

MAGNETIC TUNNEL JUNCTION DEVICE

[0001] CROSS-REFERENCE TO RELATED APPLICATIONS

[0002] The present application is a Continuation of U.S. Application No. 15/428,842 filed February 09, 2017, which is a Continuation of U.S. Application No. 14/837,558 filed on August 27, 2015 (now U.S. Patent No. 9,608,198), which is a Continuation of U.S. Application No. 13/767,290 filed on February 14, 2013 (now U.S. Patent No. 9,123,463), which is a Continuation of U.S. Application No. 13/400,340 filed on February 20, 2012 (now U.S. Patent No. 8,405,134), which is a Continuation of U.S. Application No. 12/923,643 filed on September 30, 2010 (now U.S. Patent No. 8,319,263), which is a Continuation of U.S. Application No. 10/591,947 filed on September 8, 2006 (now U.S. Patent No. 7,884,403), which is a National Stage Application of PCT/JP2005/004720 filed on March 10, 2005, and claims priority from Japanese Application Nos. 2004-313350 and 2004-071186 filed October 28, 2004 and March 12, 2004, respectively, the entire contents of each are incorporated herein by reference.

[0003] BACKGROUND OF THE INVENTION

[0004] Field of the Invention

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

[0006] Description of Related Art

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

[0008] Figs. 8(A) and 8(B) show the structure and operation principle of a magnetic tunnel junction device (to be hereafter referred to as a “MTJ device”), which is the most important part of the MRAM. As shown in Fig. 8(A), a MTJ device comprises a tunnelling junction structure in which a tunnel barrier (to be hereafter also referred to

as a “barrier layer”) made of an oxide is sandwiched between a first and a second electrode made of a ferromagnetic metal. The tunnel barrier layer comprises an amorphous Al-O layer (see Non-Patent Document 1). As shown in Fig. 8(A), in the case of parallel magnetization alignment where the directions of magnetizations of the first and second ferromagnetic electrodes are aligned parallel, the electric resistance of the device with respect to the direction normal to the interfaces of the tunneling junction structure decreases. On the other hand, in the case of antiparallel magnetization alignment where the directions of magnetizations of the first and second ferromagnetic electrodes are aligned antiparallel as shown in Fig. 8(B), the electric resistance with respect to the direction normal to the interfaces of the tunneling junction structure increases. The resistance value does not change in a general state, so that information “1” or “0” can be stored depending on whether the resistance value is high or not. Since the parallel and antiparallel magnetization alignments can be stored in a non-volatile fashion, the device can be used as a non-volatile memory device.

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

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

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

[0012] SUMMARY OF THE INVENTION

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

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

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

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

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

[0017] In another aspect, the invention provides a method of manufacturing a magnetoresistive device comprising: preparing a substrate; depositing a first Fe(001) layer on the substrate; depositing a tunnel barrier layer on the first Fe(001) layer by

electron beam evaporation under high vacuum, the tunnel barrier layer comprising a single-crystalline MgO_x (001) or a poly-crystalline MgO_x ($0 < x < 1$) in which the (001) crystal plane is preferentially oriented; and forming a second Fe(001) layer on the tunnel barrier layer.

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

oriented. The MgO layer may be deposited using a target with the value of x in MgO_x adjusted. The value of x in MgO_x may be adjusted in the step of forming the MgO.

[0019] In yet another aspect, the invention provides a magnetoresistive device comprising a magnetic tunnel junction structure comprising a tunnel barrier layer comprising MgO(001), a first ferromagnetic material layer comprising an amorphous magnetic alloy formed on a first side of the tunnel barrier layer, and a second ferromagnetic material layer comprising an amorphous magnetic alloy formed on a second side of the tunnel barrier layer, wherein the discontinuous value (the height of the tunnel barrier) between the bottom of the conduction band of the MgO(001) layer and the Fermi energy of the first or the second ferromagnetic material layer comprising the amorphous magnetic alloy is lower than an ideal value of a perfect single-crystal with no defect.

[0020] BRIEF DESCRIPTION OF THE DRAWINGS

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

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

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

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

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

[0026] Fig. 6 shows typical magnetoresistance curves of the

Fe(001)/MgO(001)/Fe(001) MTJ device.

[0027] Fig. 7(A) shows the bias voltage dependency of the MR ratio at room

temperature, and Fig. 7(B) shows the output voltage V_{out} of the MTJ device (=bias voltage $\times$ (Rap-Rp)/Rap).

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

[0029] Fig. 9 shows an example of the basic structure of an MRAM, Fig. 9(A)

showing a perspective view of the MRAM, Fig. 9(B) showing a schematic circuit

diagram, and Fig. 9(C) showing a cross-sectional view of an example of its structure.

[0030] Fig. 10 shows how the magnetoresistance of a conventional MTJ device using

an amorphous Al-O as the tunnel barrier changes depending on the bias voltage.

[0031] Fig. 11 shows the structure of a MTJ device according to a variation of the

invention, corresponding to Fig. 1(B).

[0032] DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0033] In the context of the present specification, because MgO has a cubic crystal structure (NaCl structure), the (001) plane, the (100) plane, and the (010) plane are all equivalent. The direction perpendicular to the film surface is herein considered to be the z-axis so that the film plane can be uniformly described as (001). Also in the context of the present specification, BCC structure, which the crystalline structure of ferromagnetic electrode layer, means body-centered cubic lattice structure. More specifically, BCC structure includes the BCC structure with no chemical ordering so-called A2-type structure, the BCC structure with chemical ordering such as B2-type structure and L2₁-type structure, and also the aforementioned structures with slight lattice distortion.

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

barrier of an ideal single-crystal MgO with hardly any oxygen vacancy defect or lattice defect.

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

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

[0037] where R_p and R_{ap} indicate the tunnel junction resistance in the cases of parallel and antiparallel magnetization alignments, respectively, of two electrodes.

According to the Jullire's formula, the MR ratio at low bias voltage can be expressed by:

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

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

$$[0040] \text{ where } \alpha = 1, 2 \quad (1)$$

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

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

[0043] The inventors tried an approach to deposit a MTJ device in which the tunnel barrier comprises a single-crystal (001) of magnesium oxide (MgO) or a polycrystalline MgO in which the (001) crystal plane is preferentially oriented. It is the inventors' theory that, because magnesium oxide is a crystal (where the atoms are arranged in an orderly fashion), as opposed to the conventional amorphous Al-O barrier, the electrons are not scattered and the coherent states of electrons are

concerned during the tunneling process. Fig. 1(B) shows the MTJ device structure according to an embodiment of the invention. Fig. 1(A) shows the energy band structure of the ferromagnetic Fe(001), that is, the $E-E_F$ relationship with respect to the [001] direction of the momentum space. As shown in Fig. 1(B), the MTJ device structure of the present embodiment comprises a first Fe (001) layer 1, a second Fe (001) layer 5, and a single-crystalline MgO_x (001) layer 3 or a poly-crystalline MgO_x ($0 < x < 1$) layer 3 sandwiched therebetween, the polycrystalline layer having the (001) crystal plane preferentially oriented therein. According to the aforementioned Jullire's model, assuming that the momentum of the conduction electrons is preserved in the tunneling process, the tunneling current that passes through MgO would be dominated by those electrons with wave vector k_z in the direction perpendicular to the tunnel barrier (normal to the junction interfaces). In accordance with the energy band diagram shown in Fig. 1(A) of Fe in the [001] (Γ -H) direction, the density of state (DOS) at the Fermi energy E_F does not exhibit a very high spin polarization due to the fact that the sub-bands of the majority-spin and the minority-spin have states at the Fermi energy E_F . However, in case the coherent states of electrons are conserved in the tunneling process, only those conduction electrons that have totally symmetrical

wave functions with respect to the axis perpendicular to the barrier would be coupled with the states in the barrier region and come to have a finite tunneling probability. The Δ_1 band in the Fe(001) electrode has such totally symmetric wave functions. As shown in Fig. 1(A), the majority spin Δ_1 band (solid line) has states at the Fermi energy E_F , whereas the minority spin Δ_1 band (broken line) does not have state at the Fermi energy E_F . Because of such half-metallic characteristics of the Fe Δ_1 band, there is the possibility that a very high MR ratio can be obtained in a coherent spin polarized tunneling. Since in an epitaxial (single-crystal, or (001) oriented polycrystal) MTJ device the scattering of electrons is suppressed during the tunneling process, an epitaxial MTJ device is thought to be ideal for realizing the aforementioned coherent tunneling.

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

device”). Fe(001) refers to a ferromagnetic material with the BCC structure. First, a single-crystal MgO(001) substrate 11 was prepared. In order to improve the morphology of the surface of the single-crystal MgO(001) substrate 11, a MgO(001) seed layer 15 was grown by the molecular beam epitaxy (MBE) method. This was subsequently followed by the growth of an epitaxial Fe(001) lower electrode (first electrode) 17 with the thickness of 50 nm on the MgO(001) seed layer 15 at room temperature, as shown in Fig. 1(B), and then annealing was performed at 350°C under ultrahigh vacuum (2×10^{-8} Pa). Electron-beam evaporation conditions included an acceleration voltage of 8 kV, a growth rate of 0.02 nm/sec, and the growth temperature of room temperature (about 293K). The source material of the electron-beam evaporation was MgO of the stoichiometric composition (the ratio of Mg to O being 1:1), the distance between the source and the substrate was 40 cm, the base vacuum pressure was 1×10^{-8} Pa, and the O₂ partial pressure was 1×10^{-6} Pa. Alternatively, a source with oxygen vacancy defects may be used instead of the MgO of the stoichiometric composition (the ratio of Mg to O is 1:1).

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

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

[0047] The aforementioned MgO evaporation using an electron beam involved the formation of a film under ultrahigh vacuum of 10^{-9} Torr. It can be seen that in this method, the film, even when formed on a glass substrate to the thickness of 300 nm, was colorless and transparent, showing that a good crystal film was formed. Fig. 4 shows the results of observing the quadrupole mass spectra in the deposition chamber during the MgO growth. The results show that the partial pressures regarding the spectrum P1 of O and the spectrum P2 of O₂ are high. Fig. 5 shows the film deposition rate dependency of the oxygen partial pressure during MgO evaporation. It will be seen from the figure that the oxygen partial pressure itself is high, and that the oxygen partial pressure increases as the deposition rate increases. These results indicate the separation of oxygen from MgO during the deposition of MgO. Since the separated oxygen is pumped out of the deposition chamber using vacuum pumps, there is the possibility that there are oxygen vacancy defects such as MgO_x ($0.9 < x < 1$). When there are oxygen vacancy defects, the potential barrier height of the MgO tunnel barrier is thought to decrease (such as in the range of 0.10 to 0.85 eV; more specifically, 0.2 to 0.5 eV), which is thought to result in an increase in the tunneling current. In the case of a typical Al-O tunnel barrier, the height of the tunnel barrier

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

[0048] The aforementioned tunnel barrier height ϕ was determined by fitting the electric conductance characteristics of the MTJ device (the relationship between tunnel current density J and bias voltage V) onto the Simmons' formula (Equation (20) in a non-patent document by J. G. Simmons: J. Appl. Phys. 34, pp. 1793-1803 (1963)) based on the WKB approximation, using the least squares method. The fitting was performed using the free electron mass ($m = 9.11 \times 10^{-31}$ kg) as the electron's

effective mass. When a bias voltage V (which is normally on the order of 500 mV to 1000 mV) is applied until non-linearity appears in the J-V characteristics, the height ϕ of the tunnel barrier and the effective thickness Δs of the tunnel barrier can be simultaneously determined by fitting the J-V characteristics using the Simmons' formula.

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

[0050] It is noted that, in the event that t_{MgO} can be accurately determined using the cross-sectional transmission electron microscope (TEM) image, the height ϕ of the tunnel barrier can be more simply determined by the following technique. Namely, when the bias voltage V applied to the MTJ device is small (normally 100 mV or

smaller), the tunnel current density J is proportional to the bias voltage V , such that the J-V characteristics become linear. In such a low-bias voltage region, the Simmons' formula can be described as follows:

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

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

[0053] Fig. 6 shows a typical magnetoresistance curve of the

Fe(001)/MgO(001)/Fe(001) MTJ device produced by the above-described method.

The MR ratio is 146% at the measurement temperature of 20K and 88% at the measurement temperature of 293K. These values represent the highest MR ratios that have so far been obtained at room temperature. Such high MR ratios cannot be explained by the spin polarization of the Fe(001) electrode and is thought rather to be related to a coherent spin-polarized tunneling. When 160 prototype MTJ devices were

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

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

voltage suggest the effectiveness of the technique according to the present embodiment.

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

[0056] Hereafter, a MTJ device according to a second embodiment of the invention and a method of manufacturing the same will be described. In the method of manufacturing a Fe(001)/MgO(001)/Fe(001) MTJ device according to the present embodiment, MgO(001) is initially deposited in a poly-crystalline or amorphous state by sputtering or the like, and then an annealing process is performed such that a poly-crystal in which the (001) crystal plane is preferentially oriented or a single-crystal is obtained. The sputtering conditions were such that, for example, the temperature was room temperature (293K), a 2-inch ϕ MgO was used as a target, and sputtering was conducted in an Ar atmosphere. The acceleration power was 200 W and the growth

rate was 0.008 nm/s. Because MgO that is deposited under these conditions is in an amorphous state, a crystallized MgO was obtained by increasing the temperature to 300°C from room temperature and maintaining that temperature for a certain duration of time.

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

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

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

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

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

[0061] While the MTJ device according to various embodiments of the invention has been described, it should be apparent to those skilled in the art that the invention is

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

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

art, making the MTJ device of the invention suitable for very large scale integrated
MRAMs of gigabit class.

What is claimed is:

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

a tunnel barrier layer;

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

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

said tunnel barrier layer is formed by a single-crystalline M_gO_x (001) layer or a poly-crystalline M_gO_x ($0 < x < 1$) layer in which the (001) crystal plane is preferentially oriented.

Abstract of the Disclosure

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

FIG. 1 (A)

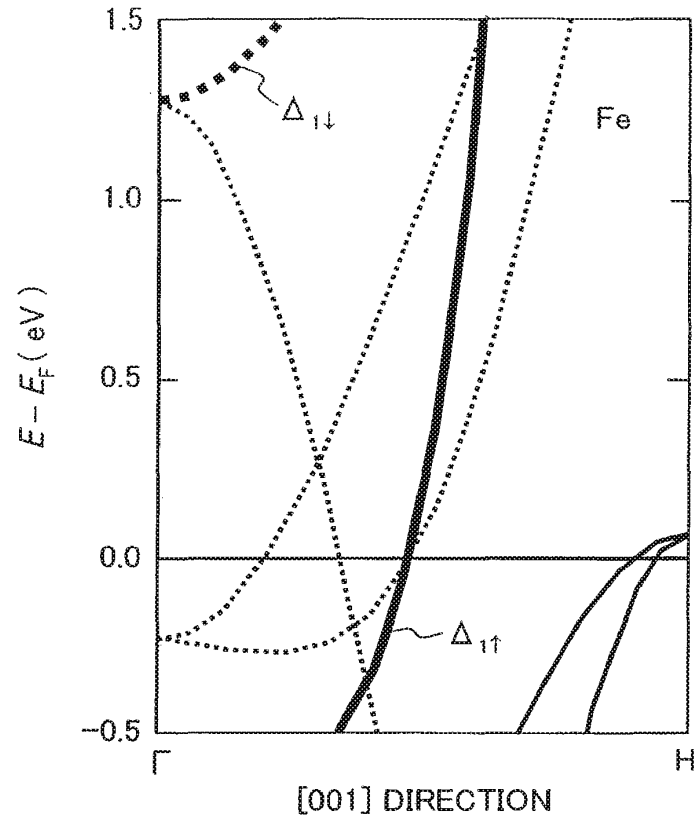


FIG. 1 (B)

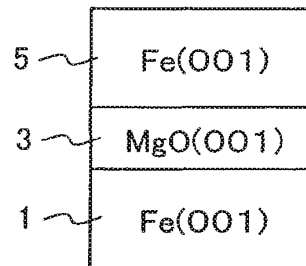


FIG. 2 (A)

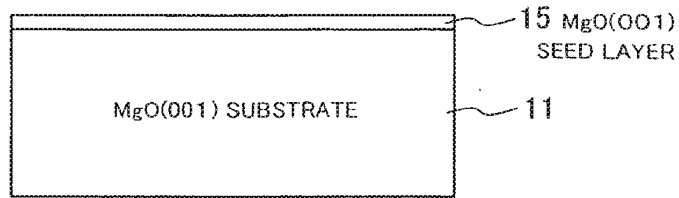


FIG. 2 (B)

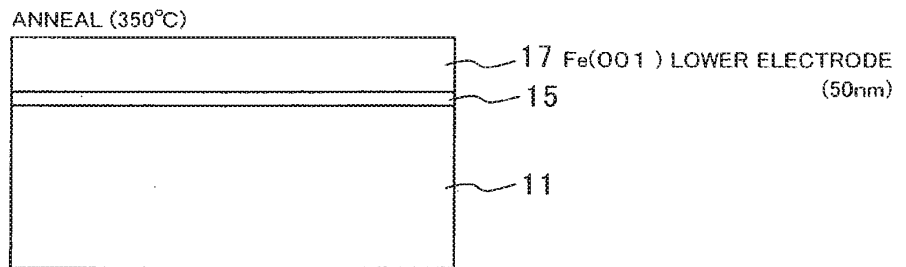


FIG. 2 (C)

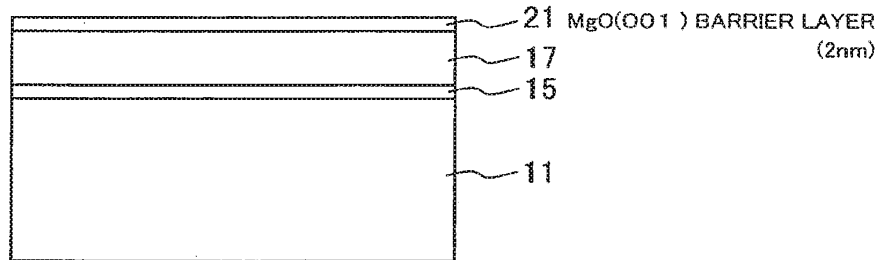


FIG. 2 (D)

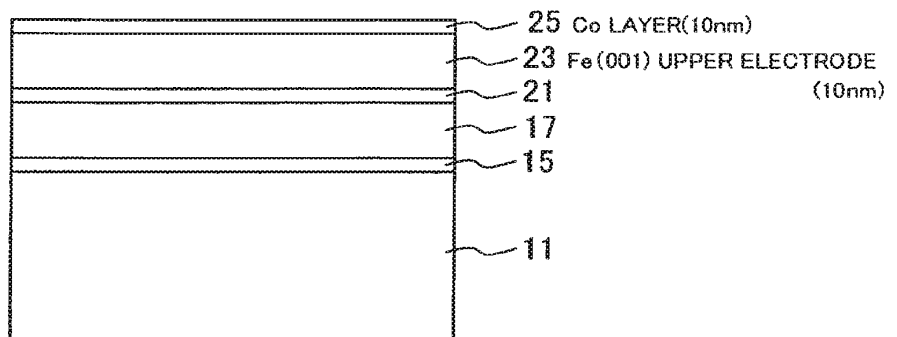


FIG. 3 (A)

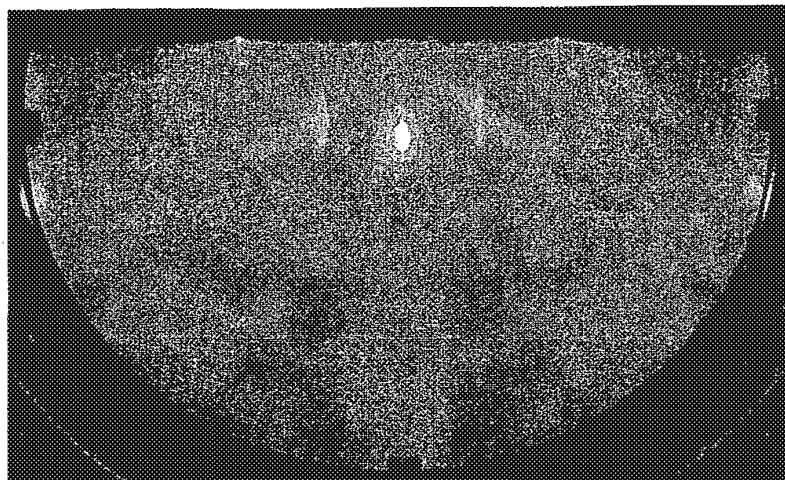


FIG. 3 (B)

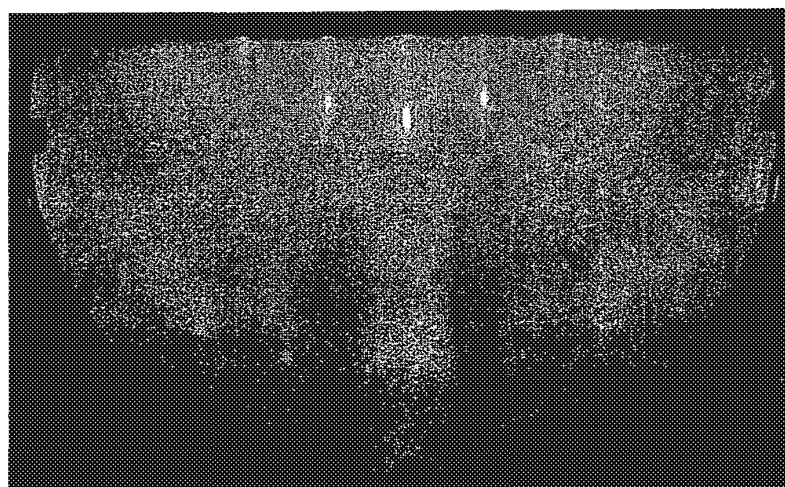


FIG. 4

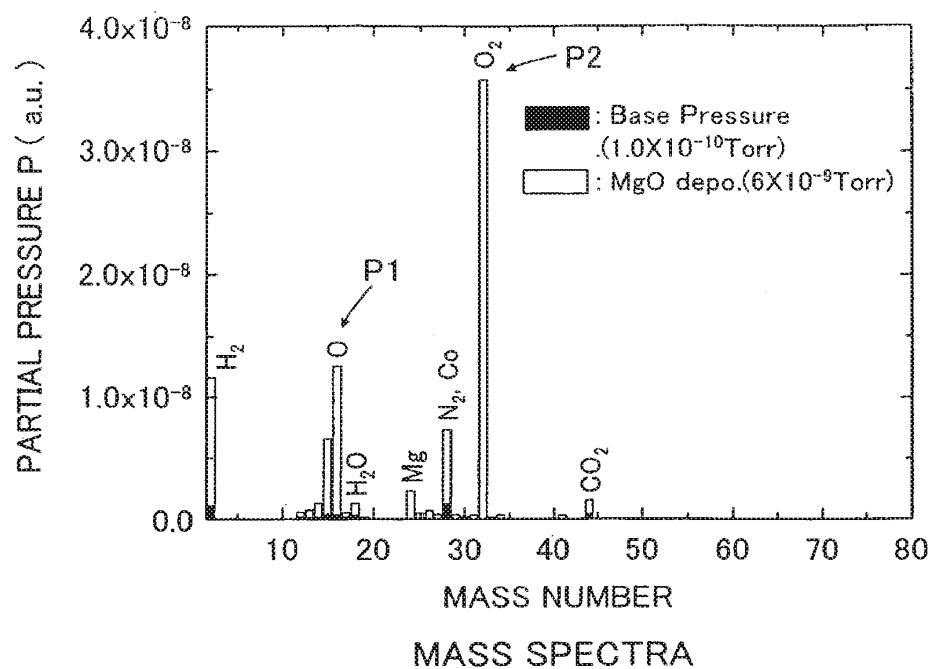
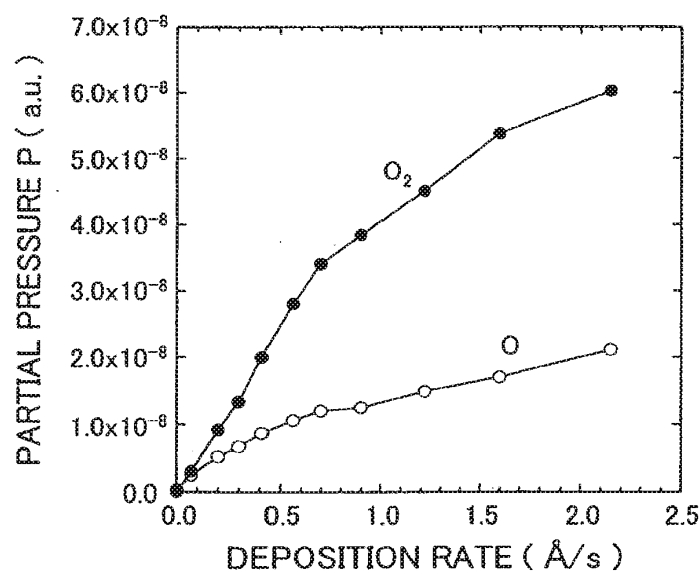


