's Statement of Reasons for Allowance<br>7. <input type="checkbox"/> Other ____. |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                                    |  |
|----------------------------------------------------|--|
| /SCOTT B GEYER/<br>Primary Examiner, Art Unit 2812 |  |
|----------------------------------------------------|--|

|                                          |                                       |  |                                                         |             |
|------------------------------------------|---------------------------------------|--|---------------------------------------------------------|-------------|
| <b><i>Notice of References Cited</i></b> | Application/Control No.<br>16/885,858 |  | Applicant(s)/Patent Under<br>Reexamination<br>LU et al. |             |
|                                          | Examiner<br>Scott B Geyer             |  | Art Unit<br>2812                                        | Page 1 of 1 |

**U.S. PATENT DOCUMENTS**

| * |   | Document Number<br>Country Code-Number-Kind Code | Date<br>MM-YYYY | Name           | CPC Classification | US Classification |
|---|---|--------------------------------------------------|-----------------|----------------|--------------------|-------------------|
| * | A | US-20180130701-A1                                | 05-2018         | Chun; Seung Ju | H01L27/1157        | 1/1               |
|   | 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>MM-YYYY | Country | Name | CPC Classification |
|---|---|--------------------------------------------------|-----------------|---------|------|--------------------|
|   | N |                                                  |                 |         |      |                    |
|   | 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 MM-YYYY format are publication dates. Classifications may be US or foreign.

|                                                                                                                  |                                              |                                                             |  |
|------------------------------------------------------------------------------------------------------------------|----------------------------------------------|-------------------------------------------------------------|--|
| <b>Issue Classification</b><br> | <b>Application/Control No.</b><br>16/885,858 | <b>Applicant(s)/Patent Under Reexamination</b><br>LU et al. |  |
|                                                                                                                  | <b>Examiner</b><br>Scott B Geyer             | <b>Art Unit</b><br>2812                                     |  |

| CPC    |   |    |   |       |      |            |
|--------|---|----|---|-------|------|------------|
| Symbol |   |    |   |       | Type | Version    |
| H01L   | / | 27 | / | 11524 | F    | 2013-01-01 |
| H01L   | / | 27 | / | 11582 | I    | 2013-01-01 |
| H01L   | / | 21 | / | 0273  | I    | 2013-01-01 |
| H01L   | / | 27 | / | 1157  | I    | 2013-01-01 |
| H01L   | / | 27 | / | 11575 | I    | 2013-01-01 |
| H01L   | / | 21 | / | 31144 | I    | 2013-01-01 |
| H01L   | / | 27 | / | 11529 | I    | 2013-01-01 |

| CPC Combination Sets |   |  |   |      |     |         |         |
|----------------------|---|--|---|------|-----|---------|---------|
| Symbol               |   |  |   | Type | Set | Ranking | Version |
|                      | / |  | / |      |     |         |         |

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|----------------------------------------------------|--------------|------------------------------|-------------------|
| NONE                                               |              | <b>Total Claims Allowed:</b> |                   |
| (Assistant Examiner)                               | (Date)       | 20                           |                   |
| /SCOTT B GEYER/<br>Primary Examiner, Art Unit 2812 | 07 June 2021 | O.G. Print Claim(s)          | O.G. Print Figure |
| (Primary Examiner)                                 | (Date)       | 1                            | 7                 |

U.S. Patent and Trademark Office

Part of Paper No.: 20210607A

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|------------------------------------------------------------------------------------------------------------------|----------------------------------------------|-------------------------------------------------------------|
| <b>Issue Classification</b><br> | <b>Application/Control No.</b><br>16/885,858 | <b>Applicant(s)/Patent Under Reexamination</b><br>LU et al. |
|                                                                                                                  | <b>Examiner</b><br>Scott B Geyer             | <b>Art Unit</b><br>2812                                     |

|                                     |  |    |       |
|-------------------------------------|--|----|-------|
| <b>INTERNATIONAL CLASSIFICATION</b> |  |    |       |
| <b>CLAIMED</b>                      |  |    |       |
| H01L27/11524                        |  | 27 | 11524 |
| <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> |  |  |  |  |  |
|                            |                                          |  |  |  |  |  |

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|----------------------------------------------------|--------------|------------------------------|-------------------|
| NONE                                               |              | <b>Total Claims Allowed:</b> |                   |
| (Assistant Examiner)                               | (Date)       | 20                           |                   |
| /SCOTT B GEYER/<br>Primary Examiner, Art Unit 2812 | 07 June 2021 | O.G. Print Claim(s)          | O.G. Print Figure |
| (Primary Examiner)                                 | (Date)       | 1                            | 7                 |

U.S. Patent and Trademark Office

Part of Paper No.: 20210607A

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|-------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|-------------------------------------------------------------|
| <b><i>Issue Classification</i></b><br> | <b>Application/Control No.</b><br>16/885,858 | <b>Applicant(s)/Patent Under Reexamination</b><br>LU et al. |
|                                                                                                                         | <b>Examiner</b><br>Scott B Geyer             | <b>Art Unit</b><br>2812                                     |

|                                                                                                                                                                                   |                 |              |                 |              |                 |              |                 |              |                 |              |                 |              |                 |              |                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|
| <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 |                 |              |                 |              |                 |              |                 |              |                 |              |                 |              |                 |              |                 |
| <b>CLAIMS</b>                                                                                                                                                                     |                 |              |                 |              |                 |              |                 |              |                 |              |                 |              |                 |              |                 |
| <b>Final</b>                                                                                                                                                                      | <b>Original</b> | <b>Final</b> | <b>Original</b> | <b>Final</b> | <b>Original</b> | <b>Final</b> | <b>Original</b> | <b>Final</b> | <b>Original</b> | <b>Final</b> | <b>Original</b> | <b>Final</b> | <b>Original</b> | <b>Final</b> | <b>Original</b> |
| 1                                                                                                                                                                                 | 1               | 10           | 10              | 19           | 19              |              |                 |              |                 |              |                 |              |                 |              |                 |
| 2                                                                                                                                                                                 | 2               | 11           | 11              | 20           | 20              |              |                 |              |                 |              |                 |              |                 |              |                 |
| 3                                                                                                                                                                                 | 3               | 12           | 12              | 8            | 21              |              |                 |              |                 |              |                 |              |                 |              |                 |
| 4                                                                                                                                                                                 | 4               | 13           | 13              |              |                 |              |                 |              |                 |              |                 |              |                 |              |                 |
| 5                                                                                                                                                                                 | 5               | 14           | 14              |              |                 |              |                 |              |                 |              |                 |              |                 |              |                 |
|                                                                                                                                                                                   | 6               | 15           | 15              |              |                 |              |                 |              |                 |              |                 |              |                 |              |                 |
| 6                                                                                                                                                                                 | 7               | 16           | 16              |              |                 |              |                 |              |                 |              |                 |              |                 |              |                 |
| 7                                                                                                                                                                                 | 8               | 17           | 17              |              |                 |              |                 |              |                 |              |                 |              |                 |              |                 |
| 9                                                                                                                                                                                 | 9               | 18           | 18              |              |                 |              |                 |              |                 |              |                 |              |                 |              |                 |

