UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

WESTERN DIGITAL TECHNOLOGIES, INC.,
Petitioner,

v.

GODO KAISHA IP BRIDGE 1,
Patent Owner.

Case Nos. IPR2024-01447, IPR2024-01493
U.S. Patent Nos. 8,405,134 and 10,680,167

REPLY DECLARATION OF JEFFREY BOKOR, PH.D.

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I, Jeffrey Bokor, hereby declare as follows:

I. INTRODUCTION

1. I have prepared this Reply Declaration supporting Western Digital Technologies, Inc.'s Petitions for *Inter Partes* Review of U.S. Patent Nos. 8,405,134 (EX1005, "the '134 Patent") and 10,680,167 (EX1013, "the '167 Patent"). In preparing this Declaration, I was asked only to respond to certain specific points asserted by Dr. Ross. I have identified those points and provided my responses in sections below.

2. I previously prepared declarations in support of Western Digital's Petitions in these cases (EX1024 in IPR2024-01447 and -01493). My compensation and my qualifications are set forth in my previous declarations and my curriculum vitae. EX1024 (First Declarations); EX1025 (Bokor CV).

II. MATERIALS CONSIDERED

3. Previously, I listed the documents I reviewed in connection with these proceedings in Paragraph 10 of each of my First Declarations. Because IP Bridge numbered its exhibits differently between the two IPR proceedings, for clarity and where needed, in this Reply Declaration I add the notations "'134 IPR" and "'167 IPR" in my citations to exhibits that were submitted in IPR2024-01447 and IPR2024-01493, respectively. For this Reply Declaration, I additionally reviewed the Board's Institution Decisions (IPR2024-01447, Paper 10 and IPR2024-01493,

Paper 9), IP Bridge's Preliminary Response Brief (IPR2024-01447, Paper 8 and IPR2024-01493, Paper 7), IP Bridge's Response Brief (IPR2024-01447, Paper 19 and IPR2024-01493, Paper 18), and any other documents cited or referenced in this Reply Declaration, and these exhibits:

Exhibit No.	Description
1097	Wang et al., *Deposition of in-plane textured MgO on amorphous Si_3N_4 substrates by ion-beam-assisted deposition and comparisons with ion-beamassisted deposited yttria-stabilized*-zirconia, 71 Appl. Phys. Letters 2955-2957 (1997)
1098	Inaba et al., *Magnetic and Crystallographic Properties of Co–Cr–Pt Longitudinal Media Prepared on MgO Seedlayers Deposited by ECR Sputtering*, 36 IEEE Trans. Magn. 2372-2374 (2000)
1099	Tonouchi et al., *Epitaxial growth of NbN on an ultrathin MgO/semiconductor system*, 62 J. Appl. Phys. 961-966 (1987)
1100	Plummer et al., *Silicon VLSI Technology, Fundamentals, Practice and Modeling* (Prentice Hall 1999) (excerpts)
1101	Transcript of Deposition of Caroline A. Ross, Ph.D., taken September 18, 2025
1102	Transcript of Deposition of Caroline A. Ross, Ph.D., taken September 19, 2025
1104	Renault et al., *Strong <200> and <111> Preferred Orientations of MgO Thin Films Synthesized on Amorphous Substrate by Aerosol Assisted-Metallorganic Chemical Vapor Deposition*, 146 J. Electrochem. Soc.3731-3735 (1999)
2005	Zhu et al., *Magnetic tunnel junctions*, 9 Materials Today 36-45 (2006)
2006	Djayaprawira et al., *230% room-temperature magnetoresistance in CoFeB/MgO/CoFeB magnetic tunnel junctions*, 86 Appl. Phys. Letters 092502 (2005)