FIG. 5



OXYGEN PARTIAL PRESSURE DURING MgO EVAPORATION

FIG. 6

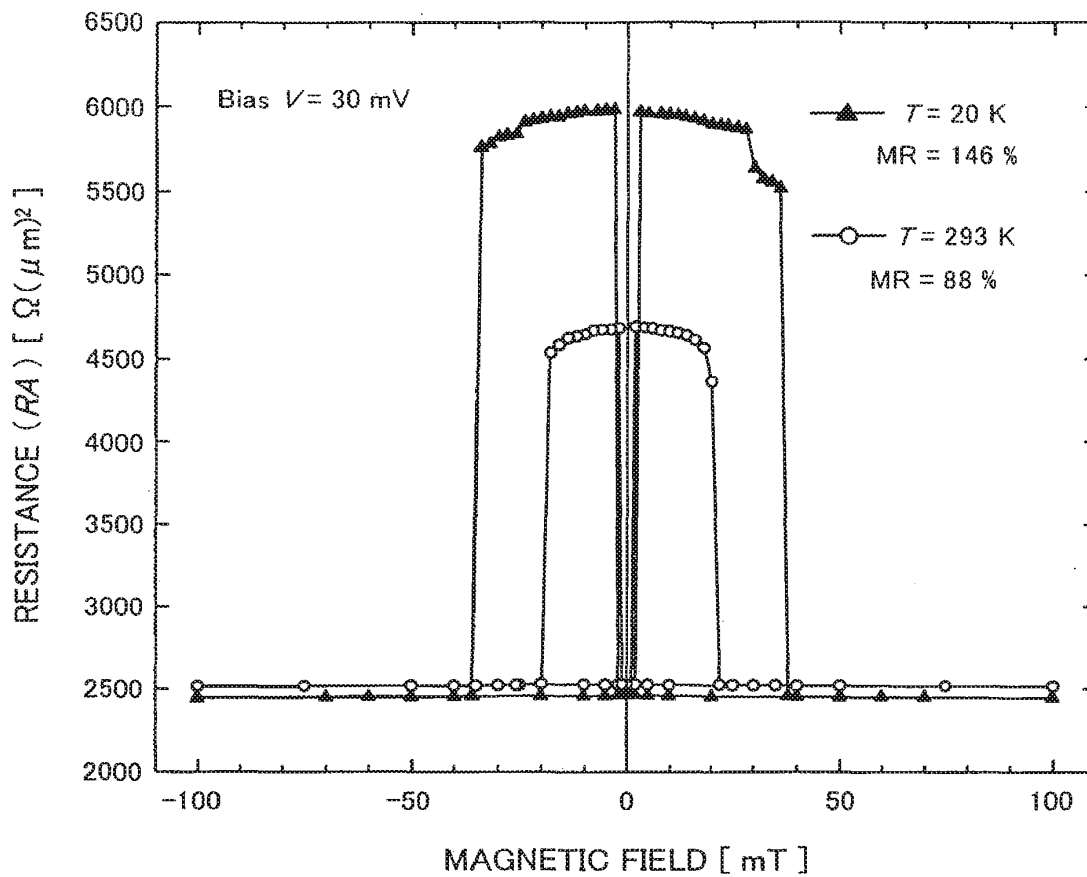


FIG. 7 (A)

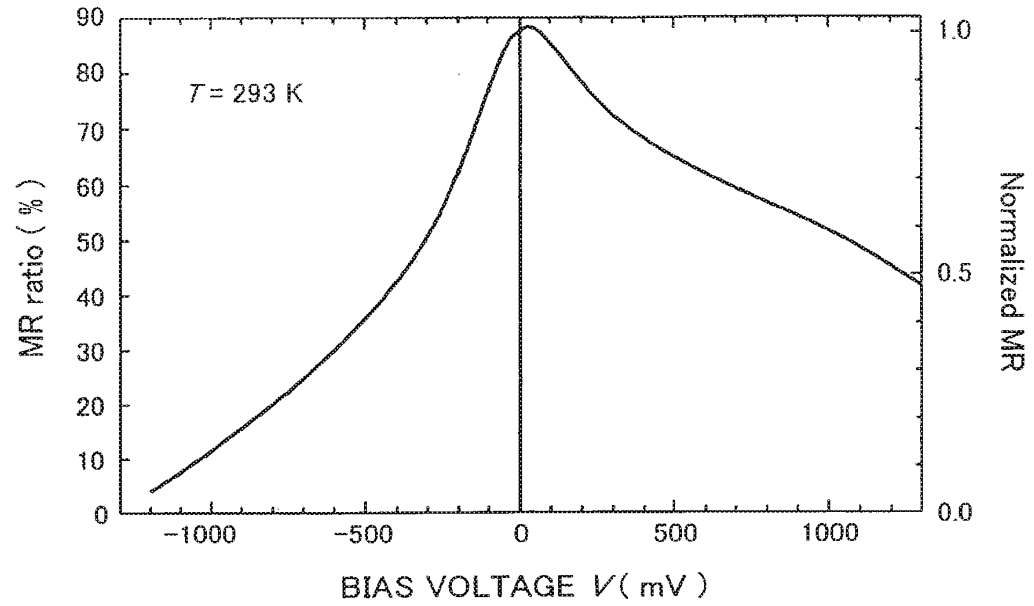


FIG. 7 (B)

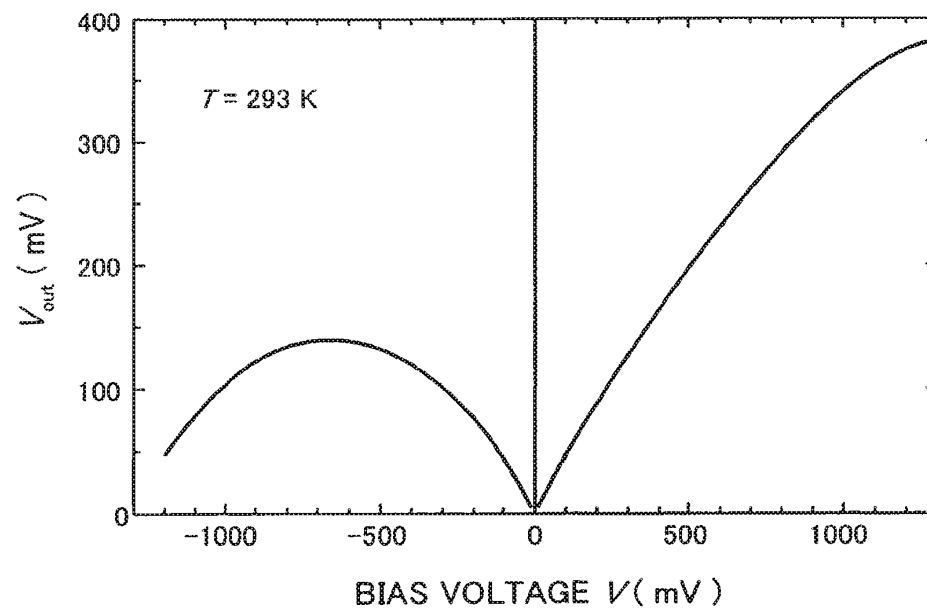


FIG. 8 (A)

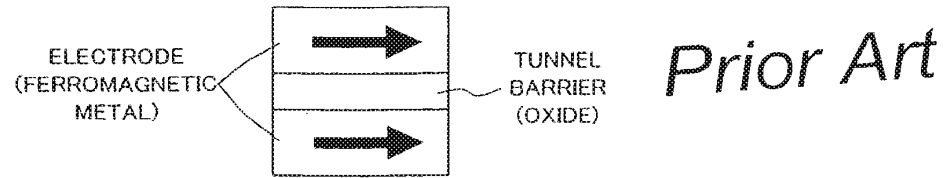


FIG. 8 (B)



FIG. 9 (A)

Prior Art

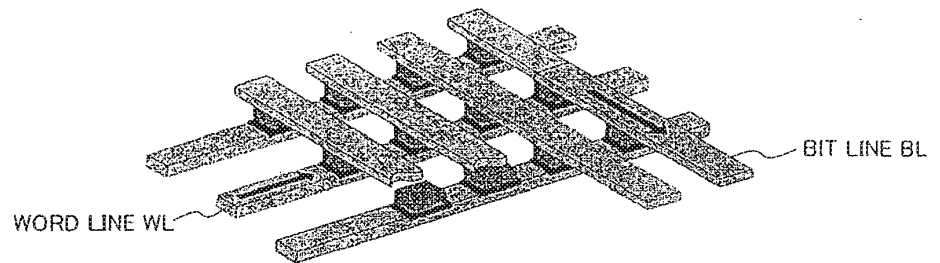


FIG. 9 (B)

Prior Art

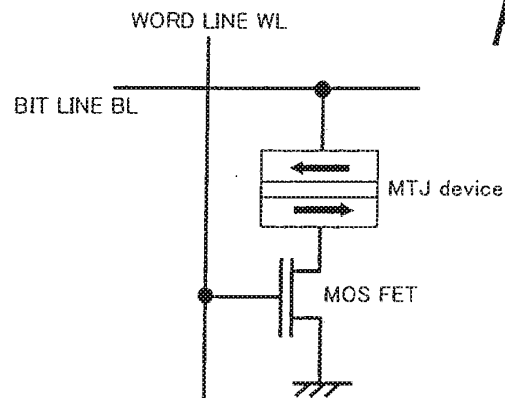


FIG. 9 (C)

Prior Art

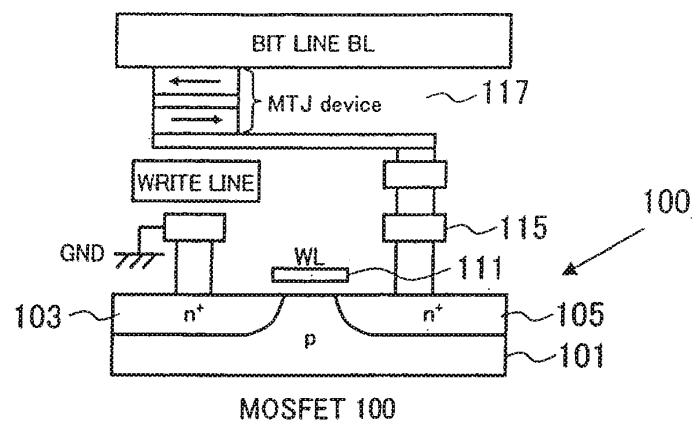


FIG. 10

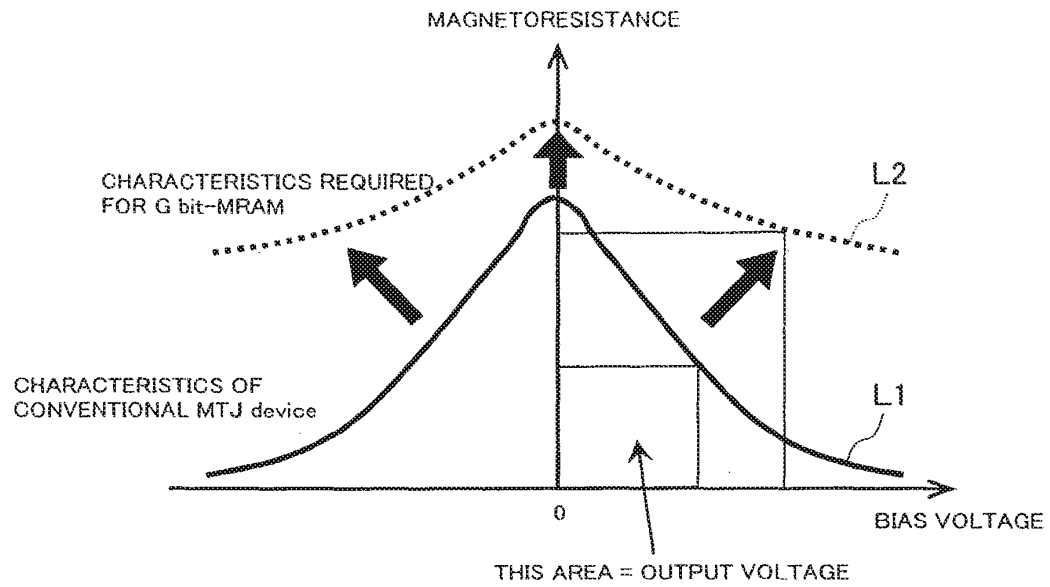
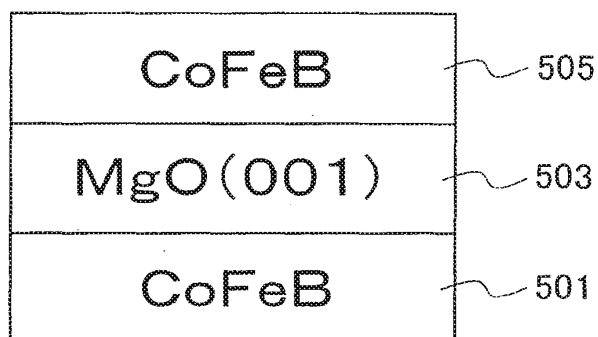


FIG. 11



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.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	12956US07CON
		Application Number	
Title of Invention	MAGNETIC TUNNEL JUNCTION DEVICE		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)
--

Inventor Information:

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

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).			
☐ An Address is being provided for the correspondence information of this application.			
Customer Number	154930		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	MAGNETIC TUNNEL JUNCTION DEVICE		
Attorney Docket Number	12956US07CON	Small Entity Status Claimed	☐
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.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	12956US07CON
		Application Number	
Title of Invention	MAGNETIC TUNNEL JUNCTION 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:	☒ Customer Number	US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number	154930		

Domestic Benefit/National Stage Information:

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

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

Prior Application Status	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	15428842	2017-02-09

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.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number		12956US07CON	
		Application Number			
Title of Invention		MAGNETIC TUNNEL JUNCTION DEVICE			

Prior Application Status		Patented		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15428842	Continuation of	14837558	2015-08-27	9608198	2017-03-28
Prior Application Status		Patented		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
14837558	Continuation of	13767290	2013-02-14	9123463	2015-09-01
Prior Application Status		Patented		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
13767290	Continuation of	13400340	2012-02-20	8405134	2013-03-26
Prior Application Status		Patented		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
13400340	Continuation of	12923643	2010-09-30	8319263	2012-11-27
Prior Application Status		Patented		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
12923643	Continuation of	10591947	2006-09-08	7884403	2011-02-08
Prior Application Status		Expired		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
10591947	a 371 of international	PCT/JP2005/004720	2005-03-10		
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.					
Add					

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)ⁱ 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 ⁱ	Filing Date (YYYY-MM-DD)	Access Code ⁱ (if applicable)
2004-313350		JP	2004-10-28	

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.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	12956US07CON
		Application Number	
Title of Invention	MAGNETIC TUNNEL JUNCTION DEVICE		

Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	Remove Access Code ^j (if applicable)
2004-071186	JP	2004-03-12	
Additional Foreign Priority Data may be generated within this form by selecting the Add button.			Add

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

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013. NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	12956US07CON
		Application Number	
Title of Invention	MAGNETIC TUNNEL JUNCTION 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.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	12956US07CON
		Application Number	
Title of Invention	MAGNETIC TUNNEL JUNCTION 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.			
Applicant	1		Remove
If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.			
		Clear	
☒ Assignee	Legal Representative under 35 U.S.C. 117		Joint Inventor
Person to whom the inventor is obligated to assign.		Person who shows sufficient proprietary interest	
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:			
Name of the Deceased or Legally Incapacitated Inventor:			
If the Applicant is an Organization check here. ☒			
Organization Name	Japan Science and Technology Agency		
Mailing Address Information For Applicant:			
Address 1	1-8, Hon-cho 4-chome		
Address 2			
City	Kawaguchi-shi, Saitama	State/Province	
Country	JP	Postal Code	332-0012
Phone Number		Fax Number	
Email Address			
Additional Applicant Data may be generated within this form by selecting the Add button. Add			

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.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	12956US07CON
		Application Number	
Title of Invention	MAGNETIC TUNNEL JUNCTION DEVICE		

Applicant	2 Remove		
If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section. Clear			
☒ Assignee	Legal Representative under 35 U.S.C. 117		Joint Inventor
Person to whom the inventor is obligated to assign.		Person who shows sufficient proprietary interest	
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:			
Name of the Deceased or Legally Incapacitated Inventor:			
If the Applicant is an Organization check here. ☒			
Organization Name	National Institute of Advanced Industrial Science and Technology		
Mailing Address Information For Applicant:			
Address 1	3-1, Kasumigaseki 1-chome,		
Address 2	Chiyoda-ku		
City	Tokyo	State/Province	
Country	JP	Postal Code	100-8921
Phone Number		Fax Number	
Email Address			
Additional Applicant Data may be generated within this form by selecting the Add button. Add			

Assignee Information including Non-Applicant Assignee Information:

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

Assignee	1 Remove
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. ☒	

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.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	12956US07CON
		Application Number	
Title of Invention	MAGNETIC TUNNEL JUNCTION DEVICE		

Organization Name	Japan Science and Technology Agency
-------------------	-------------------------------------

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1	1-8, Hon-cho 4-chome		
Address 2			
City	Kawaguchi-shi, Saitama	State/Province	
Country i	JP	Postal Code	332-0012
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

Add

--

Assignee 2

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.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here.



Organization Name	National Institute of Advanced Industrial Science and Technology
-------------------	--

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1	3-1, Kasumigaseki 1-chome,		
Address 2	Chiyoda-ku		
City	Tokyo	State/Province	
Country i	JP	Postal Code	100-8921
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	12956US07CON
		Application Number	
Title of Invention	MAGNETIC TUNNEL JUNCTION DEVICE		

Signature:

Remove

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

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

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

Signature	/James J Kulbaski/			Date (YYYY-MM-DD)	2019-06-17
First Name	James J.	Last Name	Kulbaski	Registration Number	34,648
Additional Signature may be generated within this form by selecting the Add button.					Add

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

Privacy Act Statement

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

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

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

Doc Code: 04TH - Document Description: Oath or declaration filed

Customized FTO/MA/08 (05-12)

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63) – and POWER [NOTE: Earliest of US or PCT application filing date must be on or after September 16, 2012]	Docket No.	NAGI-0005
	1 st Inventor	YUASA
	COMPLETE IF KNOWN	
	Appl. No.	13/767,290
	Filing Date	February 14, 2013
☐ Declaration Submitted with Initial Filing	Art Unit	2897
☒ Declaration Submitted after Initial Filing	Examiner	Chambless, Alonzo

TITLE OF INVENTION	Magnetic Tunnel Junction Device
-------------------------------	---------------------------------

As the below named inventor(s), I hereby declare that:

This declaration is directed to:

☐ The attached application,
☒ US Application No. 13/767,290
 filed on February 14, 2013

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than (5) years, or both.

Further, I have reviewed and understand the contents of the above-identified application; and I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

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

☐ Additional inventors named on supplemental sheet provided herewith

Stites & Harbison PLLC • 1199 North Fairfax Street • Suite 900 • Alexandria Virginia 22314 US • (703) 739-4800 • Post AIA

2358LY:00005:2235621:ALEXANDRIA

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UTILITY PATENT APPLICATION TRANSMITTAL (Only for new nonprovisional applications under 37 CFR 1.53(b))		Attorney Docket No.	12956US07CON
		First Named Inventor	Shinji YUASA
		Title	MAGNETIC TUNNEL JUNCTION DEVICE
		Priority Mail Express® Label No.	
APPLICATION ELEMENTS See MPEP chapter 600 concerning utility patent application contents.		Commissioner for Patents P.O. Box 1450 Alexandria, VA 22313-1450	
1. ☒ Fee Transmittal Form (PTO/SB/17 or equivalent) 2. ☐ Applicant asserts small entity status. See 37 CFR 1.27 3. ☐ Applicant certifies micro entity status. See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent. 4. ☒ Specification [Total Pages <u>30</u>] Both the claims and abstract must start on a new page. (See MPEP § 608.01(a) for information on the preferred arrangement) 5. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets <u>10</u>] 6. ☒ Inventor's Oath or Declaration [Total Pages <u>1</u>] (including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e)) a. ☐ Newly executed (original or copy) b. ☒ A copy from a prior application (37 CFR 1.63(d)) 7. ☒ Application Data Sheet * See note below. See 37 CFR 1.76 (PTO/AIA/14 or equivalent) 8. CD-ROM or CD-R in duplicate, large table, or Computer Program (Appendix) ☐ Landscape Table on CD 9. Nucleotide and/or Amino Acid Sequence Submission (if applicable, items a. – c. are required) a. ☐ Computer Readable Form (CRF) b. ☐ Specification Sequence Listing on: i. ☐ CD-ROM or CD-R (2 copies); or ii. ☐ Paper c. ☐ Statements verifying identity of above copies		ACCOMPANYING APPLICATION PAPERS 10. ☐ Assignment Papers (cover sheet & document(s)) Name of Assignee _____ 11. ☐ 37 CFR 3.73(c) Statement (when there is an assignee) ☒ Power of Attorney 12. ☐ English Translation Document (if applicable) 13. ☐ Information Disclosure Statement (PTO/SB/08 or PTO-1449) ☐ Copies of citations attached 14. ☐ Preliminary Amendment 15. ☐ Return Receipt Postcard (MPEP § 503) (Should be specifically itemized) 16. ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed) 17. ☐ Nonpublication Request Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent. 18. ☐ Other: _____ _____ _____ _____	
*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).			
19. CORRESPONDENCE ADDRESS			
☒ The address associated with Customer Number: <u>154930</u> OR ☐ Correspondence address below			
Name _____			
Address _____			
City _____		State _____	Zip Code _____
Country _____		Telephone _____	Email _____
Signature	/James J Kulbaski/		Date
Name (Print/Type)	James J. Kulbaski		Registration No. (Attorney/Agent)
			2019-06-17
			34,648

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.