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|----------------------------------------------------|--------------|------------------------------|-------------------|
| NONE                                               |              | <b>Total Claims Allowed:</b> |                   |
| (Assistant Examiner)                               | (Date)       | 20                           |                   |
| /SCOTT B GEYER/<br>Primary Examiner, Art Unit 2812 | 07 June 2021 | O.G. Print Claim(s)          | O.G. Print Figure |
| (Primary Examiner)                                 | (Date)       | 1                            | 7                 |

U.S. Patent and Trademark Office

Part of Paper No.: 20210607A

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|-----------------------------------------------------------------------------------------------------------------|----------------------------------------------|-------------------------------------------------------------|
| <b><i>Search Notes</i></b><br> | <b>Application/Control No.</b><br>16/885,858 | <b>Applicant(s)/Patent Under Reexamination</b><br>LU et al. |
|                                                                                                                 | <b>Examiner</b><br>Scott B Geyer             | <b>Art Unit</b><br>2812                                     |

| CPC - Searched*                                                                     |            |          |
|-------------------------------------------------------------------------------------|------------|----------|
| Symbol                                                                              | Date       | Examiner |
| H01L 27/11514, 27/11551, 27/11578, 27/11597                                         | 03/18/2021 | SBG      |
| H01L 27/11509, 27/11512, 27/11526, 27/11529, 27/11573, 27/11575, 27/11592, 27/11595 | 03/18/2021 | SBG      |

| 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 |
| Parent application (16/126,956) - references checked          | 03/18/2021 | SBG      |
| Consulted Examiner B. Paterson (AU 2812) on search strategies | 03/18/2021 | SBG      |
| PE2E-Search, details attached                                 | 03/18/2021 | SBG      |
| PE2E-Search updated, results attached                         | 06/07/2021 | SBG      |

| Interference Search |                       |            |          |
|---------------------|-----------------------|------------|----------|
| US Class/CPC Symbol | US Subclass/CPC Group | Date       | Examiner |
|                     | Interference Search   | 06/07/2021 | SBG      |

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# PE2E SEARCH - Search History (Prior Art)

| Ref # | Hits  | Search Query                                                                                                                                                                                                                                                                                                                                                  | DBs                                                        | Default Operator | Plurals | British Equivalents | Time Stamp          |
|-------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|------------------|---------|---------------------|---------------------|
| L1    | 1     | "10680003".pn.                                                                                                                                                                                                                                                                                                                                                | (US-PGPUB; USPAT)                                          | OR               | ON      | ON                  | 2021/03/16 04:27 PM |
| L2    | 15    | ("9006884"   "9331082"   "9343452"   "9373540"   "9419013"   "9478487"   "9741563"   "10002880"   "10403641"   "20110031630"   "20130270714"   "20150255385"   "20150255386"   "20170084532"   "20190081070").pn. OR ("10680003").urpn. AND (PGPB   USPT   USOC).dbnm.                                                                                        | (US-PGPUB; USPAT; USOCR)                                   | OR               | ON      | ON                  | 2021/03/16 05:15 PM |
| L5    | 74581 | (H01L27/11524 H01L21/0273 H01L21/31144 H01L27/11529 H01L27/1157 H01L27/11575 H01L27/11582).CPC.                                                                                                                                                                                                                                                               | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR               | ON      | ON                  | 2021/03/16 05:31 PM |
| L6    | 1772  | ((Yangtze WITH Memory).as. (Zhenyu WITH LU).in. (Jun WITH Chen).in. (Xiaowang WITH Dai).in. (Jifeng WITH Zhu).in. (Qian WITH Tao).in. (Yu WITH Huang).in. (Si WITH Hu).in. (Lan WITH Yao).in. (Li WITH Xiao).in. (Man WITH Zheng).in. (Kun WITH Bao).in. (Haohao Yang).in.) AND (stair-case staircase stair-step stairstep (stair ADJ case) (stair ADJ step)) | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR               | ON      | ON                  | 2021/03/16 05:31 PM |
| L9    | 525   | (H01L27/115-11597).CPC. AND (stair-case staircase stair-step stairstep (stair ADJ case) (stair ADJ step)) AND landing                                                                                                                                                                                                                                         | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR               | ON      | ON                  | 2021/03/16 05:35 PM |
| L10   | 1105  | (H01L27/115-11597).CPC. AND (stair-case staircase                                                                                                                                                                                                                                                                                                             | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;          | OR               | ON      | ON                  | 2021/03/16 05:36 PM |

|     |       |                                                                                           |                                                            |    |    |    |                     |
|-----|-------|-------------------------------------------------------------------------------------------|------------------------------------------------------------|----|----|----|---------------------|
|     |       | stair-step staircase (stair ADJ case) (stair ADJ step)) AND (landing pad)                 | IBM_TDB)                                                   |    |    |    |                     |
| L11 | 2383  | (stair-case staircase stair-step staircase (stair ADJ case) (stair ADJ step)) WITH memory | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/03/16 05:40 PM |
| L12 | 10907 | (H01L27/11524 H01L27/11529 H01L27/1157).cpc. AND (H01L27/11575 H01L27/11582).CPC.         | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/03/16 05:47 PM |
| L13 | 1199  | 12 AND (stair-case staircase stair-step staircase (stair ADJ case) (stair ADJ step))      | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/03/16 05:47 PM |
| L14 | 24999 | (H01L27/11524 H01L27/11529 H01L27/1157).cpc.                                              | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/03/16 05:47 PM |
| L15 | 1342  | 14 AND (stair-case staircase stair-step staircase (stair ADJ case) (stair ADJ step))      | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/03/16 05:47 PM |
| L16 | 942   | 15 NOT ("2021" "2020" "2019").ay.                                                         | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/03/16 05:48 PM |
| L18 | 1902  | (H01L27/11524 H01L27/11529 H01L27/1157).cpc. AND (H01L27/11551).CPC.                      | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/03/16 05:54 PM |
| L19 | 1701  | 18 NOT ("2021" "2020" "2019").ay.                                                         | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/03/16 05:54 PM |
| L24 | 9433  | (H01L27/11514 H01L27/11551 H01L27/11578 H01L27/11597).CPC.                                | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/03/17 01:07 PM |
| L25 | 3724  | 24 AND (stair-case staircase stair-step staircase (stair ADJ case) (stair ADJ step) NAND) | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/03/17 01:08 PM |
| L26 | 3306  | 25 NOT ("2021" "2020" "2019").ay.                                                         | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/03/17 01:08 PM |
| L27 | 25057 | (H01L27/11509 H01L27/11512                                                                | (US-PGPUB; USPAT; USOCR; FPRS; EPO;                        | OR | ON | ON | 2021/03/17 01:46 PM |