Exhibit No.	Description
2007	Yuasa et al., *High Tunnel Magnetoresistance at Room Temperature in Fully Epitaxial Fe/MgO/Fe Tunnel Junctions due to Coherent Spin-Polarized Tunneling*, 43 Japanese J. Appl. Phys. L588 (2004)
2008	Yuasa et al., *Giant room-temperature magnetoresistance in single crystal Fe/MgO/Fe magnetic tunnel junctions*, 3 Nature Materials, 868-871 (2004)
2017	Transcript of Deposition of Jeffrey Bokor, Ph.D. taken June 24, 2025
2018	Transcript of Deposition of Jeffrey Bokor, Ph.D. taken June 25, 2025
2019	Marrows, *Spin-polarised currents and magnetic domain walls*, 54 Advances in Physics 585-713 (2005)
2020	Tsymbal et al., *Handbook of Spin Transport and Magnetism* (Tsymbal et al. eds. 2012)
2022	Nakatani et al., *Read sensor technology for ultrahigh density magnetic recording*, 43 MRS Bulletin 106-111 (2018)
2024	*The 23rd (FY2022) Japan Society of Applied Physics Achievement Award Recipients* (with English translation), The Japan Society of Applied Physics
2026	2021 New Fellows, IEEE Japan Council
2028	Dr. Shinji Yuasa profile, Japan Science and Technology Agency
2029	*AIST wins three Science and Technology Awards in the 2016 Minister of Education, Culture, Sports, Science and Technology Commendation for Science and Technology*, https://www.aist.go.jp/aist_j/news/prize/pr20160412_3.html
2032	AIST: 20th Tsukuba Prize winner, https://www.aist.go.jp/aist_j/news/prize/itemid025-000077.html
2033	Announcing the winners for "Tsukuba Prize," "Esaki Leona Prize," and "Tsukuba Encouragement Prize," Ibaraki Prefectural Science and Technology Promotion Foundation (with English translation), https://www.tsukuba-sci.com/cms/?p=9853
2038	Maat et al., *Physics and Design of Hard Disk Drive Magnetic Recording Read Heads*, Handbook of Spintronics (2014)
2052	Yuasa citations 2, Google Scholar
2053	Declaration of Caroline A. Ross, Ph.D.

Exhibit No.	Description
2057	Yuasa citations, Google Scholar

III. RELEVANT LAW

4. I am not an attorney. For the purposes of this Declaration, I have been informed about certain aspects of the law that are relevant to my opinions, and my understanding of the relevant law is summarized in my First Declarations. '134 IPR, EX1024 (First Declaration) ¶¶11-23; '167 IPR, EX1024 (First Declaration) ¶¶11-23.

5. As I explained in paragraph 18 of my First Declaration, I understand that the obviousness analysis must include, to the extent there are any, secondary considerations of non-obviousness, such as unexpected results, industry praise, commercial success, long-felt but unmet need, failure of others, copying by others, and skepticism of experts. '134 IPR, EX1024 (First Declaration) ¶18; '167 IPR, EX1024 (First Declaration) ¶18. Sometimes secondary considerations are referred to as secondary or objective indicia of non-obviousness. I understand that for any secondary considerations of non-obviousness to be afforded substantial weight in the obviousness analysis, the evidence must have a "nexus" to the claims. Nexus requires a legally and factually sufficient connection between the evidence and the patented invention. I understand that in the circumstance where the offered secondary consideration results from something other than what is both claimed and novel in the claim, there is no nexus to the merits of the claimed invention. I also

understand that if the secondary consideration evidence relates to a limitation disclosed in the prior art, then this evidence cannot be used to show non-obviousness.