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.

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

FEE TRANSMITTAL		Complete if known	
		Application Number	New Application
☐ Applicant asserts small entity status. See 37 CFR 1.27.		Filing Date	Herewith
☐ Applicant certifies micro entity status. See 37 CFR 1.29. Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.		First Named Inventor	Shinji YUASA
TOTAL AMOUNT OF PAYMENT (\$)		Examiner Name	
		Art Unit	
(\$)		Practitioner Docket No.	12956US07CON

METHOD OF PAYMENT (check all that apply)

☐ Check ☒ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☒ Deposit Account Deposit Account Number: 602325 Deposit Account Name: Xsensius, LLP

For the above-identified deposit account, the Director is hereby authorized to (check all that apply):

☐ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☒ Charge any additional fee(s) or underpayment of fee(s) ☐ Credit any overpayment of fee(s) under 37 CFR 1.16 and 1.17

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES (U = undiscounted fee; S = small entity fee; M = micro entity fee)

Application Type	FILING FEES			SEARCH FEES			EXAMINATION FEES			Fees Paid (\$)
	U (\$)	S (\$)	M (\$)	U (\$)	S (\$)	M (\$)	U (\$)	S (\$)	M (\$)	
Utility	300	150*	75	660	330	165	760	380	190	1,720
Design	200	100	50	160	80	40	600	300	150	
Plant	200	100	50	420	210	105	620	310	155	
Reissue	300	150	75	660	330	165	2,200	1,100	550	
Provisional	280	140	70	0	0	0	0	0	0	

* The \$150 small entity status filing fee for a utility application is further reduced to \$75 for a small entity status applicant who files the application via EFS-Web.

2. EXCESS CLAIM FEES

Fee Description	Undiscounted Fee (\$)	Small Entity Fee (\$)	Micro Entity Fee (\$)
Each claim over 20 (including Reissues)	100	50	25
Each independent claim over 3 (including Reissues)	460	230	115
Multiple dependent claims	820	410	205

Total Claims	Extra Claims	Fee (\$)	Fee Paid (\$)	Multiple Dependent Claims	Fee (\$)	Fee Paid (\$)
1	-20 or HP = 0	x 0	= 0			
HP = highest number of total claims paid for, if greater than 20.						
Indep. Claims	Extra Claims	Fee (\$)	Fee Paid (\$)			
1	-3 or HP = 0	x 0	= 0			
HP = highest number of independent claims paid for, if greater than 3.						

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is \$400 (\$200 for small entity) (\$100 for micro entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof	Fee (\$)	Fee Paid (\$)
40	- 100 = 0	/ 50 = 0 (round up to a whole number)	x 0	= 0

4. OTHER FEE(S)

Non-English specification, \$130 fee (no small or micro entity discount)

Non-electronic filing fee under 37 CFR 1.16(t) for a utility application, \$400 fee (\$200 small or micro entity)

Other (e.g., late filing surcharge): _____

SUBMITTED BY

Signature	/James J Kulbaski/	Registration No. (Attorney/Agent) 34,648	Telephone (571) 376-6333
Name (Print/Type)	James J. Kulbaski		Date

This collection of information is required by 37 CFR 1.136. 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, 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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The information provided by you in this form will be subject to the following routine uses:

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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).
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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)).
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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.

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	New Application
Filing Date	Herewith
First Named Inventor	Shinji YUASA
Title	MAGNETIC TUNNEL JUNCTION DEVICE
Art Unit	
Examiner Name	
Attorney Docket Number	12956US07CON

SIGNATURE of Applicant or Patent Practitioner

Signature	/James J Kulbaski/	Date (Optional)	
Name	James J. Kulbaski	Registration Number	34,648
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)	Japan Science and Technology Agency		

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 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.**

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

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:

154930

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):

Japan Science and Technology Agency



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

Ryoji HARAGUCHI

Title

Director, Department of Intellectual Property Management

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.

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	New Application
Filing Date	Herewith
First Named Inventor	Shinji YUASA
Title	MAGNETIC TUNNEL JUNCTION DEVICE
Art Unit	
Examiner Name	
Attorney Docket Number	12956US07CON

SIGNATURE of Applicant or Patent Practitioner

Signature	/James J Kulbaski/	Date (Optional)	
Name	James J. Kulbaski	Registration Number	34,648
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)	National Institute of Advanced Industrial Science and Technology		

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 1 forms are submitted.

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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: 154930
- 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):

NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY

- ☐ 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	<i>Tetsuya Nagaishi</i>	Date (Optional)	
Name	NAGAISHI Tetsuya		
Title	Director, Intellectual Property and Standardization Promotion Division		

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.

Electronic Patent Application Fee Transmittal				
Application Number:				
Filing Date:				
Title of Invention:		MAGNETIC TUNNEL JUNCTION DEVICE		
First Named Inventor/Applicant Name:		Shinji YUASA		
Filer:		James J. Kulbaski/Xsensus Paralegal		
Attorney Docket Number:		12956US07CON		
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(\$)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1720

Electronic Acknowledgement Receipt	
EFS ID:	36325465
Application Number:	16443875
International Application Number:	
Confirmation Number:	1667
Title of Invention:	MAGNETIC TUNNEL JUNCTION DEVICE
First Named Inventor/Applicant Name:	Shinji YUASA
Customer Number:	154930
Filer:	James J. Kulbaski/Xsensus Paralegal
Filer Authorized By:	James J. Kulbaski
Attorney Docket Number:	12956US07CON
Receipt Date:	18-JUN-2019
Filing Date:	
Time Stamp:	01:02:53
Application Type:	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	061819INTEFSW01035600
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	Transmittal of New Application	12956US07CON_PTOAIA15.pdf	280336	no	2
			32ac5fbbd0f8f0e5d849252bcb8829ca9e1c633a		
Warnings:					
Information:					
2	Transmittal Letter	12956US07CON_PTOSB17.pdf	209972	no	2
			f507961157bf780314307a7620c50b99116e5aa8		
Warnings:					
Information:					
3		12956US07CON_Specification.pdf	142480	yes	30
			2f6ea7fddc72845a700611a107ad2a7fea2abcaf		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	28	
	Claims		29	29	
	Abstract		30	30	
Warnings:					
Information:					
4	Drawings-only black and white line drawings	12956US07CON_Drawings.pdf	278927	no	10
			dc569b3d5599adc0dfca48751aa1079491b50716		
Warnings:					
Information:					
5	Application Data Sheet	12956US07CON_ADS.pdf	1256922	no	10
			e8f298fb302cabea91bd1f5f5a8982ce2d2f106e		

Warnings:					
Information:					
6	Oath or Declaration filed	12956US07CON_Declaration.pdf	141944 e6b88b0e74e4f337d3183f46b2559581f3c3efb4	no	1
Warnings:					
Information:					
7	Power of Attorney	12956US07CON_POA_1.pdf	355130 d4139c3dcd9653ca627e7b28937782014b924be3	no	2
Warnings:					
Information:					
8	Power of Attorney	12956US07CON_POA_2.pdf	376209 ea4af98869b6acdb901213bc49e666e35faf3a3a	no	2
Warnings:					
Information:					
9	Fee Worksheet (SB06)	fee-info.pdf	35028 30dda322a75d2ed367bd1fad4dc4a5c941eaf40c	no	2
Warnings:					
Information:					
Total Files Size (in bytes):			3076948		
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DOCKET NO: 12956US07CON

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF :
SHINJI YUASA : EXAMINER: UNASSIGNED
SERIAL NO: 16/443,875 :
FILED: JUNE 18, 2019 : GROUP ART UNIT: 2827
FOR: MAGNETIC TUNNEL JUNCTION :
DEVICE :

PRELIMINARY AMENDMENT

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

Commissioner:

Prior to examination, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims which begins on page 2
of this paper.

Remarks/Arguments begin on page 7 of this paper.

IN THE CLAIMS

Please amend the claims as follows:

Claim 1 (Original): A magnetoresistive device comprising a magnetic tunnel junction structure comprising:

a tunnel barrier layer;

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

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

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

2. (New) A method of manufacturing a magnetic tunnel junction (MTJ) device, comprising:

forming a first CoFeB layer that is amorphous;

forming a magnesium oxide (MgO) layer over the first CoFeB layer;

forming a second CoFeB layer that is amorphous over the MgO layer; and

annealing the first and second CoFeB layers and the MgO layer,

wherein the first and second CoFeB layers are crystallized by the annealing, and

wherein the MgO layer is poly-crystalline in which a (001) crystal plane is preferentially oriented.

3. (New) The method of claim 2,
wherein after the annealing, the first and second CoFeB layers are entirely crystallized.
4. (New) The method of claim 2,
wherein after the annealing, each of the first and second CoFeB layers is poly-crystalline
in which a (001) crystal plane is preferentially oriented.
5. (New) The method of claim 2, wherein after the annealing,
the first and second CoFeB layers are entirely crystallized, and
each of the first and second CoFeB layers is poly-crystalline in which a (001) crystal
plane is preferentially oriented.
6. (New) The method of claim 2,
wherein after the annealing, each of the first and second CoFeB layers is poly-crystalline
in which a (001) crystal plane is preferentially oriented and each of the first and second CoFeB
layers includes a BCC (body-centered cubic) structure.
7. (New) The method of claim 2, wherein after the annealing,
the first and second CoFeB layers are entirely crystallized, and
each of the first and second CoFeB layers is poly-crystalline in which a (001) crystal
plane is preferentially oriented and each of the first and second CoFeB layers includes a BCC
(body-centered cubic) structure.

8. (New) The method of claim 2,
wherein in the forming the MgO layer, the MgO layer is formed as a MgO_x ($0 < x < 1$)
layer.

9. (New) The method of claim 2,
wherein in the forming the MgO layer, the value of x in MgO_x for the MgO layer is
greater than 0 and less than 1.

10. (New) The method of claim 2,
wherein in the forming the MgO layer, the MgO layer is formed directly on the first
CoFeB layer.

11. (New) The method of claim 2, wherein:
in the forming the MgO layer, the MgO layer is formed directly on the first CoFeB layer,
and
in the forming the second CoFeB layer, the second CoFeB layer is formed directly on the
MgO layer.

12. (New) A method of manufacturing a magnetic tunnel junction (MTJ) device,
comprising:
forming a first ferromagnetic layer including a first CoFeB layer that is amorphous;

forming a barrier layer including a magnesium oxide (MgO) layer to have a poly-crystalline state in which a (001) crystal plane is preferentially oriented over the first ferromagnetic layer;

forming a second ferromagnetic layer including a second CoFeB layer that is amorphous over the barrier layer; and

annealing the first and second ferromagnetic layers and the barrier layer, to crystallize the first and second CoFeB layers.

13. (New) The method of claim 12,

wherein after the annealing, the first and second CoFeB layers are entirely crystallized.

14. (New) The method of claim 12, wherein after the annealing,

the first and second CoFeB layers are entirely crystallized, and

each of the first and second CoFeB layers is poly-crystalline in which a (001) crystal plane is preferentially oriented and each of the first and second CoFeB layers includes a BCC (body-centered cubic) structure.

15. (New) The method of claim 12,

wherein in the forming the barrier layer, the MgO layer is formed as a MgO_x ($0 < x < 1$) layer.

16. (New) The method of claim 12, wherein:

in the forming the barrier layer, the barrier layer is formed directly on the first ferromagnetic layer, and

in the forming the second ferromagnetic layer, the second ferromagnetic layer is formed directly on the barrier layer.

REMARKS/ARGUMENTS

Favorable consideration of this application, as presently amended and in light of the following discussion, is respectfully requested.

Claims 1-16 are pending in the present application; Claims 2-16 having been added by way of the present amendment.

Added claims 2-16 recite the invention in method format.

Accordingly, an action on the merits is respectfully requested.

Respectfully Submitted,

XSENSUS, L.L.P.

/James J Kulbaski/

James J. Kulbaski
Attorney of Record
Registration No. 34,648
Phone No. (571) 376-6333

Customer No. 154930
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200 Daingerfield Rd, Suite 201
Alexandria, VA 22314

Electronic Acknowledgement Receipt	
EFS ID:	36392017
Application Number:	16443875
International Application Number:	
Confirmation Number:	1667
Title of Invention:	MAGNETIC TUNNEL JUNCTION DEVICE
First Named Inventor/Applicant Name:	Shinji YUASA
Customer Number:	154930
Filer:	James J. Kulbaski/Sandra Miles
Filer Authorized By:	James J. Kulbaski
Attorney Docket Number:	12956US07CON
Receipt Date:	24-JUN-2019
Filing Date:	
Time Stamp:	16:15:42
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment		no			
File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		12956US07CON_Preliminary_A mendment_signed.pdf	1791543	yes	9
			0a165c986349f39d0ff771a458c0a2d72866 bbde		

Multipart Description/PDF files in .zip description			
	Document Description	Start	End
	Transmittal Letter	1	1
	Fee Worksheet (SB06)	2	2
	Preliminary Amendment	3	3
	Claims	4	8
	Applicant Arguments/Remarks Made in an Amendment	9	9
Warnings:			
Information:			
Total Files Size (in bytes):		1791543	
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Doc Code: TRAN.LET

Document Description: Transmittal Letter

PTO/SB/21 (07-09)

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

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TRANSMITTAL FORM <i>(to be used for all correspondence after initial filing)</i>	Application Number	16/443,875	
	Filing Date	JUNE 18, 2019	
	First Named Inventor	SHINJI YUASA	
	Art Unit	2827	
	Examiner Name	TBD	
Total Number of Pages in This Submission	9	Attorney Docket Number	12956US07CON

ENCLOSURES (Check all that apply)			
☒ Fee Transmittal Form ☐ Fee Attached	☐ Drawing(s) ☐ Licensing-related Papers	☐ After Allowance Communication to TC ☐ Appeal Communication to Board of Appeals and Interferences	
☒ Amendment/Reply ☐ After Final ☐ Affidavits/declaration(s)	☐ Petition ☐ Petition to Convert to a Provisional Application ☐ Power of Attorney, Revocation ☐ Change of Correspondence Address	☐ Appeal Communication to TC (Appeal Notice, Brief, Reply Brief) ☐ Proprietary Information	
☐ Extension of Time Request ☐ Express Abandonment Request ☐ Information Disclosure Statement	☐ Terminal Disclaimer ☐ Request for Refund ☐ CD, Number of CD(s) _____ ☐ Landscape Table on CD	☐ Status Letter ☐ Other Enclosure(s) (please identify below):	
☐ Certified Copy of Priority Document(s) ☐ Reply to Missing Parts/Incomplete Application ☐ Reply to Missing Parts under 37 CFR 1.52 or 1.53	Remarks The Commissioner is hereby authorized to charge any additional fees that may be required for papers being filed herewith and for which no payment is enclosed herewith, or credit any overpayment to Deposit Account 602325, with the EXCEPTION of deficiencies in fees for multiple dependent claims.		
SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT			
Firm Name	Xsensus, LLP Customer Number: 154930		
Signature	/James J Kulbaski/		
Printed name	James J. Kulbaski		
Date	June 24, 2019	Reg. No.	34648

CERTIFICATE OF TRANSMISSION/MAILING			
I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:			
Signature			
Typed or printed name		Date	

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Doc Code: WFEE

Document Description: Fee Worksheet (PTO-875)

PTO/SB/06 (09-16)

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PATENT APPLICATION FEE DETERMINATION RECORD					Application or Docket Number 12956US07CON		
Substitute for Form PTO-875							
APPLICATION AS FILED – PART I					☐ LARGE ENTITY ☐ MICRO ENTITY ☐ SMALL ENTITY		
(Column 1) (Column 2)							
FOR	NUMBER FILED	NUMBER EXTRA					
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A					
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A					
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A					
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*					
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*					
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$400 (\$200 for small entity or \$100 for micro entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.							
APPLICATION AS AMENDED – PART II					☒ LARGE ENTITY ☐ MICRO ENTITY ☐ SMALL ENTITY		
(Column 1) (Column 2) (Column 3)							
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA			
	TOTAL (37 CFR 1.16(i))	* 16	Minus	** 20	= 0		
	INDEPENDENT (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		
	APPLICATION SIZE FEE (37 CFR 1.16(s))						
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
(Column 1) (Column 2) (Column 3)							
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA			
	TOTAL (37 CFR 1.16(i))	*	Minus	**	=		
	INDEPENDENT (37 CFR 1.16(h))	*	Minus	***	=		
	APPLICATION SIZE FEE (37 CFR 1.16(s))						
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.							

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875			Application or Docket Number 16/443,875		Filing Date 06/18/2019		☐ To be Mailed	
ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO								
APPLICATION AS FILED - PART I								
		(Column 1)	(Column 2)					
FOR		NUMBER FILED	NUMBER EXTRA		RATE (\$)		FEE (\$)	
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))		N/A	N/A		N/A			
☐ SEARCH FEE (37 CFR 1.16(k), (j), or (m))		N/A	N/A		N/A			
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))		N/A	N/A		N/A			
TOTAL CLAIMS (37 CFR 1.16(i))		minus 20 =	*		x \$100 =			
INDEPENDENT CLAIMS (37 CFR 1.16(h))		minus 3 =	*		x \$460 =			
☐ 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).						
☐ 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								
		(Column 1)	(Column 2)		(Column 3)			
AMENDMENT	06/24/2019	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)		ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(i))	* 16	Minus	** 20	= 0	x \$100 =		0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0	x \$460 =		0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
						TOTAL ADD'L FEE		0
AMENDMENT		(Column 1)		(Column 2)	(Column 3)			
		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)		ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x \$0 =		
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x \$0 =		
	☐ Application Size Fee (37 CFR 1.16(s))							
☐ 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".						/SULONDA D STEVENSON/		
*** 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.								

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO.	TOT CLAIMS	IND CLAIMS
16/443,875	06/18/2019	2827	1720	12956US07CON	16	3

CONFIRMATION NO. 1667

FILING RECEIPT



154930
XSENSUS LLP
200 Daingerfield Road
Suite 201
Alexandria, VA 22314

Date Mailed: 06/27/2019

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

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

Inventor(s)

Shinji YUASA, Ibaraki, JAPAN;

Applicant(s)

Japan Science and Technology Agency, Kawaguchi-shi, JAPAN;
National Institute of Advanced Industrial Science and Technology, Tokyo, JAPAN;

Assignment For Published Patent Application

Japan Science and Technology Agency, Kawaguchi-shi, JAPAN
National Institute of Advanced Industrial Science and Technology, Tokyo, JAPAN

Power of Attorney: The patent practitioners associated with Customer Number 154930

Domestic Priority data as claimed by applicant

This application is a CON of 15/428,842 02/09/2017
which is a CON of 14/837,558 08/27/2015 PAT 9608198
which is a CON of 13/767,290 02/14/2013 PAT 9123463
which is a CON of 13/400,340 02/20/2012 PAT 8405134
which is a CON of 12/923,643 09/30/2010 PAT 8319263
which is a CON of 10/591,947 09/08/2006 PAT 7884403
which is a 371 of PCT/JP2005/004720 03/10/2005

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

JAPAN 2004-313350 10/28/2004 No Access Code Provided

JAPAN 2004-071186 03/12/2004 No Access Code Provided

Permission to Access Application via Priority Document Exchange: Yes

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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/443,875**

Projected Publication Date: To Be Determined - pending completion of Omitted Items

Non-Publication Request: No

Early Publication Request: No

Title

MAGNETIC TUNNEL JUNCTION DEVICE

Preliminary Class

365

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

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

LICENSE FOR FOREIGN FILING UNDER
Title 35, United States Code, Section 184
Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

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

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

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

NOT GRANTED

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

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor

community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit <http://www.SelectUSA.gov> or call +1-202-482-6800.



UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/443,875	06/18/2019	Shinji YUASA	12956US07CON

CONFIRMATION NO. 1667

FORMALITIES LETTER



154930
XSENSUS LLP
200 Daingerfield Road
Suite 201
Alexandria, VA 22314

Date Mailed: 06/27/2019

NOTICE OF OMITTED ITEM(S) IN A NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

A filing date has been accorded to the above-identified nonprovisional application papers; however, the following item(s) appear to have been omitted from the application:

- Figure(s) 9 described in the specification.

Applicant must reply to this notice within the time period set forth in this notice to avoid abandonment of this application. Applicant must select one of the three following options and the reply must comply with the requirements set forth in the selected option and any other requirements set forth in this notice. **The reply should also indicate which option applicant has selected.**

I. Petition for date of deposit: Should applicant contend that the above-noted omitted item(s) was in fact deposited in the U.S. Patent and Trademark Office (USPTO) with the nonprovisional application papers, a copy of this Notice and a petition (and the petition fee set forth in 37 CFR 1.17(f) with evidence of such deposit must be filed within **TWO MONTHS** of the date of this Notice. The petition fee will be refunded if it is determined that the item(s) was received by the USPTO. THIS TWO MONTH PERIOD IS EXTENDABLE UNDER 37 CFR 1.136(a) or (b).

Applicant should review their application file and determine whether their file differs from USPTO's records. In some situations there may be a mislabeling of the drawings and/or a failure to describe in the brief description each of the figures as labeled. See 37 CFR 1.74, 1.77(b)(9), and 1.84(u)(1).

The brief description of the drawings in the specification must correspond with the figures and the figures must be labeled in accordance with 37 CFR 1.84(u)(1). For example, if the brief description describes Figure 1 and Figure 2 only, but the drawings show Fig. 1 and Fig. 2A and Fig. 2B, then the specification must be amended to refer to Figure 2A and Figure 2B and delete the reference to Figure 2 and a substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125, is required. As another example, if a drawing is labeled Figure 2, but there are actually multiple figures within the labeled Figure 2 having labels A, B, and C, then the drawings must be relabeled in accordance with 37 CFR 1.84(u)(1) (e.g., Fig. 2A, Fig. 2B, and Fig. 2C). If the specification does not refer to the figures as relabeled, then the specification must be amended to refer to the relabeled figures (e.g., Fig. 2A, Fig. 2B, and Fig. 2C) and a substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125, is required. A petition for date of deposit under option I should NOT be filed in either situation or in similar situations where there is simply a mislabeling of the drawings and/or a failure to describe in the brief description each of the figures. Instead, applicant should file a reply under option III.A below (including replacement drawing sheets and/or a substitute specification as required in III.A.2).

A petition for date of deposit under option I should NOT be filed in situations where there is simply a mislabeling of the drawings and/or a failure to describe in the brief description each of the figures. Instead, applicant should file a reply under option III(A) below (including replacement drawing sheets and/or a substitute specification as described).

II. Petition for later filing date: Should applicant desire to supply the omitted item(s) and accept the date that such omitted item(s) was filed in the USPTO as the filing date of the above-identified application, a copy of this Notice, the omitted item(s), and a petition under 37 CFR 1.182 with the petition fee set forth in 37 CFR 1.17(f) requesting the later filing date must be filed within **TWO MONTHS** of the date of this Notice. THIS TWO MONTH PERIOD IS EXTENDABLE UNDER 37 CFR 1.136(a) or (b).