|     |      |                                                                                                                                                                                                                                                                                                                                                                                       |                                                                     |    |    |    |                        |
|-----|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|----|----|----|------------------------|
|     |      | H01L27/11526<br>H01L27/11529<br>H01L27/11573<br>H01L27/11575<br>H01L27/11592<br>H01L27/11595).CPC.                                                                                                                                                                                                                                                                                    | JPO; DERWENT;<br>IBM_TDB)                                           |    |    |    |                        |
| L28 | 7466 | 27 AND (stair-case<br>staircase stair-step<br>stairstep (stair ADJ<br>case) (stair ADJ step)<br>NAND)                                                                                                                                                                                                                                                                                 | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>01:46 PM |
| L29 | 6230 | 28 NOT ("2021" "2020"<br>"2019").ay.                                                                                                                                                                                                                                                                                                                                                  | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>01:46 PM |
| L30 | 722  | 24 AND (stair-case<br>staircase stair-step<br>stairstep (stair ADJ<br>case) (stair ADJ step))                                                                                                                                                                                                                                                                                         | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>01:47 PM |
| L31 | 1935 | 27 AND (stair-case<br>staircase stair-step<br>stairstep (stair ADJ<br>case) (stair ADJ step))                                                                                                                                                                                                                                                                                         | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>01:47 PM |
| L32 | 2256 | 30 OR 31                                                                                                                                                                                                                                                                                                                                                                              | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>01:47 PM |
| L33 | 1653 | 32 NOT ("2021" "2020"<br>"2019").ay.                                                                                                                                                                                                                                                                                                                                                  | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>01:47 PM |
| L34 | 18   | ("20070134817"  <br>"20080121953"  <br>"20090317978").pn. OR<br>("8304348").urpn. AND<br>(PGPB   USPT  <br>USOC).dbnm.                                                                                                                                                                                                                                                                | (US-PGPUB; USPAT;<br>USOCR)                                         | OR | ON | ON | 2021/03/17<br>01:52 PM |
| L35 | 36   | ("7799672"   "7847334"<br>  "7910432"   "7989880"<br>  "8304348"   "8822322"<br>  "8890229"   "8912593"<br>  "9362303"   "9633945"<br>  "9911753"  <br>"20070252201"  <br>"20090230458"  <br>"20090242968"  <br>"20100059811"  <br>"20100207240"  <br>"20110031546"  <br>"20120052674"  <br>"20120112171"  <br>"20120171861"  <br>"20120184078"  <br>"20120211821"  <br>"20130062683" | (US-PGPUB; USPAT;<br>USOCR)                                         | OR | ON | ON | 2021/03/17<br>01:53 PM |

|     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                             |    |    |    |                        |
|-----|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|----|----|----|------------------------|
|     |    | "20130087846"  <br>"20130130468"  <br>"20130248965"  <br>"20140054787"  <br>"20140061776"  <br>"20150061068"  <br>"20150194441"  <br>"20150200199"  <br>"20150255484"  <br>"20170098659"  <br>"20170141122"  <br>"20170207236").pn. OR<br>("10002880").urpn.<br>AND (PGPB   USPT  <br>USOC).dbnm.                                                                                                                                                                  |                             |    |    |    |                        |
| L36 | 26 | ("5619071"   "6028363"<br>  "6271083"   "6455412"<br>  "6841442"   "7511349"<br>  "7679133"   "8039828"<br>  "8119503"   "8178917"<br>  "8304348"   "8409977"<br>  "8541831"   "8553466"<br>  "8559235"   "8654587"<br>  "9373540"   "9577085"<br>  "9711603"  <br>"10103236"  <br>"20020070457"  <br>"20070210348"  <br>"20100009531"  <br>"20110233648"  <br>"20130043509"  <br>"20150155296").pn. OR<br>("10608091").urpn.<br>AND (PGPB   USPT  <br>USOC).dbnm. | (US-PGPUB; USPAT;<br>USOCR) | OR | ON | ON | 2021/03/17<br>01:54 PM |
| L37 | 13 | ("7875922"   "8304348"<br>  "8314455"   "8324680"<br>  "8378409"   "8461566"<br>  "8659944"  <br>"20120108048"  <br>"20120146122"  <br>"20120168858"  <br>"20130043509"  <br>"20130130468").pn. OR<br>("9362226").urpn. AND<br>(PGPB   USPT  <br>USOC).dbnm.                                                                                                                                                                                                       | (US-PGPUB; USPAT;<br>USOCR) | OR | ON | ON | 2021/03/17<br>01:56 PM |
| L39 | 10 | ("8304348"  <br>"20110031630"  <br>"20130127011"  <br>"20150255386").pn. OR<br>("9373540").urpn. AND<br>(PGPB   USPT  <br>USOC).dbnm.                                                                                                                                                                                                                                                                                                                              | (US-PGPUB; USPAT;<br>USOCR) | OR | ON | ON | 2021/03/17<br>02:07 PM |
| L40 | 27 | ("5619071"   "6271083"<br>  "6455412"   "6841442"                                                                                                                                                                                                                                                                                                                                                                                                                  | (US-PGPUB; USPAT;<br>USOCR) | OR | ON | ON | 2021/03/17<br>02:07 PM |