IV. A SKILLED ARTISAN WOULD HAVE REASONABLY EXPECTED TO FORM MGO(001) ON AMORPHOUS SURFACES INCLUDING COFEB

6. Dr. Ross opined about the initial crystal formation, or nucleation, stage for MgO. '134 IPR, EX2053 (Ross Decl.) ¶¶153-59; '167 IPR, EX2053 (Ross Decl.) ¶¶162-67. She states that skilled artisans "knew that nucleation on amorphous substrates resulted in ***randomly oriented*** or weakly textured islands of crystals that could develop a preferred texture with increasing film thickness." '134 IPR, EX2053 (Ross Decl.) ¶153 (emphasis in original); '167 IPR, EX2053 (Ross Decl.) ¶162 (emphasis in original). Dr. Ross says this would apply to MgO: "without a lattice match providing epitaxy, MgO nucleation at an amorphous surface interface would most likely have resulted in random grain orientation in the MgO." '134 IPR, EX2053 (Ross Decl.) ¶155; '167 IPR, EX2053 (Ross Decl.) ¶164. Dr. Ross states that one of skill "would not have had a reasonable expectation that depositing MgO on amorphous CoFeB would have yielded a MgO(001) layer in Bowen's or Nagahama's MTJ." '134 IPR, EX2053 (Ross Decl.) ¶162; *see also* '167 IPR, EX2053 (Ross Decl.) ¶161 (Dr. Ross: POSA did not have "a reasonable expectation that depositing MgO on amorphous CoFeB would produce a MgO barrier with the

claimed microstructure"). As explained in the following paragraphs, I disagree with Dr. Ross' opinion. In addition to Parkin and Nagahama, the scientific literature, including articles authored or cited by Dr. Yuasa himself, confirm that one of skill in the art would have understood that MgO grown on an amorphous substrate, such as CoFeB, would form as MgO(001) layers. Contrary to Dr. Ross' opinion, the literature describing the successful growth of MgO, including thin films less than 10 nm, confirms one of skill would have reasonably expected success in growing MgO(001) layers on amorphous substrates. I will discuss these publications below.

A. Yuasa 2005 *Applied Physics Letters* publication (EX2006)

7. Dr. Yuasa confirmed that a skilled artisan knew MgO would form as MgO(001) when grown on an amorphous substrate. His 2005 *Applied Physics Letters* article, titled "230% room-temperature magnetoresistance in CoFeB/MgO/CoFeB magnetic tunnel junctions," discussed "CoFeB layers [that] were essentially amorphous" and reported that "the MgO layer, grown on the amorphous CoFeB layer, showed a good crystalline structure with a (001) fiber texture." EX2006 (APL 2005) at page 2.

8. Yuasa's 2005 article explained that "[t]he lattice image of MgO(001) can be clearly identified from the lower interface to the upper interface, indicating that the MgO(001) texture developed from the initial stage of growth, i.e., the nucleation stage." EX2006 (APL 2005) at page 2. Because the data in Figure 2

showing the lattice image on which this statement was based was gathered after an annealing step, which likely would have crystallized in the (001) orientation any MgO that had not yet crystallized, it was not possible for the authors to draw this conclusion from the data they gathered, as Dr. Ross conceded at her deposition, EX2006 (APL 2005) at page 2 (describing the partial crystallization of the CoFeB layers shown in Figure 2, which "may have been caused by the high annealing temperature"); EX1101 (Ross Depo. Tr.) at pages 91:4-11, 93:4-13. Thus, they likely drew the conclusion based on published literature describing the characteristics of MgO growth on amorphous substrates and thus what they expected to see. In fact, the next sentence in the article confirms that was the expected behavior of MgO: "Note that ***MgO layer grown on amorphous Si_3N_4 substrates*** by ion beam assisted deposition is also ***(001) textured right at the inception of the deposition***." *Id.* (emphases added). Yuasa's article confirms he expected to observe a (001)-textured MgO layer. In support of that statement, Dr. Yuasa *et al.* cited a 1997 publication by Wang ("Wang 1997") that I will discuss next. *Id.* at page 3 n.14. Dr. Yuasa's statement and citation to Wang 1997 both show that a skilled artisan expected to see MgO(001) when growing MgO on amorphous CoFeB and knew how to grow MgO(001) on an amorphous substrate well before the '134 and '167 Patents' earliest priority date.