Applicant is advised that generally the filing fee required for an application is the filing fee in effect on the filing date accorded the application and that payment of the requisite basic filing fee on a date later than the filing date of the application requires payment of a surcharge (37 CFR 1.16(f)). To avoid processing delays and payment of a surcharge, applicant should submit any balance due for the requisite filing fee based on the later filing date being requested when submitting the omitted item(s) and the petition (and petition fee) requesting the later filing date.

III. Acceptance of application as deposited: Applicant may accept the application as deposited in the USPTO by filing an appropriate amendment as set forth in either (A) or (B) below within **TWO MONTHS** of the date of this Notice. THIS TWO MONTH PERIOD IS EXTENDABLE UNDER 37 CFR 1.136(a) or (b). The application will maintain a filing date as of the date of deposit of the application papers in the USPTO, and original application papers (i.e., the original disclosure of the invention) will include only those application papers present in the USPTO on the date of deposit. A petition is not required for this option.

(A) If applicant wants to accept the application as deposited without adding the subject matter that was in the omitted item, applicant is required to submit one or more of the following items without adding any new matter (see 35 U.S.C. 132(a)):

To remove a missing figure of the drawings or to correct the figure labeling,

- replacement drawing sheets in compliance with 37 CFR 1.121(d) to renumber the drawing figures consecutively (if necessary), and/or
- a substitute specification excluding claims in compliance with 37 CFR 1.121(b)(3) and 1.125 that amends the specification to cancel any references to any omitted drawing(s) and corrects the references in the specification to the drawing figures to correspond with any relabeled drawing figures,

A proper substitute specification in compliance with 37 CFR 1.121(b)(3) and 1.125 consists of:

- A copy of the previously-submitted specification, with deletions shown with strikethrough or brackets and insertions shown with underlining (marked-up version) unless it is indicated above that a marked-up version is not required for each of the correction(s).
- A copy of the amended specification without markings (clean version).
- A statement that the substitute specification contains no new matter, in compliance with 37 CFR 1.121(b)(3) and 1.125.

(B) Alternatively, if applicant wants to accept the application as deposited but wishes to add the subject matter in the omitted item by relying on an incorporation by reference under 37 CFR 1.57 or other portions of the original disclosure, applicant is required to submit the following without adding any new matter (see 35 U.S.C. 132(a)):

To add a missing figure of the drawings, new and replacement drawing sheets in compliance with 37 CFR 1.121(d);

If applicant is relying on an incorporation by reference under 37 CFR 1.57 to add the omitted subject matter, then applicant must also comply with the requirements of 37 CFR 1.57.

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

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

Replies should be mailed to:

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

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice".
<https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html>

For more information about EFS-Web please call the USPTO Electronic Business Center at 1-866-217-9197 or visit our website at <http://www.uspto.gov/ebc>.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

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

/ytdemisse/

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 16/443,875			
APPLICATION AS FILED - PART I									
(Column 1)		(Column 2)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY			
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)		
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	300		
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A	660		
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760		
TOTAL CLAIMS (37 CFR 1.16(i))	16	minus 20 = *				x 100 =	0.00		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	minus 3 = *				x 460 =	0.00		
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).						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		
APPLICATION AS AMENDED - PART II									
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY	
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)	RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=	x	=
	Independent (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	
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)	RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=	x	=
	Independent (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. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.									

DOCKET NO: 12956US07CON

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF :
SHINJI YUASA : ATTN: APPLICATION DIVISION
SERIAL NO: 16/443,875 :
FILED: 06-18-2019 :
FOR: MAGNETIC TUNNEL JUNCTION :
DEVICE :

PRELIMINARY AMENDMENT

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

Commissioner:

In response to the Notice of Omitted Items mailed on June 27, 2019, please amend the
above-identified application as follows:

Amendments to the Specification begin on page 2 of this paper.

Remarks/Arguments begin on page 4 of this paper.

IN THE SPECIFICATION

Please amend the paragraph [0009] on page 4, as follows:

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

Please also amend the paragraph [0029] on page 11, as follows:

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

Docket No. 12956US07CON
Preliminary Amendment

REMARKS/ARGUMENTS

Favorable consideration of this application as presently amended and in light of the following discussion is respectfully requested.

Paragraphs [0009] and [0029] are amended herein without prejudice.

In view of the foregoing discussion and present amendment, it is respectfully submitted that this application is in condition for examination. An early and favorable action is therefore respectfully requested.

Respectfully Submitted,

XSENSUS, L.L.P.

/James J Kulbaski/

James J. Kulbaski
Attorney of Record
Registration No. 34,648

CUSTOMER NO. 154930

Phone No. 571-376-6333
Fax: 571-376-6334

Electronic Acknowledgement Receipt	
EFS ID:	36760799
Application Number:	16443875
International Application Number:	
Confirmation Number:	1667
Title of Invention:	MAGNETIC TUNNEL JUNCTION DEVICE
First Named Inventor/Applicant Name:	Shinji YUASA
Customer Number:	154930
Filer:	James J. Kulbaski/Isabelle Marquez
Filer Authorized By:	James J. Kulbaski
Attorney Docket Number:	12956US07CON
Receipt Date:	01-AUG-2019
Filing Date:	18-JUN-2019
Time Stamp:	17:47:08
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		12956US07CONPrelimforFiling.pdf	227620 99b3f134e52eb3afd11dd7dedd7e275928f9a454	yes	5

Multipart Description/PDF files in .zip description			
Document Description		Start	End
Transmittal Letter		1	1
Preliminary Amendment		2	2
Specification		3	4
Applicant Arguments/Remarks Made in an Amendment		5	5
Warnings:			
Information:			
Total Files Size (in bytes):		227620	
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. <u>New Applications Under 35 U.S.C. 111</u> 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. <u>National Stage of an International Application under 35 U.S.C. 371</u> 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. <u>New International Application Filed with the USPTO as a Receiving Office</u> 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.			

Doc Code: TRAN.LET

Document Description: Transmittal Letter

PTO/SB/21 (07-09)

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

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

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

TRANSMITTAL FORM (to be used for all correspondence after initial filing)	Application Number	16/443,875	
	Filing Date	06-18-2019	
	First Named Inventor	Shinji YUASA	
	Art Unit	2827	
	Examiner Name		
Total Number of Pages in This Submission	5	Attorney Docket Number	12956US07CON

ENCLOSURES (Check all that apply)			
☐ Fee Transmittal Form ☐ Fee Attached ☒ Amendment/Reply ☐ After Final ☐ Affidavits/declaration(s) ☐ Extension of Time Request ☐ Express Abandonment Request ☐ Information Disclosure Statement ☐ Certified Copy of Priority Document(s) ☐ Reply to Missing Parts/ Incomplete Application ☐ Reply to Missing Parts under 37 CFR 1.52 or 1.53	☐ Drawing(s) ☐ Licensing-related Papers ☐ Petition ☐ Petition to Convert to a Provisional Application ☐ Power of Attorney, Revocation Change of Correspondence Address ☐ Terminal Disclaimer ☐ Request for Refund ☐ CD, Number of CD(s) _____ ☐ Landscape Table on CD	☐ After Allowance Communication to TC ☐ Appeal Communication to Board of Appeals and Interferences ☐ Appeal Communication to TC (Appeal Notice, Brief, Reply Brief) ☐ Proprietary Information ☐ Status Letter ☒ Other Enclosure(s) (please identify below):	Remarks The Commissioner is hereby authorized to charge any additional fees that may be required for papers being filed herewith and for which no payment is enclosed herewith, or credit any overpayment to Deposit Account 602325, with the EXCEPTION of deficiencies in fees for multiple dependent claims.
SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT			
Firm Name	Xsensus, LLP Customer Number: 154930		
Signature	/James J Kulbaski/		
Printed name	James J. Kulbaski		
Date	08/01/2019	Reg. No.	34,648

CERTIFICATE OF TRANSMISSION/MAILING			
I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:			
Signature			
Typed or printed name		Date	

This collection of information is required by 37 CFR 1.5. 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 2 hours 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.

DOCKET NO: 12956US07CON

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF :
SHINJI YUASA : ATTN: APPLICATION DIVISION
SERIAL NO: 16/443,875 :
FILED: 06-18-2019 :
FOR: MAGNETIC TUNNEL JUNCTION :
DEVICE :

PRELIMINARY AMENDMENT

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

Commissioner:

In response to the Notice of Omitted Items mailed on June 27, 2019, please amend the
above-identified application as follows:

Amendments to the Specification begin on page 2 of this paper.

Remarks/Arguments begin on page 4 of this paper.

IN THE SPECIFICATION

Please amend the paragraph [0009] on page 4, as follows:

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

Please also amend the paragraph [0029] on page 11, as follows:

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

Docket No. 12956US07CON
Preliminary Amendment

REMARKS/ARGUMENTS

Favorable consideration of this application as presently amended and in light of the following discussion is respectfully requested.

Paragraphs [0009] and [0029] are amended herein without prejudice.

In view of the foregoing discussion and present amendment, it is respectfully submitted that this application is in condition for examination. An early and favorable action is therefore respectfully requested.

No new matter is added.

Respectfully Submitted,

XSENSUS, L.L.P.

/Andrew T. Harry/

Andrew T. Harry
Attorney of Record
Registration No. 56,959

CUSTOMER NO. 154930

Phone No. 571-376-6333
Fax: 571-376-6334

Electronic Acknowledgement Receipt	
EFS ID:	36761501
Application Number:	16443875
International Application Number:	
Confirmation Number:	1667
Title of Invention:	MAGNETIC TUNNEL JUNCTION DEVICE
First Named Inventor/Applicant Name:	Shinji YUASA
Customer Number:	154930
Filer:	Andrew T. Harry/Isabelle Marquez
Filer Authorized By:	Andrew T. Harry
Attorney Docket Number:	12956US07CON
Receipt Date:	01-AUG-2019
Filing Date:	18-JUN-2019
Time Stamp:	18:37:56
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		12956US07CONomittedItemsP relimforFiling.pdf	525973 c9c0fb73633f31c73628fba3bf40f4a1fe6b d29	yes	6

Multipart Description/PDF files in .zip description			
	Document Description	Start	End
	Transmittal Letter	1	1
	Applicant Response to Pre-Exam Formalities Notice	2	2
	Preliminary Amendment	3	3
	Specification	4	5
	Applicant Arguments/Remarks Made in an Amendment	6	6
Warnings:			
Information:			
Total Files Size (in bytes):		525973	
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. <u>New Applications Under 35 U.S.C. 111</u> 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. <u>National Stage of an International Application under 35 U.S.C. 371</u> 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. <u>New International Application Filed with the USPTO as a Receiving Office</u> 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.			

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.

TRANSMITTAL FORM <i>(to be used for all correspondence after initial filing)</i>	Application Number	16/443,875	
	Filing Date	06-18-2019	
	First Named Inventor	Shinji YUASA	
	Art Unit	2827	
	Examiner Name		
Total Number of Pages in This Submission	6	Attorney Docket Number	12956US07CON

ENCLOSURES (Check all that apply)		
☐ Fee Transmittal Form ☐ Fee Attached ☐ Amendment/Reply ☐ After Final ☐ Affidavits/declaration(s) ☐ Extension of Time Request ☐ Express Abandonment Request ☐ Information Disclosure Statement ☐ Certified Copy of Priority Document(s) ☐ Reply to Missing Parts/Incomplete Application ☐ Reply to Missing Parts under 37 CFR 1.52 or 1.53	☐ Drawing(s) ☐ Licensing-related Papers ☐ Petition ☐ Petition to Convert to a Provisional Application ☐ Power of Attorney, Revocation ☐ Change of Correspondence Address ☐ Terminal Disclaimer ☐ Request for Refund ☐ CD, Number of CD(s) _____ ☐ Landscape Table on CD	☐ After Allowance Communication to TC ☐ Appeal Communication to Board of Appeals and Interferences ☐ Appeal Communication to TC (Appeal Notice, Brief, Reply Brief) ☐ Proprietary Information ☐ Status Letter ☒ Other Enclosure(s) (please identify below): Preliminary Amendment; Response to Notice of Omitted Items
Remarks The Commissioner is hereby authorized to charge any additional fees that may be required for papers being filed herewith and for which no payment is enclosed herewith, or credit any overpayment to Deposit Account 602325, with the EXCEPTION of deficiencies in fees for multiple dependent claims.		
SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT		
Firm Name	Xsensus, LLP Customer Number: 154930	
Signature	/Andrew T. Harry/	
Printed name	Andrew T. Harry	
Date	08/01/2019	Reg. No. 56,959

CERTIFICATE OF TRANSMISSION/MAILING	
I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:	
Signature	
Typed or printed name	Date

This collection of information is required by 37 CFR 1.5. 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 2 hours 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.

Docket No. 12956US07CON

**THIS IS A RESPONSE TO A
NOTICE OF OMITTED ITEMS**

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

Re: Inventor: Shinji YUASA
Serial No: 16/443,875
Filed: 06-18-2019
For: MAGNETIC TUNNEL JUNCTION DEVICE

Commissioner:

Attached please find:

PRELIMINARY AMENDMENT

Credit card payment is being made online (if electronically filed), or is attached hereto (if paper filed), in the amount of **\$0.00** covering any required fees. In the event that any variance exists between the amount enclosed and the Patent Office charges for filing the above-noted documents, including any fees required under 37 CFR 1.136 for any necessary Extension of Time to make the filing of the attached documents timely, please charge or credit the difference to our Deposit Account No. 602325. Further, if these papers are not considered timely filed, then a petition is hereby made under 37 CFR 1.136 for the necessary extension of time.

Respectfully Submitted,

XSENSUS, LLP

/Andrew T. Harry/

Customer Number

154930

Tel. (571) 376-6333

Fax. (571) 376-6334

Andrew T. Harry

Attorney of Record

Registration No. 56,959



UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/443,875	06/18/2019	Shinji YUASA	12956US07CON

CONFIRMATION NO. 1667

WITHDRAWAL NOTICE



154930
XSENSUS LLP
200 Daingerfield Road
Suite 201
Alexandria, VA 22314

Date Mailed: 08/06/2019

Letter Regarding a New Notice and/or the Status of the Application

If a new notice or Filing Receipt is enclosed, applicant may disregard the previous notice mailed on 06/27/2019. The time period for reply runs from the mail date of the new notice. Within the time period for reply, applicant is required to file a reply in compliance with the requirements set forth in the new notice to avoid abandonment of the application.

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web.
<https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html>

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at <http://www.uspto.gov/ebc>.

If the reply is not filed electronically via EFS-Web, the reply must be accompanied by a copy of the new notice.

If the Office previously granted a petition to withdraw the holding of abandonment or a petition to revive under 37 CFR 1.137, the status of the application has been returned to pending status.

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

/dgela/



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UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO.	TOT CLAIMS	IND CLAIMS
16/443,875	06/18/2019	2827	1720	12956US07CON	16	3

CONFIRMATION NO. 1667

FILING RECEIPT



154930
XSENSUS LLP
200 Daingerfield Road
Suite 201
Alexandria, VA 22314

Date Mailed: 08/06/2019

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

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

Inventor(s)

Shinji YUASA, Ibaraki, JAPAN;

Applicant(s)

Japan Science and Technology Agency, Kawaguchi-shi, JAPAN;
National Institute of Advanced Industrial Science and Technology, Tokyo, JAPAN;

Assignment For Published Patent Application

Japan Science and Technology Agency, Kawaguchi-shi, JAPAN
National Institute of Advanced Industrial Science and Technology, Tokyo, JAPAN

Power of Attorney: The patent practitioners associated with Customer Number 154930

Domestic Priority data as claimed by applicant

This application is a CON of 15/428,842 02/09/2017 PAT 10367138
which is a CON of 14/837,558 08/27/2015 PAT 9608198
which is a CON of 13/767,290 02/14/2013 PAT 9123463
which is a CON of 13/400,340 02/20/2012 PAT 8405134
which is a CON of 12/923,643 09/30/2010 PAT 8319263
which is a CON of 10/591,947 09/08/2006 PAT 7884403
which is a 371 of PCT/JP2005/004720 03/10/2005

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

JAPAN 2004-313350 10/28/2004 No Access Code Provided

JAPAN 2004-071186 03/12/2004 No Access Code Provided

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

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

If Required, Foreign Filing License Granted: 06/25/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/443,875**

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

Non-Publication Request: No

Early Publication Request: No

Title

MAGNETIC TUNNEL JUNCTION DEVICE

Preliminary Class

365

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 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).

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Title 35, United States Code, Section 184
Title 37, Code of Federal Regulations, 5.11 & 5.15

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

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

NOT GRANTED

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

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/443,875	06/18/2019	Shinji YUASA	12956US07CON

CONFIRMATION NO. 1667

FORMALITIES LETTER



154930
XSENSUS LLP
200 Daingerfield Road
Suite 201
Alexandria, VA 22314

Date Mailed: 08/06/2019

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

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

The required item(s) identified below must be timely submitted to avoid abandonment:

- A substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125, is required. The substitute specification must be submitted with markings and be accompanied by a clean version (without markings) as set forth in 37 CFR 1.125(c) and a statement that the substitute specification contains no new matter (see 37 CFR 1.125(b)). The specification, claims, and/or abstract page(s) submitted is not acceptable and cannot be scanned or properly stored because:
 - A substitute specification was submitted on 06/18/2019; however, the non-marked-up copy of the substitute specification which incorporates the changes made in the marked up copy was not provided. Applicant must submit a clean copy of the revised specification.
- Applicant did not provide a statement that the substitute specification contains no new matter.

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

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

Replies should be mailed to:

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

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice".
<https://portal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html>

For more information about EFS-Web please call the USPTO Electronic Business Center at 1-866-217-9197 or visit our website at <http://www.uspto.gov/ebc>.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

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

/dgela/

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 16/443,875				
APPLICATION AS FILED - PART I										
(Column 1)		(Column 2)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY				
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)			
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	300			
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A	660			
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760			
TOTAL CLAIMS (37 CFR 1.16(i))	16	minus 20 = *				x 100 =	0.00			
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	minus 3 = *				x 460 =	0.00			
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).						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			
APPLICATION AS AMENDED - PART II										
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY		
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=		x	=
	Independent (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	
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=		x	=
	Independent (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. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.										

Substitute for Form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application #	16/443,875
	Confirmation #	1667
	Filing Date	06-18-2019
	First Inventor	Shinji YUASA
	Art Unit	2827
	Examiner	
Sheet 1 of 3	Docket #	12956US07CON

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

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

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

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

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

Substitute for Form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application #	16/443,875
	Confirmation #	1667
	Filing Date	06-18-2019
	First Inventor	Shinji YUASA
	Art Unit	2827
	Examiner	
Sheet <u>2</u> of <u>3</u>	Docket #	12956US07CON

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

	US-2008/0253039	10/16/2008	Nagamine et al.	
	US-2009/0128167	05/21/2009	Hamada et al.	
	US-5,506,063	04/09/1996	Kamijo et al.	
	US-5,817,366	10/06/1998	Arai et al.	
	US-5,945,694	08/31/1999	Reyes et al.	
	US-6,181,537	01/30/2001	Gill	
	US-6,201,672	03/13/2001	Pinarbasi	
	US-6,252,750	06/26/2001	Gill	
	US-6,275,362	08/14/2001	Pinarbasi	
	US-6,828,260	12/07/2004	Sharma et al.	
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Exam. Initial*	Include NAME of the author (in CAPS), Title of Article/Item, Date, Page(s), Volume-Issue No., Publisher, City and/or Country where published	Translation
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Examiner Signature		Date 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 the applicant.

Substitute for Form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application #	16/443,875
	Confirmation #	1667
	Filing Date	06-18-2019
	First Inventor	Shinji YUASA
	Art Unit	2827
	Examiner	
Sheet <u>3</u> of <u>3</u>	Docket #	12956US07CON

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

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

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

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16443875
	Filing Date	2019-06-18
	First Named Inventor	Shinji YUASA
	Art Unit	2827
	Examiner Name	
	Attorney Docket Number	12956US07CON

CERTIFICATION STATEMENT

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

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

OR

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

☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/James J Kulbaski/	Date (YYYY-MM-DD)	2019-08-12
Name/Print	James J. Kulbaski	Registration Number	34,648

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

Electronic Acknowledgement Receipt	
EFS ID:	36851639
Application Number:	16443875
International Application Number:	
Confirmation Number:	1667
Title of Invention:	MAGNETIC TUNNEL JUNCTION DEVICE
First Named Inventor/Applicant Name:	Shinji YUASA
Customer Number:	154930
Filer:	James J. Kulbaski/Isabelle Marquez
Filer Authorized By:	James J. Kulbaski
Attorney Docket Number:	12956US07CON
Receipt Date:	12-AUG-2019
Filing Date:	18-JUN-2019
Time Stamp:	18:00:41
Application Type:	Utility under 35 USC 111(a)

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		12956US07CONIDSforFiling.pdf	3399047	yes	11
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TRANSMITTAL FORM <i>(to be used for all correspondence after initial filing)</i>	Application Number	16/443,875	
	Filing Date	06-18-2019	
	First Named Inventor	Shinji YUASA	
	Art Unit	2827	
	Examiner Name		
Total Number of Pages in This Submission	11	Attorney Docket Number	12956US07CON

ENCLOSURES (Check all that apply)		
☐ Fee Transmittal Form ☐ Fee Attached ☐ Amendment/Reply ☐ After Final ☐ Affidavits/declaration(s) ☐ Extension of Time Request ☐ Express Abandonment Request ☒ Information Disclosure Statement ☐ Certified Copy of Priority Document(s) ☐ Reply to Missing Parts/Incomplete Application ☐ Reply to Missing Parts under 37 CFR 1.52 or 1.53	☐ Drawing(s) ☐ Licensing-related Papers ☐ Petition ☐ Petition to Convert to a Provisional Application ☐ Power of Attorney, Revocation ☐ Change of Correspondence Address ☐ Terminal Disclaimer ☐ Request for Refund ☐ CD, Number of CD(s) _____ ☐ Landscape Table on CD	☐ After Allowance Communication to TC ☐ Appeal Communication to Board of Appeals and Interferences ☐ Appeal Communication to TC (Appeal Notice, Brief, Reply Brief) ☐ Proprietary Information ☐ Status Letter ☐ Other Enclosure(s) (please identify below):
Remarks The Commissioner is hereby authorized to charge any additional fees that may be required for papers being filed herewith and for which no payment is enclosed herewith, or credit any overpayment to Deposit Account 602325, with the EXCEPTION of deficiencies in fees for multiple dependent claims.		
SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT		
Firm Name	Xsensus, LLP Customer Number: 154930	
Signature	/James J Kulbaski/	
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Date	08/12/2019	Reg. No. 34,648

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Docket No. **16/443,875**

**THIS IS A RESPONSE TO A
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COMMISSIONER FOR PATENTS
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Re: Inventor: **Shinji YUASA**
Serial No: **16/443,875**
Filed: **06-18-2019**
For: **MAGNETIC TUNNEL
JUNCTION DEVICE**

Commissioner:

Attached hereto for filing are the following papers:

**A Clean Copy of the Specification
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Respectfully Submitted,

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Registration No. **34,648**

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MAGNETIC TUNNEL JUNCTION DEVICE

[0001]CROSS-REFERENCE TO RELATED APPLICATIONS

[0002]The present application is a Continuation of U.S. Application No. 15/428,842 filed February 09, 2017, which is a Continuation of U.S. Application No. 14/837,558 filed on August 27, 2015 (now U.S. Patent No. 9,608,198), which is a Continuation of U.S. Application No. 13/767,290 filed on February 14, 2013 (now U.S. Patent No. 9,123,463), which is a Continuation of U.S. Application No. 13/400,340 filed on February 20, 2012 (now U.S. Patent No. 8,405,134), which is a Continuation of U.S. Application No. 12/923,643 filed on September 30, 2010 (now U.S. Patent No. 8,319,263), which is a Continuation of U.S. Application No. 10/591,947 filed on September 8, 2006 (now U.S. Patent No. 7,884,403), which is a National Stage Application of PCT/JP2005/004720 filed on March 10, 2005, and claims priority from Japanese Application Nos. 2004-313350 and 2004-071186 filed October 28, 2004 and March 12, 2004, respectively, the entire contents of each are incorporated herein by reference.