|     |    |                                                                                                                                                                                                                                                                                                                                                                                                                    |                             |    |    |    |                        |
|-----|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|----|----|----|------------------------|
|     |    | "7511349"   "7679133"<br>"8039828"   "8119503"<br>"8409977"   "8553466"<br>"8559235"   "8654587"<br>"20020070457"  <br>"20100009531"  <br>"20110233648"  <br>"20130043509"  <br>"20150155296").pn. OR<br>("9711603").urpn. AND<br>(PGPB   USPT  <br>USOC).dbnm.                                                                                                                                                    |                             |    |    |    |                        |
| L42 | 5  | ("8193571"   "8313998"<br>  "9373540"  <br>"20130234232"  <br>"20140054789").pn. OR<br>("10707227").urpn.<br>AND (PGPB   USPT  <br>USOC).dbnm.                                                                                                                                                                                                                                                                     | (US-PGPUB; USPAT;<br>USOCR) | OR | ON | ON | 2021/03/17<br>02:09 PM |
| L43 | 13 | ("9202780"   "9343452"<br>  "9355913"   "9373540"<br>  "9640542"   "9768193"<br>  "9831180"   "9871053"<br>  "20110031630"  <br>"20150255385"  <br>"20170271256"  <br>"20180026046"  <br>"20180166380").pn. OR<br>("10763167").urpn.<br>AND (PGPB   USPT  <br>USOC).dbnm.                                                                                                                                          | (US-PGPUB; USPAT;<br>USOCR) | OR | ON | ON | 2021/03/17<br>02:10 PM |
| L44 | 21 | ("6424044"   "6764901"<br>  "7170126"   "7183222"<br>  "7855457"   "7989880"<br>  "8704288"   "9305830"<br>  "9305935"   "9419013"<br>  "9711603"  <br>"20120070944"  <br>"20130313627"  <br>"20140054789"  <br>"20150054170"  <br>"20150255484"  <br>"20160056165"  <br>"20160343821"  <br>"20170077026"  <br>"20170117222"  <br>"20170278859").pn. OR<br>("10395982").urpn.<br>AND (PGPB   USPT  <br>USOC).dbnm. | (US-PGPUB; USPAT;<br>USOCR) | OR | ON | ON | 2021/03/17<br>02:11 PM |
| L47 | 1  | "10134672".pn.                                                                                                                                                                                                                                                                                                                                                                                                     | (USPAT)                     | OR | ON | ON | 2021/03/17<br>02:14 PM |
| L48 | 16 | ("7847334"   "8592890"<br>  "9184177"   "9853048"<br>  "20080073635"  <br>"20100207240"                                                                                                                                                                                                                                                                                                                            | (US-PGPUB; USPAT;<br>USOCR) | OR | ON | ON | 2021/03/17<br>02:14 PM |

|     |      |                                                                                                                                                                                                                                                             |                                                                     |    |    |    |                        |
|-----|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|----|----|----|------------------------|
|     |      | "20110156132"  <br>"20120077320"  <br>"20120119287"  <br>"20120322252"  <br>"20140264925"  <br>"20140377934"  <br>"20160071861"  <br>"20160133568"  <br>"20160204102"  <br>"20160268269").pn. OR<br>("10134672").urpn.<br>AND (PGPB   USPT  <br>USOC).dbnm. |                                                                     |    |    |    |                        |
| L49 | 1    | "10297543".pn.                                                                                                                                                                                                                                              | (USPAT)                                                             | OR | ON | ON | 2021/03/17<br>02:17 PM |
| L50 | 3    | ("9202780"  <br>"20150255385"  <br>"20160079257").pn. OR<br>("10297543").urpn.<br>AND (PGPB   USPT  <br>USOC).dbnm.                                                                                                                                         | (US-PGPUB; USPAT;<br>USOCR)                                         | OR | ON | ON | 2021/03/17<br>02:17 PM |
| L51 | 1264 | L24 AND (pad<br>(interlayer ADJ<br>conductor) landing)                                                                                                                                                                                                      | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>02:50 PM |
| L52 | 4376 | L27 AND (pad<br>(interlayer ADJ<br>conductor) landing)                                                                                                                                                                                                      | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>02:50 PM |
| L53 | 952  | (51 OR 52) AND (stair-<br>case staircase stair-<br>step stairstep (stair ADJ<br>case) (stair ADJ step))                                                                                                                                                     | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>02:51 PM |
| L54 | 613  | 53 NOT ("2021" "2020"<br>"2019").ay.                                                                                                                                                                                                                        | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/03/17<br>02:52 PM |
| L55 | 2    | ("20130234232"  <br>"20150255385").pn. OR<br>("9941153").urpn. AND<br>(PGPB   USPT  <br>USOC).dbnm.                                                                                                                                                         | (US-PGPUB; USPAT;<br>USOCR)                                         | OR | ON | ON | 2021/03/17<br>03:22 PM |
| L56 | 1    | "9941153".pn.                                                                                                                                                                                                                                               | (USPAT)                                                             | OR | ON | ON | 2021/03/17<br>03:23 PM |
| L57 | 31   | ("6258648"   "8975609"<br>  "20050263824"  <br>"20090100388"  <br>"20090230449"  <br>"20090242967"  <br>"20100193861"  <br>"20100207240"  <br>"20100232224"  <br>"20110031547"  <br>"20110031630"                                                           | (US-PGPUB; USPAT;<br>USOCR)                                         | OR | ON | ON | 2021/03/17<br>03:28 PM |

|     |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                             |    |    |    |                        |
|-----|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|----|----|----|------------------------|
|     |     | "20120001249"  <br>"20120119283"  <br>"20120119287"  <br>"20120238093"  <br>"20130005136"  <br>"20130056818"  <br>"20130161731"  <br>"20130334589"  <br>"20140054789"  <br>"20140327093"  <br>"20150221667"  <br>"20160005759"  <br>"20160064041"  <br>"20160071861"  <br>"20160071876"  <br>"20160086964"  <br>"20160111438"  <br>"20160126248"  <br>"20160133630").pn. OR<br>("9520402").urpn. AND<br>(PGPB   USPT  <br>USOC).dbnm.                                                                                                                                                                                                                                                                                                                                                                                                 |                             |    |    |    |                        |
| L58 | 3   | ("9716105"   "9960181"<br>  "20160365352").pn.<br>OR ("10608010").urpn.<br>AND (PGPB   USPT  <br>USOC).dbnm.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | (US-PGPUB; USPAT;<br>USOCR) | OR | ON | ON | 2021/03/17<br>03:46 PM |
| L59 | 232 | ("3708728"   "3925337"<br>  "4058430"   "4282267"<br>  "4389973"   "4565747"<br>  "4747367"   "4761269"<br>  "4767494"   "4851095"<br>  "4935661"   "5071670"<br>  "5166092"   "5221556"<br>  "5270247"   "5281274"<br>  "5306666"   "5316793"<br>  "5342652"   "5482262"<br>  "5595784"   "5603771"<br>  "5618395"   "5691235"<br>  "5693139"   "5711811"<br>  "5723384"   "5744254"<br>  "5769950"   "5789024"<br>  "5855680"   "5916365"<br>  "5946598"   "5947710"<br>  "5964943"   "5965004"<br>  "5972430"   "5973400"<br>  "6006763"   "6015590"<br>  "6087257"   "6099904"<br>  "6104074"   "6113977"<br>  "6124158"   "6139624"<br>  "6139700"   "6144060"<br>  "6156382"   "6159871"<br>  "6162501"   "6174809"<br>  "6188134"   "6194310"<br>  "6200389"   "6203613"<br>  "6206967"   "6234646"<br>  "6270572"   "6284646" | (US-PGPUB; USPAT;<br>USOCR) | OR | ON | ON | 2021/03/17<br>04:01 PM |