[0003]BACKGROUND OF THE INVENTION

[0004]Field of the Invention

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

[0006]Description of Related Art

[0007]Magnetoresistive random access memories (MRAMs) refer to a large-scale integrated memory circuit that is expected to replace the currently widely used DRAM memories. Research and development of MRAM devices, which are fast and non-

volatile memory devices, are being extensively carried out, and sample products of a 4Mbit MRAM have actually been delivered.

[0008] Figs. 8(A) and 8(B) show the structure and operation principle of a magnetic tunnel junction device (to be hereafter referred to as a “MTJ device”), which is the most important part of the MRAM. As shown in Fig. 8(A), a MTJ device comprises a tunnelling junction structure in which a tunnel barrier (to be hereafter also referred to as a “barrier layer”) made of an oxide is sandwiched between a first and a second electrode made of a ferromagnetic metal. The tunnel barrier layer comprises an amorphous Al-O layer (see Non-Patent Document 1). As shown in Fig. 8(A), in the case of parallel magnetization alignment where the directions of magnetizations of the first and second ferromagnetic electrodes are aligned parallel, the electric resistance of the device with respect to the direction normal to the interfaces of the tunneling junction structure decreases. On the other hand, in the case of antiparallel magnetization alignment where the directions of magnetizations of the first and second ferromagnetic electrodes are aligned antiparallel as shown in Fig. 8(B), the electric resistance with respect to the direction normal to the interfaces of the tunneling junction structure increases. The resistance value does not change in a general state, so that information “1” or “0” can be stored depending on whether the resistance value is high or not. Since the parallel and antiparallel magnetization alignments can be stored in a non-volatile fashion, the device can be used as a non-volatile memory device.

[0009] Figs. 9(A)-(C) show an example of the basic structure of the MRAM. Fig. 9(A) shows a perspective view of the MRAM, and Fig. 9(B) schematically shows a circuit block diagram. Fig. 9(C) is a cross-section of an example of the structure of the MRAM. Referring to Fig. 9(A), in an MRAM, a word line WL and a bit line BL are

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

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

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

[0012] SUMMARY OF THE INVENTION

[0013] Although there are prospects for achieving MRAMs with capacities on the order of 64Mbits based on the current technologies, the characteristics of the MTJ device, which is the heart of MRAM, needs to be improved if higher levels of integration are to be achieved. In particular, in order to increase the output voltage of the MTJ device, the magnetoresistance must be increased and the bias voltage characteristics must be improved. Fig. 10 illustrates how the magnetoresistance in a conventional MTJ device using an amorphous Al-O as the tunnel barrier changes as a

function of the bias voltage (L1). As shown, in the conventional MTJ device, the magnetoresistance is small and, notably, it tends to drastically decrease upon application of bias voltage. With such characteristics, the output voltage when operation margins are taken into consideration is too small for the device to be employed for an actual memory device. Specifically, the magnetoresistance of the current MTJ device is small at approximately 70%, and the output voltage is also small at no more than 200 mV, which is substantially half the output voltage of a DRAM. This has resulted in the problem that as the level of integration increases, signals are increasingly lost in noise and cannot be read.

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

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

[0016] The invention further provides a magnetoresistive device comprising a magnetic tunnel junction structure comprising: a tunnel barrier layer comprising MgO (001); a first ferromagnetic material layer comprising Fe (001) formed on a first side of the tunnel barrier layer; and a second ferromagnetic material layer comprising Fe (001) formed on a second side of the tunnel barrier layer, wherein the MgO layer is formed by a single-crystalline MgO_x (001) layer or a poly-crystalline MgO_x ($0 < x <$

1) layer in which the (001) crystal plane is preferentially oriented. In a preferred embodiment, the band discontinuity value (the height of the tunnel barrier) between the bottom of the conduction band of the MgO(001) layer and the Fermi energy of the Fe(001) layer is smaller than an ideal value of a perfect single-crystal without defect. These features increase the magnetoresistance and thereby allow the output voltage of the MTJ device to be increased. By using any of the aforementioned MTJ devices as a load for a single transistor, a non-volatile memory can be formed.

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

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

a poly-crystalline MgO_x ($0 < x < 1$) in which the (001) crystal plane is preferentially oriented. The MgO layer may be deposited using a target with the value of x in MgO_x adjusted. The value of x in MgO_x may be adjusted in the step of forming the MgO.

[0019]In yet another aspect, the invention provides a magnetoresistive device comprising a magnetic tunnel junction structure comprising a tunnel barrier layer comprising MgO(001), a first ferromagnetic material layer comprising an amorphous magnetic alloy formed on a first side of the tunnel barrier layer, and a second ferromagnetic material layer comprising an amorphous magnetic alloy formed on a second side of the tunnel barrier layer, wherein the discontinuous value (the height of the tunnel barrier) between the bottom of the conduction band of the MgO(001) layer and the Fermi energy of the first or the second ferromagnetic material layer comprising the amorphous magnetic alloy is lower than an ideal value of a perfect single-crystal with no defect.

[0020] BRIEF DESCRIPTION OF THE DRAWINGS

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

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

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

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

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

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

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

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

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

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

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

[0032]DESCRIPTION OF THE PREFERRED EMBODIMENTS

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

specifically, BCC structure includes the BCC structure with no chemical ordering so-called A2-type structure, the BCC structure with chemical ordering such as B2-type structure and L2₁-type structure, and also the aforementioned structures with slight lattice distortion.

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

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

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

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

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

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

$$\mathbf{[0040]}\text{where } \alpha = 1, 2 \quad (1)$$

[0041] In the above equations, P_α is the spin polarization of an electrode, and $D_\alpha \uparrow (E_F)$ and $D_\alpha \downarrow (E_F)$ are the density of state (DOS) at the Fermi energy (E_F) of the majority-spin band and the minority-spin band, respectively. Since the spin

polarization of ferromagnetic transition metals and alloys is approximately 0.5 or smaller, the Jullire's formula predicts a highest estimated MR ratio of about 70%.

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

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

diagram shown in Fig. 1(A) of Fe in the [001] (Γ -H) direction, the density of state (DOS) at the Fermi energy E_F does not exhibit a very high spin polarization due to the fact that the sub-bands of the majority-spin and the minority-spin have states at the Fermi energy E_F . However, in case the coherent states of electrons are conserved in the tunneling process, only those conduction electrons that have totally symmetrical wave functions with respect to the axis perpendicular to the barrier would be coupled with the states in the barrier region and come to have a finite tunneling probability. The Δ_1 band in the Fe(001) electrode has such totally symmetric wave functions. As shown in Fig. 1(A), the majority spin Δ_1 band (solid line) has states at the Fermi energy E_F , whereas the minority spin Δ_1 band (broken line) does not have state at the Fermi energy E_F . Because of such half-metallic characteristics of the Fe Δ_1 band, there is the possibility that a very high MR ratio can be obtained in a coherent spin polarized tunneling. Since in an epitaxial (single-crystal, or (001) oriented polycrystal) MTJ device the scattering of electrons is suppressed during the tunneling process, an epitaxial MTJ device is thought to be ideal for realizing the aforementioned coherent tunneling.

[0044]In the following, a MTJ device according to a first embodiment of the invention and a method of manufacturing the same will be described with reference to the drawings. Figs. 2(A) to 2(D) schematically show the method of manufacturing the MTJ device having the Fe (001)/MgO(001)/Fe(001) structure according to the embodiment (to be hereafter referred to as a “Fe(001)/MgO(001)/Fe(001) MTJ device”). Fe(001) refers to a ferromagnetic material with the BCC structure. First, a single-crystal MgO(001) substrate 11 was prepared. In order to improve the morphology of the surface of the single-crystal MgO(001) substrate 11, a MgO(001) seed layer 15 was grown by the molecular beam epitaxy (MBE) method. This was

subsequently followed by the growth of an epitaxial Fe(001) lower electrode (first electrode) 17 with the thickness of 50 nm on the MgO(001) seed layer 15 at room temperature, as shown in Fig. 1(B), and then annealing was performed at 350°C under ultrahigh vacuum (2×10^{-8} Pa). Electron-beam evaporation conditions included an acceleration voltage of 8 kV, a growth rate of 0.02 nm/sec, and the growth temperature of room temperature (about 293K). The source material of the electron-beam evaporation was MgO of the stoichiometric composition (the ratio of Mg to O being 1:1), the distance between the source and the substrate was 40 cm, the base vacuum pressure was 1×10^{-8} Pa, and the O₂ partial pressure was 1×10^{-6} Pa. Alternatively, a source with oxygen vacancy defects may be used instead of the MgO of the stoichiometric composition (the ratio of Mg to O is 1:1).

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

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

processed by microfabrication techniques to obtain the Fe(001)/MgO(001)/Fe(001) MTJ device.

[0047]The aforementioned MgO evaporation using an electron beam involved the formation of a film under ultrahigh vacuum of 10^{-9} Torr. It can be seen that in this method, the film, even when formed on a glass substrate to the thickness of 300 nm, was colorless and transparent, showing that a good crystal film was formed. Fig. 4 shows the results of observing the quadrupole mass spectra in the deposition chamber during the MgO growth. The results show that the partial pressures regarding the spectrum P1 of O and the spectrum P2 of O₂ are high. Fig. 5 shows the film deposition rate dependency of the oxygen partial pressure during MgO evaporation. It will be seen from the figure that the oxygen partial pressure itself is high, and that the oxygen partial pressure increases as the deposition rate increases. These results indicate the separation of oxygen from MgO during the deposition of MgO. Since the separated oxygen is pumped out of the deposition chamber using vacuum pumps, there is the possibility that there are oxygen vacancy defects such as MgO_x ($0.9 < x < 1$). When there are oxygen vacancy defects, the potential barrier height of the MgO tunnel barrier is thought to decrease (such as in the range of 0.10 to 0.85 eV; more specifically, 0.2 to 0.5 eV), which is thought to result in an increase in the tunneling current. In the case of a typical Al-O tunnel barrier, the height of the tunnel barrier with respect to Fe(001) electrodes is considered to be 0.7 to 2.5 eV. An ideal tunnel barrier height of a MgO crystal is 3.6 eV, and experimental values of 0.9 to 3.7 eV have been obtained. Using the method according to the present embodiment of the invention, a tunnel barrier height of approximately 0.3 eV is expected, indicating that the resistance of the tunnel barrier can be lowered. However, it should be noted that other factors, such as the influence of the aforementioned coherent tunneling, might

also be involved. The value of x in MgO_x due to oxygen vacancy defects is such that $0.98 < x < 1$, and more preferably $0.99 < x < 1$. These are the ranges such that the sole presence of Mg is excluded and the characteristics of MgO can be basically maintained.

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

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

[0050] It is noted that, in the event that t_{MgO} can be accurately determined using the cross-sectional transmission electron microscope (TEM) image, the height ϕ of the tunnel barrier can be more simply determined by the following technique. Namely,

when the bias voltage V applied to the MTJ device is small (normally 100 mV or smaller), the tunnel current density J is proportional to the bias voltage V , such that the J - V characteristics become linear. In such a low-bias voltage region, the Simmons' formula can be described as follows:

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

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

[0053] Fig. 6 shows a typical magnetoresistance curve of the

Fe(001)/MgO(001)/Fe(001) MTJ device produced by the above-described method.

The MR ratio is 146% at the measurement temperature of 20K and 88% at the measurement temperature of 293K. These values represent the highest MR ratios that have so far been obtained at room temperature. Such high MR ratios cannot be explained by the spin polarization of the Fe(001) electrode and is thought rather to be related to a coherent spin-polarized tunneling. When 160 prototype MTJ devices were made, the variations regarding the MR ratio and tunneling resistance value were not more than 20%. The yield of the MTJ devices was 90% or more at the laboratory stage. These high values suggest the effectiveness of the approach of the invention. The resistance-area (RA) product of the MTJ device was on the order of a few $\text{k}\Omega\mu\text{m}^2$, which is suitable for MRAM.

[0054] Fig. 7(a) shows the bias voltage dependency of the MR ratio at room temperature. It will be seen that the bias voltage dependency of the MR ratio is fairly small. Although the characteristics are asymmetric, the voltage V_{half} at which the MR

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

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

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

300°C from room temperature and maintaining that temperature for a certain duration of time.

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

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

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

[0060] As the amorphous magnetic alloy, FeCoB, FeCoBSi, FeCoBP, FeZr, and CoZr may be used, for example. Although an anneal process after the preparation of the MTJ device might cause the amorphous magnetic alloy in the electrode layers to be

partially or entirely crystallized, this would not lead to a significant deterioration of the MR ratio. Thus, such a crystallized amorphous magnetic alloy may be used in the electrode layers.

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

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

MAGNETIC TUNNEL JUNCTION DEVICE

[0001]CROSS-REFERENCE TO RELATED APPLICATIONS

[0002]The present application is a Continuation of U.S. Application No. 15/428,842 filed February 09, 2017, which is a Continuation of U.S. Application No. 14/837,558 filed on August 27, 2015 (now U.S. Patent No. 9,608,198), which is a Continuation of U.S. Application No. 13/767,290 filed on February 14, 2013 (now U.S. Patent No. 9,123,463), which is a Continuation of U.S. Application No. 13/400,340 filed on February 20, 2012 (now U.S. Patent No. 8,405,134), which is a Continuation of U.S. Application No. 12/923,643 filed on September 30, 2010 (now U.S. Patent No. 8,319,263), which is a Continuation of U.S. Application No. 10/591,947 filed on September 8, 2006 (now U.S. Patent No. 7,884,403), which is a National Stage Application of PCT/JP2005/004720 filed on March 10, 2005, and claims priority from Japanese Application Nos. 2004-313350 and 2004-071186 filed October 28, 2004 and March 12, 2004, respectively, the entire contents of each are incorporated herein by reference.

[0003]BACKGROUND OF THE INVENTION

[0004]Field of the Invention

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

[0006]Description of Related Art

[0007]Magnetoresistive random access memories (MRAMs) refer to a large-scale integrated memory circuit that is expected to replace the currently widely used DRAM memories. Research and development of MRAM devices, which are fast and non-

volatile memory devices, are being extensively carried out, and sample products of a 4Mbit MRAM have actually been delivered.

[0008] Figs. 8(A) and 8(B) show the structure and operation principle of a magnetic tunnel junction device (to be hereafter referred to as a “MTJ device”), which is the most important part of the MRAM. As shown in Fig. 8(A), a MTJ device comprises a tunnelling junction structure in which a tunnel barrier (to be hereafter also referred to as a “barrier layer”) made of an oxide is sandwiched between a first and a second electrode made of a ferromagnetic metal. The tunnel barrier layer comprises an amorphous Al-O layer (see Non-Patent Document 1). As shown in Fig. 8(A), in the case of parallel magnetization alignment where the directions of magnetizations of the first and second ferromagnetic electrodes are aligned parallel, the electric resistance of the device with respect to the direction normal to the interfaces of the tunneling junction structure decreases. On the other hand, in the case of antiparallel magnetization alignment where the directions of magnetizations of the first and second ferromagnetic electrodes are aligned antiparallel as shown in Fig. 8(B), the electric resistance with respect to the direction normal to the interfaces of the tunneling junction structure increases. The resistance value does not change in a general state, so that information “1” or “0” can be stored depending on whether the resistance value is high or not. Since the parallel and antiparallel magnetization alignments can be stored in a non-volatile fashion, the device can be used as a non-volatile memory device.

[0009] ~~Fig. 9 shows~~ Figs. 9(A)-(C) show an example of the basic structure of the MRAM. Fig. 9(A) shows a perspective view of the MRAM, and Fig. 9(B) schematically shows a circuit block diagram. Fig. 9(C) is a cross-section of an example of the structure of the MRAM. Referring to Fig. 9(A), in an MRAM, a word

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

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

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

[0012] SUMMARY OF THE INVENTION

[0013] Although there are prospects for achieving MRAMs with capacities on the order of 64Mbits based on the current technologies, the characteristics of the MTJ device, which is the heart of MRAM, needs to be improved if higher levels of integration are to be achieved. In particular, in order to increase the output voltage of the MTJ device, the magnetoresistance must be increased and the bias voltage characteristics must be improved. Fig. 10 illustrates how the magnetoresistance in a conventional MTJ device using an amorphous Al-O as the tunnel barrier changes as a

function of the bias voltage (L1). As shown, in the conventional MTJ device, the magnetoresistance is small and, notably, it tends to drastically decrease upon application of bias voltage. With such characteristics, the output voltage when operation margins are taken into consideration is too small for the device to be employed for an actual memory device. Specifically, the magnetoresistance of the current MTJ device is small at approximately 70%, and the output voltage is also small at no more than 200 mV, which is substantially half the output voltage of a DRAM. This has resulted in the problem that as the level of integration increases, signals are increasingly lost in noise and cannot be read.

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

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

[0016]The invention further provides a magnetoresistive device comprising a magnetic tunnel junction structure comprising: a tunnel barrier layer comprising $\text{MgO}(001)$; a first ferromagnetic material layer comprising $\text{Fe}(001)$ formed on a first side of the tunnel barrier layer; and a second ferromagnetic material layer comprising $\text{Fe}(001)$ formed on a second side of the tunnel barrier layer, wherein the MgO layer is formed by a single-crystalline MgO_x (001) layer or a poly-crystalline MgO_x ($0 < x <$

1) layer in which the (001) crystal plane is preferentially oriented. In a preferred embodiment, the band discontinuity value (the height of the tunnel barrier) between the bottom of the conduction band of the MgO(001) layer and the Fermi energy of the Fe(001) layer is smaller than an ideal value of a perfect single-crystal without defect. These features increase the magnetoresistance and thereby allow the output voltage of the MTJ device to be increased. By using any of the aforementioned MTJ devices as a load for a single transistor, a non-volatile memory can be formed.

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

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

a poly-crystalline MgO_x ($0 < x < 1$) in which the (001) crystal plane is preferentially oriented. The MgO layer may be deposited using a target with the value of x in MgO_x adjusted. The value of x in MgO_x may be adjusted in the step of forming the MgO.

[0019]In yet another aspect, the invention provides a magnetoresistive device comprising a magnetic tunnel junction structure comprising a tunnel barrier layer comprising MgO(001), a first ferromagnetic material layer comprising an amorphous magnetic alloy formed on a first side of the tunnel barrier layer, and a second ferromagnetic material layer comprising an amorphous magnetic alloy formed on a second side of the tunnel barrier layer, wherein the discontinuous value (the height of the tunnel barrier) between the bottom of the conduction band of the MgO(001) layer and the Fermi energy of the first or the second ferromagnetic material layer comprising the amorphous magnetic alloy is lower than an ideal value of a perfect single-crystal with no defect.

[0020] BRIEF DESCRIPTION OF THE DRAWINGS

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

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

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

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

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

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

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

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

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

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

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

[0032]DESCRIPTION OF THE PREFERRED EMBODIMENTS

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

ferromagnetic electrode layer, means body-centered cubic lattice structure. More specifically, BCC structure includes the BCC structure with no chemical ordering so-called A2-type structure, the BCC structure with chemical ordering such as B2-type structure and L2₁-type structure, and also the aforementioned structures with slight lattice distortion.

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

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

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

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

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

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

$$\mathbf{[0040]}\text{where } \alpha = 1, 2 \quad (1)$$

[0041] In the above equations, P_α is the spin polarization of an electrode, and $D_\alpha \uparrow (E_F)$ and $D_\alpha \downarrow (E_F)$ are the density of state (DOS) at the Fermi energy (E_F) of the

majority-spin band and the minority-spin band, respectively. Since the spin polarization of ferromagnetic transition metals and alloys is approximately 0.5 or smaller, the Jullire's formula predicts a highest estimated MR ratio of about 70%.

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

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

tunnel barrier (normal to the junction interfaces). In accordance with the energy band diagram shown in Fig. 1(A) of Fe in the [001] (Γ -H) direction, the density of state (DOS) at the Fermi energy E_F does not exhibit a very high spin polarization due to the fact that the sub-bands of the majority-spin and the minority-spin have states at the Fermi energy E_F . However, in case the coherent states of electrons are conserved in the tunneling process, only those conduction electrons that have totally symmetrical wave functions with respect to the axis perpendicular to the barrier would be coupled with the states in the barrier region and come to have a finite tunneling probability. The Δ_1 band in the Fe(001) electrode has such totally symmetric wave functions. As shown in Fig. 1(A), the majority spin Δ_1 band (solid line) has states at the Fermi energy E_F , whereas the minority spin Δ_1 band (broken line) does not have state at the Fermi energy E_F . Because of such half-metallic characteristics of the Fe Δ_1 band, there is the possibility that a very high MR ratio can be obtained in a coherent spin polarized tunneling. Since in an epitaxial (single-crystal, or (001) oriented polycrystal) MTJ device the scattering of electrons is suppressed during the tunneling process, an epitaxial MTJ device is thought to be ideal for realizing the aforementioned coherent tunneling.

[0044]In the following, a MTJ device according to a first embodiment of the invention and a method of manufacturing the same will be described with reference to the drawings. Figs. 2(A) to 2(D) schematically show the method of manufacturing the MTJ device having the Fe (001)/MgO(001)/Fe(001) structure according to the embodiment (to be hereafter referred to as a “Fe(001)/MgO(001)/Fe(001) MTJ device”). Fe(001) refers to a ferromagnetic material with the BCC structure. First, a single-crystal MgO(001) substrate 11 was prepared. In order to improve the morphology of the surface of the single-crystal MgO(001) substrate 11, a MgO(001)

seed layer 15 was grown by the molecular beam epitaxy (MBE) method. This was subsequently followed by the growth of an epitaxial Fe(001) lower electrode (first electrode) 17 with the thickness of 50 nm on the MgO(001) seed layer 15 at room temperature, as shown in Fig. 1(B), and then annealing was performed at 350°C under ultrahigh vacuum (2×10^{-8} Pa). Electron-beam evaporation conditions included an acceleration voltage of 8 kV, a growth rate of 0.02 nm/sec, and the growth temperature of room temperature (about 293K). The source material of the electron-beam evaporation was MgO of the stoichiometric composition (the ratio of Mg to O being 1:1), the distance between the source and the substrate was 40 cm, the base vacuum pressure was 1×10^{-8} Pa, and the O₂ partial pressure was 1×10^{-6} Pa. Alternatively, a source with oxygen vacancy defects may be used instead of the MgO of the stoichiometric composition (the ratio of Mg to O is 1:1).

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

[0046] As shown in Fig. 2(D), a Fe(001) upper electrode (a second electrode) 23 with the thickness of 10 nm was formed on the MgO(001) barrier layer 21 at room temperature. This was successively followed by the deposition of a Co layer 25 with the thickness of 10 nm on the Fe(001) upper electrode (second electrode) 23. The Co layer 25 is provided to increase the coercive force of the upper electrode 23 so as to

realize the antiparallel magnetization alignment. The thus prepared sample was then processed by microfabrication techniques to obtain the Fe(001)/MgO(001)/Fe(001) MTJ device.

[0047] The aforementioned MgO evaporation using an electron beam involved the formation of a film under ultrahigh vacuum of 10^{-9} Torr. It can be seen that in this method, the film, even when formed on a glass substrate to the thickness of 300 nm, was colorless and transparent, showing that a good crystal film was formed. Fig. 4 shows the results of observing the quadrupole mass spectra in the deposition chamber during the MgO growth. The results show that the partial pressures regarding the spectrum P1 of O and the spectrum P2 of O₂ are high. Fig. 5 shows the film deposition rate dependency of the oxygen partial pressure during MgO evaporation. It will be seen from the figure that the oxygen partial pressure itself is high, and that the oxygen partial pressure increases as the deposition rate increases. These results indicate the separation of oxygen from MgO during the deposition of MgO. Since the separated oxygen is pumped out of the deposition chamber using vacuum pumps, there is the possibility that there are oxygen vacancy defects such as MgO_x ($0.9 < x < 1$). When there are oxygen vacancy defects, the potential barrier height of the MgO tunnel barrier is thought to decrease (such as in the range of 0.10 to 0.85 eV; more specifically, 0.2 to 0.5 eV), which is thought to result in an increase in the tunneling current. In the case of a typical Al-O tunnel barrier, the height of the tunnel barrier with respect to Fe(001) electrodes is considered to be 0.7 to 2.5 eV. An ideal tunnel barrier height of a MgO crystal is 3.6 eV, and experimental values of 0.9 to 3.7 eV have been obtained. Using the method according to the present embodiment of the invention, a tunnel barrier height of approximately 0.3 eV is expected, indicating that the resistance of the tunnel barrier can be lowered. However, it should be noted that

other factors, such as the influence of the aforementioned coherent tunneling, might also be involved. The value of x in MgO_x due to oxygen vacancy defects is such that $0.98 < x < 1$, and more preferably $0.99 < x < 1$. These are the ranges such that the sole presence of Mg is excluded and the characteristics of MgO can be basically maintained.

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

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

[0050] It is noted that, in the event that t_{MgO} can be accurately determined using the cross-sectional transmission electron microscope (TEM) image, the height ϕ of the

tunnel barrier can be more simply determined by the following technique. Namely, when the bias voltage V applied to the MTJ device is small (normally 100 mV or smaller), the tunnel current density J is proportional to the bias voltage V , such that the J-V characteristics become linear. In such a low-bias voltage region, the Simmons' formula can be described as follows:

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

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

[0053] Fig. 6 shows a typical magnetoresistance curve of the

Fe(001)/MgO(001)/Fe(001) MTJ device produced by the above-described method.

The MR ratio is 146% at the measurement temperature of 20K and 88% at the measurement temperature of 293K. These values represent the highest MR ratios that have so far been obtained at room temperature. Such high MR ratios cannot be explained by the spin polarization of the Fe(001) electrode and is thought rather to be related to a coherent spin-polarized tunneling. When 160 prototype MTJ devices were made, the variations regarding the MR ratio and tunneling resistance value were not more than 20%. The yield of the MTJ devices was 90% or more at the laboratory stage. These high values suggest the effectiveness of the approach of the invention. The resistance-area (RA) product of the MTJ device was on the order of a few $\text{k}\Omega\mu\text{m}^2$, which is suitable for MRAM.

[0054] Fig. 7(a) shows the bias voltage dependency of the MR ratio at room temperature. It will be seen that the bias voltage dependency of the MR ratio is fairly

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

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

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

amorphous state, a crystallized MgO was obtained by increasing the temperature to 300°C from room temperature and maintaining that temperature for a certain duration of time.

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

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

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

[0060] As the amorphous magnetic alloy, FeCoB, FeCoBSi, FeCoBP, FeZr, and CoZr may be used, for example. Although an anneal process after the preparation of the

MTJ device might cause the amorphous magnetic alloy in the electrode layers to be partially or entirely crystallized, this would not lead to a significant deterioration of the MR ratio. Thus, such a crystallized amorphous magnetic alloy may be used in the electrode layers.

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

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



UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/443,875	06/18/2019	Shinji YUASA	12956US07CON

CONFIRMATION NO. 1667

FORMALITIES LETTER



0000000111724118

154930
XSENSUS LLP
200 Daingerfield Road
Suite 201
Alexandria, VA 22314

Date Mailed: 10/09/2019

NOTICE OF INCOMPLETE REPLY (NONPROVISIONAL)

Filing Date Granted

The U.S. Patent and Trademark Office has received your reply on 10/04/2019 to the NOTICE TO FILE CORRECTED APPLICATION PAPERS (Notice) mailed 08/06/2019 and it has been entered into the application. The reply, however, is not a complete reply for the reason(s) listed below. A complete reply must be timely filed to prevent ABANDONMENT of the above-identified application. Replies should be mailed to: Mail Stop Missing Parts, Commissioner for Patents, P.O.Box 1450, Alexandria VA 22313-1450.

The period for reply continues to run from the date of the Notice mailed 08/06/2019. Applicant must submit all required items and pay any fees required below within two months from the date of the NOTICE TO FILE CORRECTED APPLICATION PAPERS to avoid abandonment. If the reply is submitted after two months from the date of the NOTICE TO FILE CORRECTED APPLICATION PAPERS, extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

Items Required to Avoid Abandonment:

The required items noted below SHOULD be filed along with any items required above.

The application is informal since it does not comply with the regulations for the reason(s) indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- Applicant did not provide a statement that the substitute specification contains no new matter.

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Mail date of Notice: 08/06/2019
Last date that extension may be obtained: (Note: The petition and fee must be received 03/06/2020
by this date, or include a proper certificate of mailing under 37 CFR 1.8 with a date on or
before this date, and extend the time to include this date.)

Length of Extension of Time (response due on or before)	Fee under 37 CFR 1.17(a) effective March 19, 2013		
	Undiscounted	Small Entity	Micro Entity
One Month (11/06/2019)	\$200	\$100	\$50
Two Months (12/06/2019)	\$600	\$300	\$150
Three Months (01/06/2020)	\$1400	\$700	\$350
Four Months (02/06/2020)	\$2200	\$1100	\$550
Five Months (03/06/2020)	\$3000	\$1500	\$750

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

Replies should be mailed to:

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

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice".
<https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html>

For more information about EFS-Web please call the USPTO Electronic Business Center at 1-866-217-9197 or visit our website at <http://www.uspto.gov/ebc>.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

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

/zabraha/

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 16/443,875				
APPLICATION AS FILED - PART I										
(Column 1)		(Column 2)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY				
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)			
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	300			
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A	660			
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760			
TOTAL CLAIMS (37 CFR 1.16(i))	16	minus 20 = *			OR	x 100 =	0.00			
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	minus 3 = *				x 460 =	0.00			
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).						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			
APPLICATION AS AMENDED - PART II										
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY		
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=	OR	x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=	OR	x	=
	Application Size Fee (37 CFR 1.16(s))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=	OR	x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=	OR	x	=
	Application Size Fee (37 CFR 1.16(s))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.										



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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO.	TOT CLAIMS	IND CLAIMS
16/443,875	06/18/2019	2827	1720	12956US07CON	16	3

CONFIRMATION NO. 1667

UPDATED FILING RECEIPT



154930
XSENSUS LLP
200 Daingerfield Road
Suite 201
Alexandria, VA 22314

Date Mailed: 10/10/2019

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

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

Inventor(s)

Shinji YUASA, Ibaraki, JAPAN;

Applicant(s)

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National Institute of Advanced Industrial Science and Technology, Tokyo, JAPAN;

Assignment For Published Patent Application

Japan Science and Technology Agency, Kawaguchi-shi, JAPAN
National Institute of Advanced Industrial Science and Technology, Tokyo, JAPAN

Power of Attorney: The patent practitioners associated with Customer Number 154930

Domestic Priority data as claimed by applicant

This application is a CON of 15/428,842 02/09/2017 PAT 10367138
which is a CON of 14/837,558 08/27/2015 PAT 9608198
which is a CON of 13/767,290 02/14/2013 PAT 9123463
which is a CON of 13/400,340 02/20/2012 PAT 8405134
which is a CON of 12/923,643 09/30/2010 PAT 8319263
which is a CON of 10/591,947 09/08/2006 PAT 7884403
which is a 371 of PCT/JP2005/004720 03/10/2005

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

JAPAN 2004-313350 10/28/2004 No Access Code Provided

JAPAN 2004-071186 03/12/2004 No Access Code Provided

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

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

If Required, Foreign Filing License Granted: 06/25/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/443,875**

Projected Publication Date: 01/16/2020

Non-Publication Request: No

Early Publication Request: No

Title

MAGNETIC TUNNEL JUNCTION DEVICE

Preliminary Class

365

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 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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Title 37, Code of Federal Regulations, 5.11 & 5.15

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/443,875	06/18/2019	Shinji YUASA	12956US07CON

CONFIRMATION NO. 1667

WITHDRAWAL NOTICE



154930
XSENSUS LLP
200 Daingerfield Road
Suite 201
Alexandria, VA 22314

Date Mailed: 10/10/2019

Letter Regarding a New Notice and/or the Status of the Application

If a new notice or Filing Receipt is enclosed, applicant may disregard the previous notice mailed on 10/09/2019. The time period for reply runs from the mail date of the new notice. Within the time period for reply, applicant is required to file a reply in compliance with the requirements set forth in the new notice to avoid abandonment of the application.

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web.
<https://portal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html>

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at <http://www.uspto.gov/ebc>.

If the reply is not filed electronically via EFS-Web, the reply must be accompanied by a copy of the new notice.

If the Office previously granted a petition to withdraw the holding of abandonment or a petition to revive under 37 CFR 1.137, the status of the application has been returned to pending status.

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

/snguyen/

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 16/443,875				
APPLICATION AS FILED - PART I										
(Column 1)		(Column 2)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY				
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)			
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	300			
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A	660			
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760			
TOTAL CLAIMS (37 CFR 1.16(i))	16	minus 20 = *			OR	x 100 =	0.00			
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	minus 3 = *				x 460 =	0.00			
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).						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			
APPLICATION AS AMENDED - PART II										
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY		
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=	OR	x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=	OR	x	=
	Application Size Fee (37 CFR 1.16(s))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total (37 CFR 1.16(i))	*	Minus	**	=	x	=	OR	x	=
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x	=	OR	x	=
	Application Size Fee (37 CFR 1.16(s))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.										

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16443875
	Filing Date	2019-06-18
	First Named Inventor	Shinji YUASA
	Art Unit	2897
	Examiner Name	TBD
	Attorney Docket Number	12956US07CON

U.S.PATENTS							Remove
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	
	1	8294228	B2	2012-10-23	PENG et al.	Evidence Submitted by Plaintiffs 16 for 2014(wa) 25200 Case of Claiming Damages in Japan	
	2	8091209	B2	2012-01-10	GAO et al.	Evidence Submitted by Plaintiffs 29 for 2014(wa) 25200 Case of Claiming Damages in Japan	
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U.S.PATENT APPLICATION PUBLICATIONS							Remove
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	
	1	20040144995	A1	2004-07-29	NAGAHAMA et al.	Corresponds to JP2003-318465, which is Evidence submitted by Defendant 34 for 2014(wa) 25200 Case of Claiming Damages in Japan, already submitted as IDS on August 1, 2019.	
	2	20020064069	A1	2002-05-30	GOEBEL et al.	Corresponds to JP2002-540594, which is Evidence submitted for Defendant 35 for 2014(wa) 25200 Case of Claiming Damages in Japan	
	3	20030203189	A1	2003-10-30	FUTAMOTO et al.	Corresponds to JP2001-023140, which is Evidence submitted by Defendant 49 for 2014(wa) 25200 Case of Claiming Damages in Japan, already submitted as IDS on August 1, 2019.	
	4	20030080363	A1	2003-05-01	MARUYAMA et al.	Corresponds to JP2003-133531, which is Evidence submitted by Defendant 52 for 2014(wa) 25200 Case of Claiming Damages in Japan	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		16443875
	Filing Date		2019-06-18
	First Named Inventor	Shinji YUASA	
	Art Unit	2897	
	Examiner Name	TBD	
	Attorney Docket Number	12956US07CON	

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

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

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	2	Plaintiffs Preliminary Documents (1) Page 69 - Page 74 submitted on March 13, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
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5	Defendant Preliminary Documents (3) Page 47 line 14 - Page 79 submitted on October 1, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
6	Plaintiffs Preliminary Documents (4) Page 2 - Page 16 submitted on November 20, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
7	Defendant Preliminary Documents (5) Page 5 - Page 39 submitted on February 5, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
8	Plaintiffs Preliminary Documents (6) submitted on March 4, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
9	Defendant Preliminary Documents (7) Page 4 - Page 23 submitted on April 4, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
10	Defendant Preliminary Documents (10) Page 4 line 4 from the bottom - Page 8 line 3 from the bottom and Page 23 line 9 - Page 24 submitted on July 29, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
11	Plaintiffs Preliminary Documents (9) Page 8 - Page 14 line 13 and Page 18 line 19 - Page 22 submitted on August 9, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
12	Defendant Preliminary Documents (11) Page 17 line 3 - Page 21 line 5 from the bottom and Page 22 line 5 - Page 27 line 12 submitted on October 14, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
13	Plaintiffs Preliminary Documents (10) Page 8 - Page 10 submitted on October 21, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
14	Plaintiffs Preliminary Documents (11) Page 2 - Page 8 and Page 15 - Page 19 submitted on November 18, 2016 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
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16	Plaintiffs Preliminary Documents (12) Page 12 - Page 16 submitted on January 25, 2017 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
17	Plaintiffs Preliminary Documents (13) submitted on January 26, 2017 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
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23	Plaintiffs Preliminary Documents (22) submitted on July 20, 2018 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
24	Plaintiffs Preliminary Documents (23) submitted on August 9, 2018 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
25	Defendant Preliminary Documents (21) submitted on September 14, 2018 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
26	YUASA, S., "Recent Developments of Spintronics Device Technologies Based on Magnetic Tunnel Junctions with Magnesium Oxide Tunnel Barrier", IEEJ Transactions on Electronics, Information and Systems, Vol.133, No.3, pp.471-478, which is Attachment(1) of Evidence Kou 11 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒

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

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38	Written Opinion submitted on March 23, 2012 for Japanese Patent Application No.2011-226907, which is Evidence Submitted by Defendants 7-1 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
39	Notice of Reasons for Refusal drafted on January 18, 2012 for Japanese Patent Application No.2011-226907, which is Evidence Submitted by Defendants 7-2 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation, already submitted as IDS on August 12, 2019	☒
40	Written Statement submitted on April 20, 2012 for Japanese Patent Application No.2012-067089, which is Evidence Submitted by Defendants 8 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
41	Written Opinion submitted on October 9, 2012 for Japanese Patent Application No.2011-226908, which is Evidence Submitted by Defendants 9-2 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
42	Written Statement submitted on November 11, 2011 for Japanese Patent Application No.2011-226908, which is Evidence Submitted by Defendants 9-3 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
43	Written Amendment submitted on March 10, 2008 for Japanese Patent Application No.2004-259280, which is Evidence Submitted by Defendants 10-1 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
44	Notice of Reasons for Refusal drafted on July 29, 2008 for Japanese Patent Application No.2004-259280, which is Evidence Submitted by Defendants 10-2 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
45	Written Amendment submitted on October 3, 2008 for Japanese Patent Application No.2004-259280, which is Evidence Submitted by Defendants 0-3 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
46	Written Opinion submitted on October 3, 2008 for Japanese Patent Application No.2004-259280, which is Evidence Submitted by Defendants 10-4 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
47	DJYAPRAWIRA, D.D. et al, "230% Room-Temperature Magnetoresistance in CoFeB/MgO/CoFeB Magnetic Tunnel Junctions", Appl. Phys. Lett., vol. 86, (2005), pp. 092502-1 – 092502-3, which is Evidence Submitted by Defendants 12 for 2014(wa)25200 Case of Claiming Damages in Japan, and which is also called as "Djyaprawira article", already submitted as IDS on August 12, 2019	☐
48	"Part I Chapter 1" of "Examination Guidelines for Patent and Utility Model in Japan" of July 2013, which is Evidence Submitted by Defendants 13 for 2014(wa)25200 Case of Claiming Damages in Japan, with English translation	☒

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

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Name/Print	James J. Kulbaski	Registration Number	34848

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First Named Inventor/Applicant Name:	Shinji YUASA
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EFS ID:	37741662
Application Number:	16443875
International Application Number:	
Confirmation Number:	1667
Title of Invention:	MAGNETIC TUNNEL JUNCTION DEVICE
First Named Inventor/Applicant Name:	Shinji YUASA
Customer Number:	154930
Filer:	James J. Kulbaski/Sandra Miles
Filer Authorized By:	James J. Kulbaski
Attorney Docket Number:	12956US07CON
Receipt Date:	13-NOV-2019
Filing Date:	18-JUN-2019
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Application Type:	Utility under 35 USC 111(a)

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16443875
	Filing Date	2019-06-18
	First Named Inventor	Shinji YUASA
	Art Unit	2897
	Examiner Name	TBD
	Attorney Docket Number	12956US07CON

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		16443875
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	First Named Inventor	Shinji YUASA	
	Art Unit	2897	
	Examiner Name	TBD	
	Attorney Docket Number	12956US07CON	

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

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		16443875
	Filing Date		2019-06-18
	First Named Inventor	Shinji YUASA	
	Art Unit	2897	
	Examiner Name	TBD	
	Attorney Docket Number	12956US07CON	

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See attached certification statement.

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

☒ A certification statement is not submitted herewith.

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

Signature	/James J Kulbaski/	Date (YYYY-MM-DD)	2019-11-13
Name/Print	James J. Kulbaski	Registration Number	34648

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EFS ID:	37741766
Application Number:	16443875
International Application Number:	
Confirmation Number:	1667
Title of Invention:	MAGNETIC TUNNEL JUNCTION DEVICE
First Named Inventor/Applicant Name:	Shinji YUASA
Customer Number:	154930
Filer:	James J. Kulbaski/Sandra Miles
Filer Authorized By:	James J. Kulbaski
Attorney Docket Number:	12956US07CON
Receipt Date:	13-NOV-2019
Filing Date:	18-JUN-2019
Time Stamp:	15:40:54
Application Type:	Utility under 35 USC 111(a)

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16443875
	Filing Date	2019-06-18
	First Named Inventor	Shinji YUASA
	Art Unit	2897
	Examiner Name	CHAMBLISS, ALONZO
	Attorney Docket Number	12956US07CON

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	1	8294228	B2	2012-10-23	PENG et al.	Evidence Kou 16 (Evidence submitted by the Plaintiffs 16) for 2014(wa) 25200 Case of Claiming Damages in Japan	
	2	8091209	B2	2012-01-10	GAO et al.	Evidence Kou 29 (Evidence submitted by the Plaintiffs 29) for 2014(wa) 25200 Case of Claiming Damages in Japan	
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	1	20040144995	A1	2004-07-29	NAGAHAMA et al.	Corresponds to JP2003-318465, which is Evidence Otsu 34 (Evidence submitted by the Defendant 34) for 2014(wa) 25200 Case of Claiming Damages in Japan, already	+
	2	20020064069	A1	2002-05-30	GOEBEL et al.	Corresponds to JP2002-540594, which is Evidence Otsu 35 (Evidence submitted by the Defendant 35) for 2014(wa) 25200 Case of Claiming Damages in Japan	
	3	20030203189	A1	2003-10-30	FUTAMOTO et al.	Corresponds to JP2001-023140, which is Evidence Otsu 49 (Evidence submitted by the Defendant 49) for 2014(wa) 25200 Case of Claiming Damages in Japan, already	+
	4	20030080363	A1	2003-05-01	MARUYAMA et al.	Corresponds to JP2003-133531, which is Evidence Otsu 52 (Evidence submitted by the Defendant 52) for 2014(wa) 25200 Case of Claiming Damages in Japan	
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	1	4963744	JP	B2	2012-06-27	JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.	Evidence Kou 2 (Evidence submitted by the Plaintiffs 2), for 2014 (wa) 25200 Case of Claiming Damages in +	×
	2	5002788	JP	B2	2012-08-15	JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.	Evidence Kou 4 (Evidence submitted by the Plaintiffs 4), for 2014 (wa) 25200 Case of Claiming Damages in +	☒
	3	5120680	JP	B2	2013-01-16	JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.	Evidence Kou 6 (Evidence submitted by the Plaintiffs 6), for 2014 (wa) 25200 Case of Claiming Damages in +	☒
	4	5152734	JP	B2	2013-02-27	JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.	Evidence Kou 8 (Evidence submitted by the Plaintiffs 8), for 2014 (wa) 25200 Case of Claiming Damages in +	☒
	5	4774092	JP	B2	2011-09-14	JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.	Evidence Kou 10 (Evidence submitted by the Plaintiffs 10), for 2014(wa) 25200 Case of Claiming Damages in +	☒
	6	2005/88745	WO	A1	2005-09-22	JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.	Evidence Otsu 3-1 (Evidence submitted by the Defendant 3-1), for 2014(wa) 25200 Case of Claiming Damages in +	☒
	7	2006-196612	JP	A	2006-07-27	SONY CORP.	Evidence Otsu 28 (Evidence submitted by the Defendant 28), for 2014(wa) 25200 Case of Claiming Damages in +	☒
	8	2003-318465	JP	A	2003-11-07	ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY et al.	Evidence Otsu 34 (Evidence submitted by the Defendant 34) for 2014(wa) 25200 Case of Claiming Damages in +	☒
	9	2002-540594	JP	T	2002-11-26	INFINEON TECHNOLOGIES AG	Evidence Otsu 35 (Evidence submitted by the Defendant 35) for 2014(wa) 25200 Case of Claiming Damages in +	☒
	10	2001-23140	JP	A	2001-01-26	HITACHI, LTD.	Evidence Otsu 49 (Evidence submitted by the Defendant 49) for 2014(wa) 25200 Case of Claiming Damages in +	☒

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

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	1	Defendant Preliminary Documents (1) Page 33 line 11 - Page 57 submitted on January 30, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
	2	Plaintiffs Preliminary Documents (1) Page 69 - Page 74 submitted on March 13, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
	3	Defendant Preliminary Documents (2) Page 23 line 16 - Page 46 submitted on June 4, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
	4	Plaintiffs Preliminary Documents (2) Page 31 line 13 - Page 32 submitted on July 23, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒

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

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

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	Attorney Docket Number	12956US07CON

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

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

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

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Signature	/James J Kulbaski/	Date (YYYY-MM-DD)	2019-12-11
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If you wish to add additional Foreign Patent Document citation information please click the Add button.								Add
NON-PATENT LITERATURE DOCUMENTS								Remove
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.						T ⁵

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		16443875
	Filing Date		2019-06-18
	First Named Inventor	Shinji YUASA	
	Art Unit	2897	
	Examiner Name	CHAMBLISS, ALONZO	
	Attorney Docket Number	12956US07CON	

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

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

EXAMINER SIGNATURE

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

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16443875
	Filing Date	2019-06-18
	First Named Inventor	Shinji YUASA
	Art Unit	2897
	Examiner Name	CHAMBLISS, ALONZO
	Attorney Docket Number	12956US07CON

CERTIFICATION STATEMENT

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

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

OR

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

See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/James J Kulbaski/	Date (YYYY-MM-DD)	2019-12-11
Name/Print	James J. Kulbaski	Registration Number	34648

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

Privacy Act Statement

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

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

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

Electronic Acknowledgement Receipt	
EFS ID:	37997235
Application Number:	16443875
International Application Number:	
Confirmation Number:	1667
Title of Invention:	MAGNETIC TUNNEL JUNCTION DEVICE
First Named Inventor/Applicant Name:	Shinji YUASA
Customer Number:	154930
Filer:	James J. Kulbaski/Sandra Miles
Filer Authorized By:	James J. Kulbaski
Attorney Docket Number:	12956US07CON
Receipt Date:	11-DEC-2019
Filing Date:	18-JUN-2019
Time Stamp:	13:43:46
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment		no			
File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	12956US07CON_Letter_to_PT O-signed.pdf	61722 9d3abf36ba8fd1ad0f27c757b830aec0071e2b4a	no	1
Warnings:					

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	12956US07CON_US16-443875_2ndIDSlist1-signed.pdf	1038286 93ecfaaaa1a8472167286810ac0e126e01ed b8a0	no	10
Warnings:					
Information:					
3	Information Disclosure Statement (IDS) Form (SB08)	12956US07CON_US16-443875_2ndIDSlist2-signed.pdf	1035753 8f2fcaf2fadff4ed7805e5d0e44b3aa3905a7 735	no	4
Warnings:					
Information:					
A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.					
Total Files Size (in bytes):			2135761		
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. <u>New Applications Under 35 U.S.C. 111</u> 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. <u>National Stage of an International Application under 35 U.S.C. 371</u> 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. <u>New International Application Filed with the USPTO as a Receiving Office</u> 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.					