|  |  |                       |  |  |  |  |  |
|--|--|-----------------------|--|--|--|--|--|
|  |  | "6287965"   "6342277" |  |  |  |  |  |
|  |  | "6355561"   "6380627" |  |  |  |  |  |
|  |  | "6391785"   "6410462" |  |  |  |  |  |
|  |  | "6416577"   "6464779" |  |  |  |  |  |
|  |  | "6475276"   "6482262" |  |  |  |  |  |
|  |  | "6482733"   "6482740" |  |  |  |  |  |
|  |  | "6511539"   "6534395" |  |  |  |  |  |
|  |  | "6576053"   "6583048" |  |  |  |  |  |
|  |  | "6599572"   "6613383" |  |  |  |  |  |
|  |  | "6616982"   "6632595" |  |  |  |  |  |
|  |  | "6652924"   "6706115" |  |  |  |  |  |
|  |  | "6727169"   "6780704" |  |  |  |  |  |
|  |  | "6794287"   "6797340" |  |  |  |  |  |
|  |  | "6800383"   "6800552" |  |  |  |  |  |
|  |  | "6809026"   "6821889" |  |  |  |  |  |
|  |  | "6827978"   "6833161" |  |  |  |  |  |
|  |  | "6863727"   "6902763" |  |  |  |  |  |
|  |  | "6986914"   "7015153" |  |  |  |  |  |
|  |  | "7045406"   "7074690" |  |  |  |  |  |
|  |  | "7115534"   "7115974" |  |  |  |  |  |
|  |  | "7138336"   "7211144" |  |  |  |  |  |
|  |  | "7211508"   "7268078" |  |  |  |  |  |
|  |  | "7329590"   "7405158" |  |  |  |  |  |
|  |  | "7410666"   "7416981" |  |  |  |  |  |
|  |  | "7611751"   "7749871" |  |  |  |  |  |
|  |  | "7776396"   "7794798" |  |  |  |  |  |
|  |  | "7824492"   "8217446" |  |  |  |  |  |
|  |  | "9111746"   "9171736" |  |  |  |  |  |
|  |  | "9243324"   "9425038" |  |  |  |  |  |
|  |  | "9455138"   "9784695" |  |  |  |  |  |
|  |  | "9786491"   "9786492" |  |  |  |  |  |
|  |  | "10424477"            |  |  |  |  |  |
|  |  | "10453675"            |  |  |  |  |  |
|  |  | "20010004479"         |  |  |  |  |  |
|  |  | "20010005546"         |  |  |  |  |  |
|  |  | "20010024387"         |  |  |  |  |  |
|  |  | "20010034097"         |  |  |  |  |  |
|  |  | "20010041250"         |  |  |  |  |  |
|  |  | "20020004293"         |  |  |  |  |  |
|  |  | "20020104481"         |  |  |  |  |  |
|  |  | "20020182320"         |  |  |  |  |  |
|  |  | "20030015764"         |  |  |  |  |  |
|  |  | "20030026989"         |  |  |  |  |  |
|  |  | "20030031793"         |  |  |  |  |  |
|  |  | "20030049931"         |  |  |  |  |  |
|  |  | "20030072975"         |  |  |  |  |  |
|  |  | "20030082296"         |  |  |  |  |  |
|  |  | "20030104126"         |  |  |  |  |  |
|  |  | "20030119305"         |  |  |  |  |  |
|  |  | "20030123216"         |  |  |  |  |  |
|  |  | "20030127043"         |  |  |  |  |  |
|  |  | "20030153181"         |  |  |  |  |  |
|  |  | "20030157760"         |  |  |  |  |  |
|  |  | "20030161952"         |  |  |  |  |  |
|  |  | "20030181035"         |  |  |  |  |  |
|  |  | "20030194825"         |  |  |  |  |  |
|  |  | "20030203616"         |  |  |  |  |  |
|  |  | "20040130029"         |  |  |  |  |  |

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|--|---------------|--|--|--|--|--|
|  | "20040185183" |  |  |  |  |  |
|  | "20040206008" |  |  |  |  |  |
|  | "20040208994" |  |  |  |  |  |
|  | "20040224504" |  |  |  |  |  |
|  | "20040231799" |  |  |  |  |  |
|  | "20040238876" |  |  |  |  |  |
|  | "20040240820" |  |  |  |  |  |
|  | "20050037557" |  |  |  |  |  |
|  | "20050106877" |  |  |  |  |  |
|  | "20050215008" |  |  |  |  |  |
|  | "20050236694" |  |  |  |  |  |
|  | "20050271813" |  |  |  |  |  |
|  | "20060019494" |  |  |  |  |  |
|  | "20060078679" |  |  |  |  |  |
|  | "20060079090" |  |  |  |  |  |
|  | "20060079099" |  |  |  |  |  |
|  | "20060165892" |  |  |  |  |  |
|  | "20060211224" |  |  |  |  |  |
|  | "20060223300" |  |  |  |  |  |
|  | "20060240187" |  |  |  |  |  |
|  | "20070054046" |  |  |  |  |  |
|  | "20070148350" |  |  |  |  |  |
|  | "20070218670" |  |  |  |  |  |
|  | "20070251444" |  |  |  |  |  |
|  | "20080102204" |  |  |  |  |  |
|  | "20080102613" |  |  |  |  |  |
|  | "20080113110" |  |  |  |  |  |
|  | "20080182411" |  |  |  |  |  |
|  | "20080274617" |  |  |  |  |  |
|  | "20090081868" |  |  |  |  |  |
|  | "20090104791" |  |  |  |  |  |
|  | "20090211526" |  |  |  |  |  |
|  | "20090315093" |  |  |  |  |  |
|  | "20100092781" |  |  |  |  |  |
|  | "20100148903" |  |  |  |  |  |
|  | "20100239742" |  |  |  |  |  |
|  | "20100297545" |  |  |  |  |  |
|  | "20110159202" |  |  |  |  |  |
|  | "20110262642" |  |  |  |  |  |
|  | "20110278533" |  |  |  |  |  |
|  | "20120003831" |  |  |  |  |  |
|  | "20120119283" |  |  |  |  |  |
|  | "20120141770" |  |  |  |  |  |
|  | "20120208347" |  |  |  |  |  |
|  | "20120269962" |  |  |  |  |  |
|  | "20130078454" |  |  |  |  |  |
|  | "20130112605" |  |  |  |  |  |
|  | "20130115763" |  |  |  |  |  |
|  | "20130134372" |  |  |  |  |  |
|  | "20130196082" |  |  |  |  |  |
|  | "20130330935" |  |  |  |  |  |
|  | "20140030432" |  |  |  |  |  |
|  | "20140048131" |  |  |  |  |  |
|  | "20140272194" |  |  |  |  |  |
|  | "20140295109" |  |  |  |  |  |
|  | "20140302267" |  |  |  |  |  |
|  | "20140349107" |  |  |  |  |  |
|  | "20140367764" |  |  |  |  |  |