DOCKET NO: 12956US07CON

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF :
SHINJI YUASA : EXAMINER: CHAMBLISS, ALONZO
SERIAL NO: 16/443,875 :
FILED: JUNE 18, 2019 : GROUP ART UNIT: 2897
FOR: MAGNETIC TUNNEL JUNCTION :
DEVICE :

LETTER TO PTO

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

Commissioner:

Please replace the two Information Disclosure Statement forms PTO/SB/08a filed November 13, 2019 with the attached corrected IDS (PTO/SB/08a) Forms. These new PTO/SB/08a forms are being submitted to correct typographical errors found in NPL item 26 and 45 as well as changing “Defendants” to –Defendant—throughout the IDS Forms. All references cited in the IDS were previously filed on November 13, 2019.

Respectfully Submitted,

XSENSUS, L.L.P.

/James J Kulbaski/

James J. Kulbaski
Attorney of Record
Registration No. 34,648

CUSTOMER NO.
154930

Phone No. 571-376-6333
Fax: 571-376-6334



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/443,875	06/18/2019	Shinji YUASA	12956US07CON	1667
154930	7590	12/20/2019		
XSENSUS LLP 200 Daingerfield Road Suite 201 Alexandria, VA 22314			EXAMINER CHAMBLISS, ALONZO	
			ART UNIT	PAPER NUMBER
			2897	
			NOTIFICATION DATE	DELIVERY MODE
			12/20/2019	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):

Arlene.Hudgens@Xsensus.com
Faith.Baggett@xsensus.com
anaquadocketing@Xsensus.com

Office Action Summary	Application No. 16/443,875	Applicant(s) YUASA, Shinji	
	Examiner ALONZO CHAMBLISS	Art Unit 2897	AIA (FITF) Status No

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

Period for Reply

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

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).

Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☒ Responsive to communication(s) filed on 12/11/19.
 ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on ____.

2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.

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

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

Disposition of Claims*

5) ☒ Claim(s) 1-16 is/are pending in the application.
 5a) Of the above claim(s) ____ is/are withdrawn from consideration.

6) ☒ Claim(s) 2-16 is/are allowed.

7) ☒ Claim(s) 1 is/are rejected.

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

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

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

Application Papers

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

11) ☒ The drawing(s) filed on 6/18/19 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
 Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
 Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
Certified copies:
 a) ☒ All b) ☐ Some** c) ☐ None of the:
 1. ☐ Certified copies of the priority documents have been received.
 2. ☒ Certified copies of the priority documents have been received in Application No. 10/591,947.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

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

Attachment(s)

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

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
 Paper No(s)/Mail Date 8/12/19, 11/13/19, 12/11/19

3) ☐ Interview Summary (PTO-413)
 Paper No(s)/Mail Date _____

4) ☐ Other: _____

Notice of Pre-AIA or AIA Status

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

Information Disclosure Statement

2. The information disclosure statement (IDS) submitted on 8/12/19, 11/13/19, and 12/11/19 were filed after the mailing date of the Non-final rejection on 12/17/2019. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Drawings

3. The formal drawings filed on 6/18/19 have been approved by the examiner.

Claim Rejections - 35 USC § 103

4. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.
 3. Resolving the level of ordinary skill in the pertinent art.
 4. Considering objective evidence present in the application indicating obviousness or nonobviousness.
6. Claim 1 is rejected under 35 U.S.C. 103(a) as being unpatentable over Parkin (US 2008/0062581) in view of Nashimoto (US 5,514,484).

With respect to Claim 1, Parkin discloses a substrate 111 and a first amorphous ferromagnetic material layer 115 made of CoFeB alloy of a BCC structure on a substrate 111. An amorphous second ferromagnetic material layer 175 comprising a CoFeB alloy. A tunnel barrier layer 120' made of MgO located between the first and second ferromagnetic material layers 115,175, wherein the tunnel barrier layer comprising a poly-crystalline MgO layer in which (100) crystal plane is substantially oriented. Parkin discloses less oxygen between the tunnel barrier layer and the upper ferromagnetic layer (see abstract, paragraphs 41,42, 45, and 71 ; Figs. 3 and 11). Parkin fails to explicitly recite a barrier layer which is a (001) crystal plane oriented. However, Nashimoto discloses that it is well known in the semiconductor industry that a MgO barrier layer can have a (100) or (001) crystal plane as evident by Nashimoto see col. 6 lines 25-40 and col. 8 lines 1-15). Thus, Parkin and Nashimoto have substantially the same environment of a MgO layer formed on a substrate. Therefore, one skilled in the art at the time of invention would readily recognize the MgO barrier layer of Parkin can have a (001) structure, since the (001) structure is well known in the semiconductor industry to substitute a (001) structure for a (100) structure in the MgO layer as evident by Nashimoto.

Double Patenting

7. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the “right to exclude” granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP §§ 706.02(I)(1) - 706.02(I)(3) 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. 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 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.

8. Claim 1 is rejected on the ground of nonstatutory double patenting as being unpatentable over claim 1 of U.S. Patent No. 7,884,403. Although the claims at issue are not identical, they are not patentably distinct from each other because both the application and patent recite a tunnel barrier layer. A first ferromagnetic material layer of the BCC structure formed on a first side of said tunnel barrier layer. A second ferromagnetic material layer of the BCC structure formed on a second side of said tunnel barrier layer, wherein said tunnel barrier layer is formed by a single-crystalline MgO_x (001) layer or a poly-crystalline MgO_x ($0 < x < 1$) layer in which the (001) crystal plane is preferentially oriented.

Allowable Subject Matter

9. Claims 2-16 are allowed.
10. The following is a statement of reasons for the indication of allowance subject matter: the prior art of record does not teach or suggest the combination of annealing the first and second CoFeB layers and the MgO layer, wherein the first and second

CoFeB layers are crystallized by the annealing. The MgO layer is poly-crystalline in which a (001) crystal plane is preferentially oriented along with the other limitations in claim 2.

Forming a second ferromagnetic layer including a second CoFeB layer that is amorphous over the barrier layer. Annealing the first and second ferromagnetic layers and the barrier layer, to crystallize the first and second CoFeB layers along with the other limitations in claim 12.

Any inquiry concerning the communication or earlier communications from the examiner should be directed to Alonzo Chambliss whose telephone number is (571) 272- 1927.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Fernando L. Toledo can be reached on (571) 272-1867. The fax phone number for the organization where this application or proceeding is assigned is 571 - 273- 8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system Status information for published applications may be obtained from either Private PMR or Public PMR.

Status information for unpublished applications is available through Private PMR only. For more information about the PMR system see <http://pair-dkect.uspto.gov>.

Application/Control Number: 16/443,875
Art Unit: 2897

Page 7

Should you have questions on access to the Private PMR system contact the
Electronic Business Center (EBC) at 866-217-9197 (toll-free) or
EBC_Support@uspto.gov.

AC/December 17, 2019

/Alonzo Chambliss/

Primary Examiner, Art Unit 2897

<i>Notice of References Cited</i>	Application/Control No. 16/443,875		Applicant(s)/Patent Under Reexamination YUASA, Shinji	
	Examiner ALONZO CHAMBLISS		Art Unit 2897	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-10367138-B2	07-2019	Yuasa; Shinji	G11C11/161	1/1
	B					
	C					
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	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date 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.

U.S. Patent and Trademark Office
PTO-892 (Rev. 01-2001)

Notice of References Cited

Part of Paper No. 20191217

<i>Search Notes</i> 	Application/Control No. 16/443,875	Applicant(s)/Patent Under Reexamination YUASA, Shinji
	Examiner ALONZO CHAMBLISS	Art Unit 2897

CPC - Searched*		
Symbol	Date	Examiner
H01L43/08, 43/10, 43/02, 43/12, 27/228, 27/11507; G11C11/161, 11/16, 11/15; H01F10/3254, 10/132; B82Y25/00	12/17/2019	AC

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

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

Search Notes		
Search Notes	Date	Examiner
East text search only - see attached printout	12/17/2019	AC

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

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EAST Search History**EAST Search History (Prior Art)**

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	1	("10367138").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2019/12/17 22:08
L2	465	257/\$.ccls. and (MgO magnesium adj2 oxide) with crystal\$5 and (MTJ magnetic adj2 tunnel adj2 junction) and CoFeB	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/17 23:00
L3	229	438/\$.ccls. and (MgO magnesium adj2 oxide) with crystal\$5 and (MTJ magnetic adj2 tunnel adj2 junction) and CoFeB	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/17 23:01
L4	464	2 AND ((H01L43/08 OR H01L43/10 OR H01L43/02 OR H01L43/12 OR H01L27/222 OR G11C11/161 OR G11C11/16 OR G11C11/15 OR H01F10/3254 OR B82Y25/00 OR H01F10/132 OR H01L27/228 OR H01L27/11507).CPC.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/17 23:06

EAST Search History (Interference)

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

Substitute for Form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application #	16/443,875
	Confirmation #	1667
	Filing Date	06-18-2019
	First Inventor	Shinji YUASA
	Art Unit	2827
	Examiner	
Sheet 1 of 3	Docket #	12956US07CON

U.S. PATENT DOCUMENTS				
Initial (*)	Document No. Number – Kind Code	Publ. Date MM-DD-YYYY	Name Patentee or Applicant	Corresponds to
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Initial (*)	Country-Number- Kind Code if known	Publ. Date MM-DD-YYYY	Name Patentee or Applicant	Trans- lation

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

Examiner Signature	/ALONZO CHAMBLISS/	Date Considered	12/17/2019
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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 the applicant.

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	Confirmation #	1667
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	Examiner	
Sheet <u>2</u> of <u>3</u>	Docket #	12956US07CON

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	BOUBETA, et al "Magnetization Reversal and Magnetic Anisotropies in Epitaxial FE/MGO and Fe/MgO/Fe heterostructures grown on Si(001)", February 15, 2003, pp. 2126-2134, vol. 93, no. 4, J. Appl. Phys.	

Examiner Signature	/ALONZO CHAMBLISS/	Date Considered	12/17/2019
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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 the applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.C/

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

Substitute for Form 1449/PTO INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application #	16/443,875
	Confirmation #	1667
	Filing Date	06-18-2019
	First Inventor	Shinji YUASA
	Art Unit	2827
	Examiner	
Sheet <u>3</u> of <u>3</u>	Docket #	12956US07CON

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

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

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

Examiner Signature	/ALONZO CHAMBLISS/	Date Considered	12/17/2019
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**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	16443875
Filing Date	2019-06-18
First Named Inventor	Shinji YUASA
Art Unit	2827
Examiner Name	
Attorney Docket Number	12956US07CON

CERTIFICATION STATEMENT

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

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

OR

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

☐ See attached certification statement.

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

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/James J Kulbaski/	Date (YYYY-MM-DD)	2019-08-12
Name/Print	James J. Kulbaski	Registration Number	34,648

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

Receipt date: 12/11/2019

16/443,875 - GAU: 2897

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16443875
	Filing Date	2019-06-18
	First Named Inventor	Shinji YUASA
	Art Unit	2897
	Examiner Name	CHAMBLISS, ALONZO
	Attorney Docket Number	12956US07CON

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Application Number	16443875
Filing Date	2019-06-18
First Named Inventor	Shinji YUASA
Art Unit	2897
Examiner Name	CHAMBLISS, ALONZO
Attorney Docket Number	12956US07CON

1	YUASA, S. et al., "Giant tunnel magnetoresistance in magnetic tunnel junctions with a crystalline MgO(001) barrier", Journal of Physics D: Applied Physics, 40, (2007), R337-R354, which is Evidence Otsu 29 (Evidence submitted by the Defendant 29) for 2014(wa)25200 Case of Claiming Damages in Japan, already submitted as IDS on August 12, 2019	
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Examiner Signature	/ALONZO CHAMBLISS/	Date Considered	12/17/2019
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¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

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

Application Number	16443875
Filing Date	2019-06-18
First Named Inventor	Shinji YUASA
Art Unit	2897
Examiner Name	CHAMBLISS, ALONZO
Attorney Docket Number	12956US07CON

CERTIFICATION STATEMENT

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OR

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

See attached certification statement.

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

☒ A certification statement is not submitted herewith.**SIGNATURE**

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

Signature	/James J Kulbaski/	Date (YYYY-MM-DD)	2019-12-11
Name/Print	James J. Kulbaski	Registration Number	34648

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

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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.

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Receipt date: 11/13/2019

16/443,875 - GAU: 2897

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16443875
	Filing Date	2019-06-18
	First Named Inventor	Shinji YUASA
	Art Unit	2897
	Examiner Name	TBD
	Attorney Docket Number	12956US07CON

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Filing Date	2019-06-18
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STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	16443875
Filing Date	2019-06-18
First Named Inventor	Shinji YUASA
Art Unit	2897
Examiner Name	TBD
Attorney Docket Number	12956US07CON

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Signature	/James J Kulbaski/	Date (YYYY-MM-DD)	2019-11-13
Name/Print	James J. Kulbaski	Registration Number	34648

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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.
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Receipt date: 12/11/2019

16/443,875 - GAU: 2897

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)

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

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	Art Unit	2897
	Examiner Name	CHAMBLISS, ALONZO
	Attorney Docket Number	12956US07CON

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	1	8294228	B2	2012-10-23	PENG et al.	Evidence Kou 16 (Evidence submitted by the Plaintiffs 16) for 2014(wa) 25200 Case of Claiming Damages in Japan	
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	1	20040144995	A1	2004-07-29	NAGAHAMA et al.	Corresponds to JP2003-318465, which is Evidence Otsu 34 (Evidence submitted by the Defendant 34) for 2014(wa) 25200 Case of Claiming Damages in Japan, already	+
	2	20020064069	A1	2002-05-30	GOEBEL et al.	Corresponds to JP2002-540594, which is Evidence Otsu 35 (Evidence submitted by the Defendant 35) for 2014(wa) 25200 Case of Claiming Damages in Japan	
	3	20030203189	A1	2003-10-30	FUTAMOTO et al.	Corresponds to JP2001-023140, which is Evidence Otsu 49 (Evidence submitted by the Defendant 49) for 2014(wa) 25200 Case of Claiming Damages in Japan, already	+
	4	20030080363	A1	2003-05-01	MARUYAMA et al.	Corresponds to JP2003-133531, which is Evidence Otsu 52 (Evidence submitted by the Defendant 52) for 2014(wa) 25200 Case of Claiming Damages in Japan	
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Application Number	16443875
Filing Date	2019-06-18
First Named Inventor	Shinji YUASA
Art Unit	2897
Examiner Name	CHAMBLISS, ALONZO
Attorney Docket Number	12956US07CON

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

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

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	1	Defendant Preliminary Documents (1) Page 33 line 11 - Page 57 submitted on January 30, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
	2	Plaintiffs Preliminary Documents (1) Page 69 - Page 74 submitted on March 13, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
	3	Defendant Preliminary Documents (2) Page 23 line 16 - Page 46 submitted on June 4, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
	4	Plaintiffs Preliminary Documents (2) Page 31 line 13 - Page 32 submitted on July 23, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒

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

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

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

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

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

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

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Signature	/James J Kulbaski/	Date (YYYY-MM-DD)	2019-12-11
Name/Print	James J. Kulbaski	Registration Number	34848

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

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	2	20020064069	A1	2002-05-30	GOEBEL et al.	Corresponds to JP2002-540594, which is Evidence submitted for Defendant 35 for 2014(wa) 25200 Case of Claiming Damages in Japan	
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Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	1	4963744	JP	B2	2012-06-27	JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.	Evidence Submitted by Plaintiffs 2, for 2014(wa) 25200 Case of Claiming Damages in Japan, which is also called as +	×
	2	5002788	JP	B2	2012-08-15	JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.	Evidence Submitted by Plaintiffs 4, for 2014(wa) 25200 Case of Claiming Damages in Japan, which is also called as +	⊗
	3	5120680	JP	B2	2013-01-16	JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.	Evidence Submitted by Plaintiffs 6, for 2014(wa) 25200 Case of Claiming Damages in Japan, which is also called as +	⊗
	4	5152734	JP	B2	2013-02-27	JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.	Evidence Submitted by Plaintiffs 8, for 2014(wa) 25200 Case of Claiming Damages in Japan, which is also called as +	⊗
	5	4774092	JP	B2	2011-09-14	JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.	Evidence Submitted by Plaintiffs 10, for 2014 (wa) 25200 Case of Claiming Damages in Japan, which is also +	⊗
	6	2005/88745	WO	A1	2005-09-22	JAPAN SCIENCE AND TECHNOLOGY AGENCY et al.	Evidence Submitted by Defendant 3-1, for 2014 (wa) 25200 Case of Claiming Damages in Japan, with English +	⊗
	7	2006-196612	JP	A	2006-07-27	SONY CORP.	Evidence Submitted by Defendant 28, for 2014 (wa) 25200 Case of Claiming Damages in Japan, with English +	⊗
	8	2003-318465	JP	A	2003-11-07	ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY et al.	Evidence Submitted by Defendant 34 for 2014 (wa) 25200 Case of Claiming Damages in Japan, with English +	⊗
	9	2002-540594	JP	T	2002-11-26	INFINEON TECHNOLOGIES AG	Evidence Submitted by Defendant 35 for 2014 (wa) 25200 Case of Claiming Damages in Japan, with English +	⊗
	10	2001-23140	JP	A	2001-01-26	HITACHI, LTD.	Evidence Submitted by Defendant 49 for 2014 (wa) 25200 Case of Claiming Damages in Japan, with English +	⊗

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

Application Number	16443875
Filing Date	2019-06-18
First Named Inventor	Shinji YUASA
Art Unit	2897
Examiner Name	TBD
Attorney Docket Number	12956US07CON

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

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	1	Defendant Preliminary Documents (1) Page 33 line 11 - Page 57 submitted on January 30, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
	2	Plaintiffs Preliminary Documents (1) Page 69 - Page 74 submitted on March 13, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
	3	Defendant Preliminary Documents (2) Page 23 line 16 - Page 46 submitted on June 4, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
	4	Plaintiffs Preliminary Documents (2) Page 31 line 13 - Page 32 submitted on July 23, 2015 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒

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Attorney Docket Number	12956US07CON

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

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Attorney Docket Number	12956US07CON

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

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

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38	Written Opinion submitted on March 23, 2012 for Japanese Patent Application No.2011-226907, which is Evidence Submitted by Defendants 7-1 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
39	Notice of Reasons for Refusal drafted on January 18, 2012 for Japanese Patent Application No.2011-226907, which is Evidence Submitted by Defendants 7-2 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation, already submitted as IDS on August 12, 2019	☒
40	Written Statement submitted on April 20, 2012 for Japanese Patent Application No.2012-067089, which is Evidence Submitted by Defendants 8 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
41	Written Opinion submitted on October 9, 2012 for Japanese Patent Application No.2011-226908, which is Evidence Submitted by Defendants 9-2 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
42	Written Statement submitted on November 11, 2011 for Japanese Patent Application No.2011-226908, which is Evidence Submitted by Defendants 9-3 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
43	Written Amendment submitted on March 10, 2008 for Japanese Patent Application No.2004-259280, which is Evidence Submitted by Defendants 10-1 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
44	Notice of Reasons for Refusal drafted on July 29, 2008 for Japanese Patent Application No.2004-259280, which is Evidence Submitted by Defendants 10-2 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
45	Written Amendment submitted on October 3, 2008 for Japanese Patent Application No.2004-259280, which is Evidence Submitted by Defendants 0-3 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
46	Written Opinion submitted on October 3, 2008 for Japanese Patent Application No.2004-259280, which is Evidence Submitted by Defendants 10-4 for 2014(wa)25200 Case of Claiming Damages in Japan, with English machine translation	☒
47	DJYAPRAWIRA, D.D. et al, "230% Room-Temperature Magnetoresistance in CoFeB/MgO/CoFeB Magnetic Tunnel Junctions", Appl. Phys. Lett., vol. 86, (2005), pp. 092502-1 – 092502-3, which is Evidence Submitted by Defendants 12 for 2014(wa)25200 Case of Claiming Damages in Japan, and which is also called as "Djyaprawira article", already submitted as IDS on August 12, 2019	☐
48	"Part I Chapter 1" of "Examination Guidelines for Patent and Utility Model in Japan" of July 2013, which is Evidence Submitted by Defendants 13 for 2014(wa)25200 Case of Claiming Damages in Japan, with English translation	☒

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

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Examiner Signature	/ALONZO CHAMBLISS/	Date Considered	12/17/2019
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Art Unit	2897
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Attorney Docket Number	12956US07CON

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

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

OR

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

See attached certification statement.