|     |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                            |    |    |    |                     |
|-----|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|----|----|----|---------------------|
|     |     | "20150087156"<br>"20150118865"<br>"20150214103"<br>"20150217240"<br>"20150217330"<br>"20150275355"<br>"20150303056"<br>"20150303101"<br>"20150376211"<br>"20160064281"<br>"20160093485"<br>"20160225616"<br>"20160336338"<br>"20170140924"<br>"20170213726"<br>"20170309476"<br>"20170323782"<br>"20170352680"<br>"20170365462"<br>"20180005814"<br>"20180013078"<br>"20180122742"<br>"20180151355"<br>"20180182618"<br>"20180350587").pn. OR<br>("10847529").urpn.<br>AND (PGPB   USPT  <br>USOC).dbnm. |                                                            |    |    |    |                     |
| L61 | 122 | 59 AND (stair-case staircase stair-step stairstep (stair ADJ case) (stair ADJ step) nand memory)                                                                                                                                                                                                                                                                                                                                                                                                         | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/03/17 04:01 PM |
| L62 | 7   | 61 AND (pad (interlayer ADJ conductor) landing)                                                                                                                                                                                                                                                                                                                                                                                                                                                          | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/03/17 04:02 PM |
| L63 | 24  | 59 AND (pad (interlayer ADJ conductor) landing)                                                                                                                                                                                                                                                                                                                                                                                                                                                          | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/03/17 04:02 PM |
| L64 | 710 | L26 AND (pad (interlayer ADJ conductor) landing)                                                                                                                                                                                                                                                                                                                                                                                                                                                         | (US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB) | OR | ON | ON | 2021/03/17 04:22 PM |
| L65 | 16  | ("20110031630"<br>"10002880" "9343452"<br>"9362226"<br>"20130043509"<br>"9373540" "9711603"<br>"10395982"<br>"20170271256"<br>"20180166380"<br>"9941153" "9520402"<br>"20130056818"<br>"20190280001"                                                                                                                                                                                                                                                                                                     | (US-PGPUB; USPAT)                                          | OR | ON | ON | 2021/03/17 04:30 PM |

|     |      |                                                                                                                                                                                |                                                                     |    |    |    |                        |
|-----|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|----|----|----|------------------------|
|     |      | "20180301460"<br>"20190006385").PN.                                                                                                                                            |                                                                     |    |    |    |                        |
| L74 | 11   | ("20130043509"<br>"9711603" "10395982"<br>"20170271256"<br>"20180166380"<br>"9941153" "9520402"<br>"20130056818"<br>"20190280001"<br>"20180301460"<br>"20190006385").PN.       | (US-PGPUB; USPAT)                                                   | OR | ON | ON | 2021/03/18<br>02:15 PM |
| L75 | 4450 | H01L27/\$.cpc. AND<br>(stair-case staircase<br>stair-step stairstep (stair<br>ADJ case) (stair ADJ<br>step))                                                                   | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/06/07<br>05:45 PM |
| L76 | 589  | H01L27/\$.cpc. AND<br>(stair-case staircase<br>stair-step stairstep (stair<br>ADJ case) (stair ADJ<br>step)) AND (land\$3<br>near3 (contact pad))                              | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/06/07<br>05:48 PM |
| L77 | 384  | L76 NOT ("2021"<br>"2020" "2019").ay.                                                                                                                                          | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/06/07<br>05:50 PM |
| L78 | 91   | (H01L27/11502-<br>11514).cpc. AND (stair<br>step stair-case<br>staircase stair-step<br>stairstep (stair ADJ<br>case) (stair ADJ step))<br>AND (land\$3 near3<br>(contact pad)) | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/06/07<br>05:57 PM |
| L79 | 739  | (H01L27/11517-<br>1156).cpc. AND (stair<br>step stair-case<br>staircase stair-step<br>stairstep (stair ADJ<br>case) (stair ADJ step))<br>AND (land\$3 near3<br>(contact pad))  | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/06/07<br>05:57 PM |
| L80 | 866  | (H01L27/11563-<br>11582).cpc. AND (stair<br>step stair-case<br>staircase stair-step<br>stairstep (stair ADJ<br>case) (stair ADJ step))<br>AND (land\$3 near3<br>(contact pad)) | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/06/07<br>05:57 PM |
| L81 | 7    | (H01L27/11585-<br>11597).cpc. AND (stair<br>step stair-case<br>staircase stair-step<br>stairstep (stair ADJ                                                                    | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/06/07<br>05:57 PM |

|     |      |                                                                       |                                                                     |    |    |    |                        |
|-----|------|-----------------------------------------------------------------------|---------------------------------------------------------------------|----|----|----|------------------------|
|     |      | case) (stair ADJ step))<br>AND (land\$3 near3<br>(contact pad))       |                                                                     |    |    |    |                        |
| L82 | 84   | L78 NOT ("2021"<br>"2020" "2019").ay.                                 | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/06/07<br>05:59 PM |
| L83 | 546  | L79 NOT ("2021"<br>"2020" "2019").ay.                                 | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/06/07<br>05:59 PM |
| L84 | 612  | L80 NOT ("2021"<br>"2020" "2019").ay.                                 | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/06/07<br>05:59 PM |
| L85 | 6    | L81 NOT ("2021"<br>"2020" "2019").ay.                                 | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/06/07<br>05:59 PM |
| L90 | 119  | (H01L27/11502-<br>11514).cpc. AND<br>(land\$3 near3 (contact<br>pad)) | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/06/07<br>06:46 PM |
| L91 | 862  | (H01L27/11517-<br>1156).cpc. AND (land\$3<br>near3 (contact pad))     | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/06/07<br>06:47 PM |
| L92 | 978  | (H01L27/11563-<br>11582).cpc. AND<br>(land\$3 near3 (contact<br>pad)) | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/06/07<br>06:47 PM |
| L93 | 12   | (H01L27/11585-<br>11597).cpc. AND<br>(land\$3 near3 (contact<br>pad)) | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/06/07<br>06:47 PM |
| L94 | 1301 | (L90 OR L91 OR L92<br>OR L93)                                         | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/06/07<br>06:48 PM |
| L95 | 1008 | L94 NOT ("2021"<br>"2020" "2019").ay.                                 | (US-PGPUB; USPAT;<br>USOCR; FPRS; EPO;<br>JPO; DERWENT;<br>IBM_TDB) | OR | ON | ON | 2021/06/07<br>06:48 PM |

## PE2E SEARCH - Search History (Interference)

| Ref # | Hits | Search Query                                                                                                                     | DBs               | Default Operator | Plurals | British Equivalents | Time Stamp             |
|-------|------|----------------------------------------------------------------------------------------------------------------------------------|-------------------|------------------|---------|---------------------|------------------------|
| N2    |      | (semiconductor<br>memory).clm. AND<br>(stair step stair-case<br>staircase stair-step<br>stairstep (stair ADJ<br>case) (stair ADJ | (US-PGPUB; USPAT) | OR               | ON      | ON                  | 2021/06/07<br>10:04 PM |

|    |  |                                                                                                                                                        |                   |    |    |    |                     |
|----|--|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|----|----|----|---------------------|
|    |  | step)).clm. AND (land\$3 near3 (contact pad)).clm.                                                                                                     |                   |    |    |    |                     |
| N3 |  | N2 AND ((land\$3 near3 (contact pad)) WITH (height depth tall thick\$4 dimension)).clm.                                                                | (US-PGPUB; USPAT) | OR | ON | ON | 2021/06/07 10:05 PM |
| N4 |  | N2 AND ((land\$3 near3 (contact pad)) WITH (curvature curv\$3 round\$3)).clm.                                                                          | (US-PGPUB; USPAT) | OR | ON | ON | 2021/06/07 10:06 PM |
| N5 |  | (memory).clm. AND (stair step stair-case staircase stair-step stairstep (stair ADJ case) (stair ADJ step)).clm. AND (land\$3 near3 (contact pad)).clm. | (US-PGPUB; USPAT) | OR | ON | ON | 2021/06/07 10:07 PM |
| N6 |  | N5 AND ((land\$3 near3 (contact pad)) WITH (curvature curv\$3 round\$3)).clm.                                                                          | (US-PGPUB; USPAT) | OR | ON | ON | 2021/06/07 10:07 PM |

YUANFENG GAO  
PATENT AGENT  
202-772-8731  
YGAO@STERNEKESSLER.COM



September 13, 2021

Commissioner for Patents  
PO Box 1450  
Alexandria, VA 22313-1450

**Confirmation No. 1041**  
**Mail Stop Issue Fee**

Re: Allowed U.S. Utility Patent Application  
Appl. No. 16/885,858; Filed: May 28, 2020  
For: **STAIRCASE STRUCTURE FOR MEMORY DEVICE**  
First Named Inventor: Zhenyu LU  
Our Ref: 4123.0460003

Commissioner:

In response to the **Notice of Allowance and Fee(s) Due** dated **June 14, 2021**, the following documents are transmitted for appropriate action by the U.S. Patent and Trademark office:

1. Online Credit Card Payment Authorization for **\$1,200.00** to cover issue fee due; and
2. Issue Fee Transmittal (Form PTOL-85).

The above-listed documents are filed electronically.

Fee payment is provided through online credit card payment.

The U.S. Patent and Trademark Office is hereby authorized to charge any fee deficiency, or credit any overpayment, to our Deposit Account No. 19-0036.

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.

/Yuanfeng Gao/

Yuanfeng Gao  
Agent for Applicant  
Registration No. 79,573

Y-G/cms  
Enclosure  
16947871\_1



## ELECTRONIC PAYMENT RECEIPT

APPLICATION #  
16/885,858

RECEIPT DATE / TIME  
09/13/2021 03:11:40 PM ET

ATTORNEY DOCKET #  
4123.0460003

### Title of Invention

STAIRCASE STRUCTURE FOR MEMORY DEVICE

### Application Information

APPLICATION TYPE Utility - Nonprovisional Application  
under 35 USC 111(a)

PATENT # -

CONFIRMATION # 1041

FILED BY Tonyia Skinner

PATENT CENTER # 60310669

AUTHORIZED BY Yuanfeng Gao

CUSTOMER # 26111

FILING DATE 05/28/2020

CORRESPONDENCE  
ADDRESS -

FIRST NAMED  
INVENTOR Zhenyu LU

### Payment Information

PAYMENT METHOD  
CARD / 1008

PAYMENT TRANSACTION ID  
E20219CF13042081

PAYMENT AUTHORIZED BY  
Tonyia Skinner

| FEE CODE      | DESCRIPTION       | ITEM PRICE(\$) | QUANTITY | ITEM TOTAL(\$) |
|---------------|-------------------|----------------|----------|----------------|
| 1501          | UTILITY ISSUE FEE | 1200.00        | 1        | 1200.00        |
| TOTAL AMOUNT: |                   |                |          | \$1,200.00     |

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.

**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 including the Patent, advance orders and notification of maintenance fees 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.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

26111 7590 06/14/2021  
STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.  
1100 NEW YORK AVENUE, N.W.  
WASHINGTON, DC 20005

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. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 16/885,858      | 05/28/2020  | Zhenyu LU            | 4123.0460003        | 1041             |

TITLE OF INVENTION: STAIRCASE STRUCTURE FOR MEMORY 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           | 09/14/2021 |

| EXAMINER       | ART UNIT | CLASS-SUBCLASS |
|----------------|----------|----------------|
| GEYER, SCOTT B | 2812     | 257-324000     |

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/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 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 Sterne, Kessler, Goldstein  
& Fox P.L.L.C.  
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)

Yangtze Memory Technologies Co., Ltd.