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

☒ A certification statement is not submitted herewith.**SIGNATURE**

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

Signature	/James J Kulbaski/	Date (YYYY-MM-DD)	2019-11-13
Name/Print	James J. Kulbaski	Registration Number	34848

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.C/

Bibliographic Data

Application No: 16/443,875

Foreign Priority claimed: ☒ Yes ☐ No

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

Verified and Acknowledged:

/ALONZO CHAMBLISS/

Examiner's Signature

Initials

Title:

MAGNETIC TUNNEL JUNCTION DEVICE

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
06/18/2019	257	2897	12956US07CON
RULE			

APPLICANTS

Japan Science and Technology Agency, Kawaguchi-shi, JAPAN

National Institute of Advanced Industrial Science and Technology, Tokyo, JAPAN

INVENTORS

Shinji YUASA Ibaraki, JAPAN

CONTINUING DATA

This application is a CON of 15428842 02/09/2017 PAT 10367138

15428842 is a CON of 14837558 08/27/2015 PAT 9608198

14837558 is a CON of 13767290 02/14/2013 PAT 9123463

13767290 is a CON of 13400340 02/20/2012 PAT 8405134

13400340 is a CON of 12923643 09/30/2010 PAT 8319263

12923643 is a CON of 10591947 09/08/2006 PAT 7884403

10591947 is a 371 of PCT/JP2005/004720 03/10/2005

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JAPAN 2004-071186 03/12/2004

JAPAN 2004-313350 10/28/2004

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/443,875	06/18/2019	Shinji YUASA	12956US07CON

CONFIRMATION NO. 1667

PUBLICATION NOTICE



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154930
XSENSUS LLP
200 Daingerfield Road
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Alexandria, VA 22314

Title:MAGNETIC TUNNEL JUNCTION DEVICE

Publication No.US-2020-0020851-A1

Publication Date:01/16/2020

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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.

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IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF :
SHINJI YUASA : EXAMINER: CHAMBLISS, ALONZO
SERIAL NO: 16/443,875 :
FILED: JUNE 18, 2019 : GROUP ART UNIT: 2897
FOR: MAGNETIC TUNNEL JUNCTION :
DEVICE :

AMENDMENT

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

Commissioner:

In response to the non-final Office Action of December 20, 2019, please amend the
above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims which begins on page 2
of this paper.

Remarks/Arguments begin on page 7 of this paper.

IN THE CLAIMS

Please amend the claims as follows:

Claim 1 (Canceled).

2. (Previously Presented) A method of manufacturing a magnetic tunnel junction (MTJ) device, comprising:

forming a first CoFeB layer that is amorphous;

forming a magnesium oxide (MgO) layer over the first CoFeB layer;

forming a second CoFeB layer that is amorphous over the MgO layer; and

annealing the first and second CoFeB layers and the MgO layer,

wherein the first and second CoFeB layers are crystallized by the annealing, and

wherein the MgO layer is poly-crystalline in which a (001) crystal plane is preferentially oriented.

3. (Previously Presented) The method of claim 2,

wherein after the annealing, the first and second CoFeB layers are entirely crystallized.

4. (Previously Presented) The method of claim 2,

wherein after the annealing, each of the first and second CoFeB layers is poly-crystalline in which a (001) crystal plane is preferentially oriented.

5. (Previously Presented) The method of claim 2, wherein after the annealing,

the first and second CoFeB layers are entirely crystallized, and

each of the first and second CoFeB layers is poly-crystalline in which a (001) crystal plane is preferentially oriented.

6. (Previously Presented) The method of claim 2,
wherein after the annealing, each of the first and second CoFeB layers is poly-crystalline in which a (001) crystal plane is preferentially oriented and each of the first and second CoFeB layers includes a BCC (body-centered cubic) structure.

7. (Previously Presented) The method of claim 2, wherein after the annealing,
the first and second CoFeB layers are entirely crystallized, and
each of the first and second CoFeB layers is poly-crystalline in which a (001) crystal plane is preferentially oriented and each of the first and second CoFeB layers includes a BCC (body-centered cubic) structure.

8. (Previously Presented) The method of claim 2,
wherein in the forming the MgO layer, the MgO layer is formed as a MgO_x ($0 < x < 1$) layer.

9. (Previously Presented) The method of claim 2,
wherein in the forming the MgO layer, the value of x in MgO_x for the MgO layer is greater than 0 and less than 1.

10. (Previously Presented) The method of claim 2,

wherein in the forming the MgO layer, the MgO layer is formed directly on the first CoFeB layer.

11. (Previously Presented) The method of claim 2, wherein:

in the forming the MgO layer, the MgO layer is formed directly on the first CoFeB layer,
and

in the forming the second CoFeB layer, the second CoFeB layer is formed directly on the MgO layer.

12. (Previously Presented) A method of manufacturing a magnetic tunnel junction (MTJ) device, comprising:

forming a first ferromagnetic layer including a first CoFeB layer that is amorphous;

forming a barrier layer including a magnesium oxide (MgO) layer to have a polycrystalline state in which a (001) crystal plane is preferentially oriented over the first ferromagnetic layer;

forming a second ferromagnetic layer including a second CoFeB layer that is amorphous over the barrier layer; and

annealing the first and second ferromagnetic layers and the barrier layer, to crystallize the first and second CoFeB layers.

13. (Previously Presented) The method of claim 12,

wherein after the annealing, the first and second CoFeB layers are entirely crystallized.

14. (Previously Presented) The method of claim 12, wherein after the annealing, the first and second CoFeB layers are entirely crystallized, and each of the first and second CoFeB layers is poly-crystalline in which a (001) crystal plane is preferentially oriented and each of the first and second CoFeB layers includes a BCC (body-centered cubic) structure.

15. (Previously Presented) The method of claim 12, wherein in the forming the barrier layer, the MgO layer is formed as a MgO_x ($0 < x < 1$) layer.

16. (Previously Presented) The method of claim 12, wherein: in the forming the barrier layer, the barrier layer is formed directly on the first ferromagnetic layer, and in the forming the second ferromagnetic layer, the second ferromagnetic layer is formed directly on the barrier layer.

REMARKS/ARGUMENTS

Favorable consideration of this application, as presently amended and in light of the following discussion, is respectfully requested.

Claims 2-16 are pending in the present application; Claim 1 having been canceled by way of the present amendment.

In the outstanding Office Action, Claim 1 was rejected under 35 U.S.C. 103(a) as being unpatentable over Parkin (US 2008/0062581) in view of Nashimoto (US 5,514,484), Claim 1 was rejected on the ground of nonstatutory double patenting as being unpatentable over claim 1 of U.S. Patent No. 7,884,403, and Claims 2-16 were allowed.

In response to the indication of allowable subject matter, Claim 1 has been canceled in order to place the application in condition for allowable. The cancellation of Claim 1 should not be construed as an admission that Claim 1 is not patentable, and the applicant reserves the right to file a continuing application directed to the subject matter of Claim 1.

As only allowed Claims 2-16 remain pending, the present application should be allowed.

It is noted that paragraph no. 2 on the top of p. 2 of the Office Action states, “The information disclosure statement (IDS) submitted on 8/12/19, 11 /13/19, and 12/11 /19 were filed *after* the mailing date of the Non-final rejection on 12/17/2019.” This is an obvious typographical error as the various IDS documents were filed *before* the mailing date of the Non-Final rejection.

Should the Examiner deem that any further action is necessary to place this application in form for allowance, the Examiner is encouraged to contact the undersigned representative at the below listed telephone number.

Respectfully Submitted,

XSENSUS, L.L.P.

/James J Kulbaski/

James J. Kulbaski
Attorney of Record
Registration No. 34,648
Phone No. (571) 376-6333

Customer No. 154930
Xsensus LLP
200 Daingerfield Rd, Suite 201
Alexandria, VA 22314

Electronic Acknowledgement Receipt	
EFS ID:	38345481
Application Number:	16443875
International Application Number:	
Confirmation Number:	1667
Title of Invention:	MAGNETIC TUNNEL JUNCTION DEVICE
First Named Inventor/Applicant Name:	Shinji YUASA
Customer Number:	154930
Filer:	James J. Kulbaski/Christine Grimes
Filer Authorized By:	James J. Kulbaski
Attorney Docket Number:	12956US07CON
Receipt Date:	21-JAN-2020
Filing Date:	18-JUN-2019
Time Stamp:	10:45:15
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		12956US07CON_Response.pdf	267766 a11092a7ccc6fdb3551959558359ea69b73c77c4	yes	9

Multipart Description/PDF files in .zip description			
Document Description		Start	End
Transmittal Letter		1	1
Fee Worksheet (SB06)		2	2
Amendment/Req. Reconsideration-After Non-Final Reject		3	3
Claims		4	7
Applicant Arguments/Remarks Made in an Amendment		8	9

Warnings:

Information:

Total Files Size (in bytes):	267766
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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 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.

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.

Doc Code: TRAN.LET

Document Description: Transmittal Letter

PTO/SB/21 (07-09)

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

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

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

TRANSMITTAL FORM <i>(to be used for all correspondence after initial filing)</i>	Application Number	16/443,875	
	Filing Date	18 Jun 2019	
	First Named Inventor	Shinji YUASA	
	Art Unit	2897 Confirmation No. 1667	
	Examiner Name	CHAMBLISS, ALONZO	
Total Number of Pages in This Submission	9	Attorney Docket Number	12956US07CON

ENCLOSURES (Check all that apply)		
☒ Fee Transmittal Form ☐ Fee Attached ☒ Amendment/Reply ☐ After Final ☐ Affidavits/declaration(s) ☐ Extension of Time Request ☐ Express Abandonment Request ☐ Information Disclosure Statement ☐ Certified Copy of Priority Document(s) ☐ Reply to Missing Parts/ Incomplete Application ☐ Reply to Missing Parts under 37 CFR 1.52 or 1.53	☐ Drawing(s) ☐ Licensing-related Papers ☐ Petition ☐ Petition to Convert to a Provisional Application ☐ Power of Attorney, Revocation ☐ Change of Correspondence Address ☐ Terminal Disclaimer ☐ Request for Refund ☐ CD, Number of CD(s) _____ ☐ Landscape Table on CD	☐ After Allowance Communication to TC ☐ Appeal Communication to Board of Appeals and Interferences ☐ Appeal Communication to TC (Appeal Notice, Brief, Reply Brief) ☐ Proprietary Information ☐ Status Letter ☐ Other Enclosure(s) (please identify below):
SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT		
Firm Name	XSensus, LLP Customer Number 154930	
Signature	/James J Kulbaski/	
Printed name	James J. Kulbaski	
Date	2020-1-21	Reg. No. 34,648

CERTIFICATE OF TRANSMISSION/MAILING		
I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:		
Signature		
Typed or printed name		Date

This collection of information is required by 37 CFR 1.5. 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 2 hours 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 & TRADEMARK OFFICE
FEE TRANSMITTAL

Application Number	16/443,875
Filing Date	18 Jun 2019
First Named Inventor	Shinji YUASA
Art Unit	2897
Examiner Name	CHAMBLISS, ALONZO
Attorney Docket Number	12956US07CON

☐ No additional fee is required

☐ Small entity status is claimed

	Claims Remaining After Amendment		Highest Number of Claims Previously Paid For	Current Extra Claims	Rate	Additional Fee
Total Claims	15	-	20	= 0	x \$ 100.00 =	\$ 0.00
Independent Claims	2	-	3	= 0	x \$ 460.00 =	\$ 0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))					\$	\$
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A	\$
					TOTAL	\$ 0.00
EXTENSION OF TIME						\$
REQUEST FOR RECONSIDERATION (RCE)						\$
NOTICE OF APPEAL						\$
TERMINAL DISCLAIMER						\$
						\$
						\$
TOTAL						\$ 0.00
The Commissioner is hereby authorized to charge any additional fees that may be required for papers being filed herewith and for which no payment is enclosed herewith, or credit any overpayment to Deposit Account 602325						

XSENSUS, LLP
Customer Number:

154930

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875			Application or Docket Number 16/443,875		Filing Date 06/18/2019		☐ To be Mailed		
ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO									
APPLICATION AS FILED - PART I									
	(Column 1)	(Column 2)							
FOR	NUMBER FILED	NUMBER EXTRA				RATE (\$)	FEE (\$)		
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A				N/A			
☐ SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A				N/A			
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A				N/A			
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*				x \$100 =			
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*				x \$460 =			
☐ 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).								
☐ 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									
	(Column 1)		(Column 2)	(Column 3)					
AMENDMENT	01/21/2020	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)		ADDITIONAL FEE (\$)		
	Total (37 CFR 1.16(i))	* 15	Minus	** 20	= 0	x \$100 =		0	
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0	x \$460 =		0	
	☐ Application Size Fee (37 CFR 1.16(s))								
	☐ 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 (37 CFR 1.16(i))	*	Minus	**	=	x \$0 =			
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x \$0 =			
	☐ Application Size Fee (37 CFR 1.16(s))								
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))								
						TOTAL ADD'L FEE	LIE		
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.									
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".						/SULONDA D STEVENSON/			
*** 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.



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NOTICE OF ALLOWANCE AND FEE(S) DUE

154930 7590 02/03/2020
XSensus LLP
200 Daingerfield Road
Suite 201
Alexandria, VA 22314

EXAMINER

CHAMBLISS, ALONZO

ART UNIT

PAPER NUMBER

2897

DATE MAILED: 02/03/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/443,875	06/18/2019	Shinji YUASA	12956US07CON	1667

TITLE OF INVENTION: MAGNETIC TUNNEL JUNCTION DEVICE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0.00	\$0.00	\$1000	05/04/2020

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.

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)

154930 7590 02/03/2020
XSensus LLP
200 Daingerfield Road
Suite 201
Alexandria, VA 22314

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.
16/443,875	06/18/2019	Shinji YUASA	12956US07CON	1667

TITLE OF INVENTION: MAGNETIC TUNNEL JUNCTION DEVICE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0.00	\$0.00	\$1000	05/04/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
CHAMBLISS, ALONZO	2897	257-421000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/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. _____



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/443,875	06/18/2019	Shinji YUASA	12956US07CON	1667
154930	7590	02/03/2020	EXAMINER	
XSENSUS LLP			CHAMBLISS, ALONZO	
200 Daingerfield Road			ART UNIT	
Suite 201			PAPER NUMBER	
Alexandria, VA 22314			2897	

DATE MAILED: 02/03/2020

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.

Notice of Allowability	Application No. 16/443,875	Applicant(s) YUASA, Shinji	
	Examiner ALONZO CHAMBLISS	Art Unit 2897	AIA (FITF) Status No

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

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to the amendment filed on 1/21/2020.
☐ 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 2-16. 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 or send an inquiry to PPHfeedback@uspto.gov.

4. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
Certified copies:
a) ☒ All b) ☐ Some *c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
2. ☒ Certified copies of the priority documents have been received in Application No. 10/591,947.
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).
* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892) 2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____. 3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____. 4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____.	5. ☐ Examiner's Amendment/Comment 6. ☐ Examiner's Statement of Reasons for Allowance 7. ☒ Other <u>see Detailed Action</u> .
---	--

/ALONZO CHAMBLISS/
Primary Examiner, Art Unit 2897

Notice of Pre-AIA or AIA Status

1. The present application is being examined under the pre-AIA first to invent provisions.
2. The amendment filed on 1/21/2020 has been fully considered and made of record in this application.

Any inquiry concerning the communication or earlier communications from the examiner should be directed to Alonzo Chambliss whose telephone number is (571) 272- 1927.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Fernando L. Toledo can be reached on (571) 272-1867. The fax phone number for the organization where this application or proceeding is assigned is 571 -273- 8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system Status information for published applications may be obtained from either Private PMR or Public PMR.

Status information for unpublished applications is available through Private PMR only. For more information about the PMR system see <http://pair-dkect.uspto.gov>.

Application/Control Number: 16/443,875
Art Unit: 2897

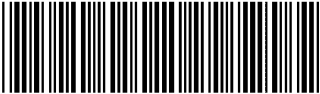
Page 3

Should you have questions on access to the Private PMR system contact the
Electronic Business Center (EBC) at 866-217-9197 (toll-free) or
EBC_Support@uspto.gov.

AC/January 27, 2020

/Alonzo Chambliss/

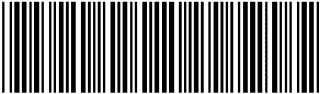
Primary Examiner, Art Unit 2897

Issue Classification 	Application/Control No. 16/443,875	Applicant(s)/Patent Under Reexamination YUASA, Shinji
	Examiner ALONZO CHAMBLISS	Art Unit 2897

CPC						
Symbol					Type	Version
H01L	/	43	/	10	F	2013-01-01
H01F	/	10	/	132	I	2013-01-01
G11C	/	11	/	15	I	2013-01-01
H01L	/	28	/	55	I	2013-01-01
H01L	/	27	/	11507	I	2013-01-01
B82Y	/	25	/	00	I	2013-01-01
G11C	/	11	/	16	I	2013-01-01
H01L	/	27	/	228	I	2013-01-01
H01L	/	43	/	08	I	2013-01-01
H01L	/	43	/	12	I	2013-01-01
H01F	/	10	/	3254	I	2013-01-01
H01L	/	43	/	02	I	2013-01-01
G11C	/	11	/	161	I	2013-01-01
H01L	/	27	/	222	I	2013-01-01
H01L	/	27	/	22	A	2013-01-01
B82Y	/	10	/	00	A	2013-01-01

CPC Combination Sets					
Symbol		Type	Set	Ranking	Version
	/		/		

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	15	
/ALONZO CHAMBLISS/ Primary Examiner, Art Unit 2897	27 January 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1B

Issue Classification 	Application/Control No. 16/443,875	Applicant(s)/Patent Under Reexamination YUASA, Shinji
	Examiner ALONZO CHAMBLISS	Art Unit 2897

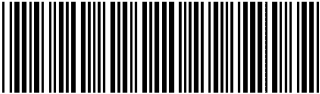
INTERNATIONAL CLASSIFICATION			
CLAIMED			
H01L	/	21	/ 02
H01L	/	21	/ 00

NON-CLAIMED			
/		/	

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

CROSS REFERENCES(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	15	
/ALONZO CHAMBLISS/ Primary Examiner, Art Unit 2897	27 January 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1B

Issue Classification 	Application/Control No. 16/443,875	Applicant(s)/Patent Under Reexamination YUASA, Shinji
	Examiner ALONZO CHAMBLISS	Art Unit 2897

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47															
CLAIMS															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1	9	10												
1	2	10	11												
2	3	11	12												
3	4	12	13												
4	5	13	14												
5	6	14	15												
6	7	15	16												
7	8														
8	9														

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	15	
/ALONZO CHAMBLISS/ Primary Examiner, Art Unit 2897	27 January 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1B

U.S. Patent and Trademark Office

Part of Paper No.: 20200127

Search Notes 	Application/Control No. 16/443,875	Applicant(s)/Patent Under Reexamination YUASA, Shinji
	Examiner ALONZO CHAMBLISS	Art Unit 2897

CPC - Searched*		
Symbol	Date	Examiner
H01L43/08, 43/10, 43/02, 43/12, 27/228, 27/11507; G11C11/161, 11/16, 11/15; H01F10/3254, 10/132; B82Y25/00	12/17/2019	AC
H01L43/08, 43/10, 43/02, 43/12, 27/228, 27/11507; G11C11/161, 11/16, 11/15; H01F10/3254, 10/132; B82Y25/00	01/27/2020	AC

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

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

Search Notes		
Search Notes	Date	Examiner
East text search only - see attached printout	12/17/2019	AC
Updated previous East text search only - see attached printout	01/27/2020	AC

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
US PGPUB text search only		01/27/2020	AC

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	465	257/\$.ccls. and (MgO magnesium adj2 oxide) with crystal\$5 and (MTJ magnetic adj2 tunnel adj2 junction) and CoFeB	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/01/27 11:09
L2	229	438/\$.ccls. and (MgO magnesium adj2 oxide) with crystal\$5 and (MTJ magnetic adj2 tunnel adj2 junction) and CoFeB	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/01/27 11:10
L3	0	361/\$.ccls. and (MgO magnesium adj2 oxide) with crystal\$5 and (MTJ magnetic adj2 tunnel adj2 junction) and CoFeB	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/01/27 11:11
L4	464	1 AND ((H01L43/08 OR H01L43/10 OR H01L43/02 OR H01L43/12 OR H01L27/222 OR G11C11/161 OR G11C11/16 OR G11C11/15 OR H01F10/3254 OR B82Y25/00 OR H01F10/132 OR H01L27/228 OR H01L27/11507).CPC.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/01/27 11:13

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L5	227	438/\$.ccls. and (MgO magnesium adj2 oxide) with crystal\$5 and (MTJ magnetic adj2 tunnel adj2 junction) and CoFeB	US-PGPUB; USPAT	OR	ON	2020/01/27 11:13
L6	462	257/\$.ccls. and (MgO magnesium adj2 oxide) with crystal\$5 and (MTJ magnetic adj2 tunnel adj2 junction) and CoFeB	US-PGPUB; USPAT	OR	ON	2020/01/27 11:14

1/ 27/ 2020 11:21:20 AM

C:\Users\achambliss\Documents\EAST\Workspaces\15570686.wsp

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)

154930 7590 02/03/2020
XSensus LLP
200 Daingerfield Road
Suite 201
Alexandria, VA 22314

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.
16/443,875	06/18/2019	Shinji YUASA	12956US07CON	1667

TITLE OF INVENTION: MAGNETIC TUNNEL JUNCTION DEVICE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0.00	\$0.00	\$1000	05/04/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
CHAMBLISS, ALONZO	2897	257-421000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/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. XSensus LLP

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

- JAPAN SCIENCE AND TECHNOLOGY AGENCY
- NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY

(B) RESIDENCE: (CITY AND STATE OR COUNTRY)

- Kawaguchi-shi, Japan
- Tokyo, Japan

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required) ☐ 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. 602325

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 _____ /James J Kulbaski/

Date _____ April 30, 2020

Typed or printed name _____ James J. Kulbaski

Registration No. _____ 34,648

Electronic Patent Application Fee Transmittal				
Application Number:		16443875		
Filing Date:		18-Jun-2019		
Title of Invention:		MAGNETIC TUNNEL JUNCTION DEVICE		
First Named Inventor/Applicant Name:		Shinji YUASA		
Filer:		James J. Kulbaski/Christine Grimes		
Attorney Docket Number:		12956US07CON		
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	1000	1000

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1000

Electronic Acknowledgement Receipt	
EFS ID:	39316330
Application Number:	16443875
International Application Number:	
Confirmation Number:	1667
Title of Invention:	MAGNETIC TUNNEL JUNCTION DEVICE
First Named Inventor/Applicant Name:	Shinji YUASA
Customer Number:	154930
Filer:	James J. Kulbaski/Christine Grimes
Filer Authorized By:	James J. Kulbaski
Attorney Docket Number:	12956US07CON
Receipt Date:	30-APR-2020
Filing Date:	18-JUN-2019
Time Stamp:	15:20:28
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$1000
RAM confirmation Number	E20204TF21090622
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	Issue Fee Payment (PTO-85B)	12956US07CON_IssueFeeTransmittal.pdf	1646369	no	1
			dcde3116d7137582e322a531005d4dd77da4814		
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30383	no	2
			c705e6e21ff8d42fd83b26b1c73a72bf1ea2ca52		
Warnings:					
Information:					
Total Files Size (in bytes):			1676752		
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. <u>New Applications Under 35 U.S.C. 111</u> 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. <u>National Stage of an International Application under 35 U.S.C. 371</u> 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. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					



UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/443,875	06/09/2020	10680167	12956US07CON	1667

154930 7590 05/20/2020
XSENSUS LLP
200 Daingerfield Road
Suite 201
Alexandria, VA 22314

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):

Shinji YUASA, Ibaraki, JAPAN;
Japan Science and Technology Agency, Kawaguchi-shi, JAPAN;
National Institute of Advanced Industrial Science and Technology, Tokyo, JAPAN;

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.

IR103 (Rev. 10/09)