Hubei, CHINA

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) ☐ Advance Order - # of Copies \_\_\_\_\_

4b. Method of Payment: (Please first reapply any previously paid fee shown above)

☒ Electronic Payment via 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. 19-0036

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 /Yuanfeng Gao/Date 2021/09/13Typed or printed name Yuanfeng GaoRegistration No. 79,573



## ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #  
**16/885,858**

RECEIPT DATE / TIME  
**09/13/2021 03:11:40 PM ET**

ATTORNEY DOCKET #  
**4123.0460003**

### Title of Invention

STAIRCASE STRUCTURE FOR MEMORY DEVICE

### Application Information

APPLICATION TYPE Utility - Nonprovisional Application  
under 35 USC 111(a)

PATENT # -

CONFIRMATION # 1041

FILED BY Tonyia Skinner

PATENT CENTER # 60310669

FILING DATE 05/28/2020

CUSTOMER # 26111

FIRST NAMED  
INVENTOR Zhenyu LU

CORRESPONDENCE  
ADDRESS -

AUTHORIZED BY Yuanfeng Gao

### Documents

**TOTAL DOCUMENTS: 2**

| DOCUMENT                                 | PAGES | DESCRIPTION                 | SIZE (KB) |
|------------------------------------------|-------|-----------------------------|-----------|
| 2021-09-13-Cover-Letter-4123-0460003.pdf | 1     | Transmittal Letter          | 215 KB    |
| 2021-09-13-Issue-Fee-4123-0460003.PDF    | 1     | Issue Fee Payment (PTO-85B) | 113 KB    |

### Digest

| DOCUMENT                                 | MESSAGE DIGEST(SHA-512)                                                                                |
|------------------------------------------|--------------------------------------------------------------------------------------------------------|
| 2021-09-13-Cover-Letter-4123-0460003.pdf | E3A83C02ACBC5DF3B18FBD7B181FFF431DFFF33DC45B219C<br>429A133C054459196B9A50E12D16A9E831A8DE28C750C6A659 |

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968D207342565C59B708DE9D3078DD

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2021-09-13-Issue-Fee-4123-  
0460003.PDF32BC7C9CC62184C663A4BDCB52012E3DDEFA56CD2A86A15  
C40D78C298B5512BF77CC4989A2AA68BC0AFEE6DBB9A55BA  
B84EEF9C008699AF848C495645C969454

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](http://www.uspto.gov)

| APPLICATION NO. | ISSUE DATE | PATENT NO. | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|------------|------------|---------------------|------------------|
| 16/885,858      | 10/12/2021 | 11145666   | 4123.0460003        | 1041             |

26111 7590 09/22/2021  
STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.  
1100 NEW YORK AVENUE, N.W.  
WASHINGTON, DC 20005

## ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

### **Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)** (application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

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 Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

Yangtze Memory Technologies Co., Ltd., Wuhan, CHINA;

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 USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit [SelectUSA.gov](http://SelectUSA.gov).

IR103 (Rev. 10/09)

## TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA/82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

|                        |                                       |
|------------------------|---------------------------------------|
| Application Number     | 16885858                              |
| Filing Date            | May 28, 2020                          |
| First Named Inventor   | Zhenyu LU                             |
| Title                  | STAIRCASE STRUCTURE FOR MEMORY DEVICE |
| Art Unit               | 2812                                  |
| Examiner Name          | SCOTT GEYER                           |
| Attorney Docket Number | 2017-00295-YMTC-PCT-US-CON1           |

### SIGNATURE of Applicant or Patent Practitioner

|                                                    |                                       |                     |              |
|----------------------------------------------------|---------------------------------------|---------------------|--------------|
| Signature                                          | /Mark C. Zimmerman /                  | Date (Optional)     | July 3, 2024 |
| Name                                               | Mark C. Zimmerman                     | Registration Number | 44006        |
| Title (if Applicant is a juristic entity)          | Attorney for Applicant                |                     |              |
| Applicant Name (if Applicant is a juristic entity) | Yangtze Memory Technologies Co., Ltd. |                     |              |

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

☐

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

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 0651-0035. Public burden for this form is estimated to average 3 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](mailto: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.

## 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:

34431

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):

Yangtze Memory Technologies Co., Ltd.



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

Tuenlap Daniel Chan

Title

Deputy General Counsel, Head of Intellectual Property Department

**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.

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 0651-0035. Public burden for this form is estimated to average 3 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](mailto: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.

## 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.



## ELECTRONIC ACKNOWLEDGEMENT RECEIPT

|                                    |                                                           |                                          |
|------------------------------------|-----------------------------------------------------------|------------------------------------------|
| APPLICATION #<br><b>16/885,858</b> | RECEIPT DATE / TIME<br><b>07/03/2024 03:20:10 PM Z ET</b> | ATTORNEY DOCKET #<br><b>4123.0460003</b> |
|------------------------------------|-----------------------------------------------------------|------------------------------------------|

### Title of Invention

STAIRCASE STRUCTURE FOR MEMORY DEVICE

### Application Information

|                           |                                                             |                         |                |
|---------------------------|-------------------------------------------------------------|-------------------------|----------------|
| APPLICATION TYPE          | Utility - Nonprovisional Application<br>under 35 USC 111(a) | PATENT #                | 11145666       |
| CONFIRMATION #            | 1041                                                        | FILED BY                | Hillary White  |
| PATENT CENTER #           | 66232596                                                    | FILING DATE             | 05/28/2020     |
| CUSTOMER #                | 26111                                                       | FIRST NAMED<br>INVENTOR | Zhenyu LU      |
| CORRESPONDENCE<br>ADDRESS | -                                                           | AUTHORIZED BY           | Mark Zimmerman |

### Documents

**TOTAL DOCUMENTS: 1**

| DOCUMENT                                | PAGES | DESCRIPTION       | SIZE (KB) |
|-----------------------------------------|-------|-------------------|-----------|
| 2017-00295-YMTC-PCT-US-<br>CON1_POA.pdf | 3     | Power of Attorney | 402 KB    |

### Digest

| DOCUMENT                                | MESSAGE DIGEST(SHA-512)                                                                                                                  |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| 2017-00295-YMTC-PCT-US-<br>CON1_POA.pdf | 91D51F2374728491FF3389528924C0CDE5A236B477AD5A2A62<br>7876A018BCC9F99E9DC72A664FD243868A8BC03A09A106C45<br>594DB253FE4813FC48AC9DAF7DFDE |

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.