B. Wang 1997 *Applied Physics Letters* publication (EX1097)

9. Wang's 1997 *Applied Physics Letters* publication reported using ion beam assisted deposition (IBAD) as a promising method for "produc[ing] textured films on nonepitaxial substrates." EX1097 (Wang 1997) at page 1. Wang noted IBAD having "important implications" for "real manufacturing processes" such as "magnetic thin films." *Id.* at Abstract. Wang discussed "the growth of in-plane textured (100) MgO on amorphous Si_3N_4 substrates by" IBAD at room temperature. *Id.* at Abstract, page 2955. He reported being "able to make 100 Å [10 nm] thick MgO films with 7° in-plane alignment." *Id.* at Abstract; *see also id.* at page 2955 ("This letter reports a study of IBAD MgO deposited on amorphous Si_3N_4 substrates in which we have obtained 7° in-plane alignment in films as thin as 100 Å.").

10. Using Reflection High Energy Electron Diffraction (RHEED), a technique used primarily to study the surface structure and growth of thin films and crystalline materials, Wang further observed "a crystalline pattern of MgO at about 20 Å" or 2 nm. EX1097 (Wang 1997) at page 2955. Wang explained that this "pattern suggests that the MgO molecules form well-aligned small 3D crystallites right ***at the inception of the deposition***, i.e., right at the nucleation stage." *Id.* (emphasis added); *id.* at Figs. 1(a)-(c) (showing the RHEED pattern for MgO at 20, 50, and 100 Å all deposited at room temperature, respectively). In other words, Wang confirms what a skilled artisan knew by the earliest priority date of the '134

and ’167 Patents: that MgO(001) could be formed on amorphous substrates and that it crystallized at the inception of deposition.

11. Wang’s teachings are highly relevant, and one of skill would have known about and consulted them, as evidenced by several citations to the Wang article for Wang’s findings about growing MgO(001) on an amorphous substrate. In addition to being cited by the Yuasa 2005 Applied Physics Letters publication (EX2006) as I mentioned in paragraph 8 above, Wang was also cited by the Yoon reference discussed in my First Declarations. EX1040 (Yoon) at page 2843 n.18; *see also* ’134 IPR, EX1024 (First Declaration) ¶¶70-71, 127, 182 (discussing Yoon); ’167 IPR, EX1024 (First Declaration) ¶¶70-71, 175, 283. Yoon cites to Wang 1997 to support the statement that “[a]ll the films show highly (100)-textured structure regardless of the substrate materials…. These results suggest that the texturing of vapor deposited MgO films is a nucleation-controlled process.” EX1040 (Yoon) at page 2840; *see also* ’134 IPR, EX1024 (First Declaration) ¶127 (quoting the same); ’167 IPR, EX1024 (First Declaration) ¶175 (quoting the same).

C. Wang (EX1055)

12. Dr. Ross alleges that “Wang reported failure in trying to grow a crystalline barrier layer on amorphous CoFeB” and cites this excerpt from Wang in support: “amorphous CoFeB does not support any crystalline grain growth.” ’134 IPR, EX2053 (Ross Decl.) ¶110 (quoting EX1055 (Wang) at page 2270); *see also*

'167 IPR, EX2053 (Ross Decl.) ¶137 (quoting the same); '134 IPR, EX2053 (Ross Decl.) ¶¶110-12. Dr. Ross' quote left out an important part of Wang's text. Wang was referring, not to MgO, but to Wang's CrMnPt (Chromium Manganese Platinum) layer as the "crystalline barrier layer":

> Examination of the microstructure using HRTEM reveals that amorphous CoFeB does not support any crystalline grain growth ***of the CrMnPt layer***, for which a correct crystal structure and large enough grains are needed to provide ***pinning*** to the CoFeB layer beneath it.

EX1055 (Wang) at page 2270 (emphases added). One of skill would not have understood Wang to teach "failure" to grow an MgO barrier layer on amorphous CoFeB. *See id*. Further, Wang expressly taught that its CrMnPt layer was a pinning layer, not a barrier layer. *Id.* ("CrMnPt layer… provide[d] ***pinning*** to the CoFeB layer beneath it." (emphasis added)); *see also id.* at page 2269 ("antiferromagnetic CrMnPt layers for pinning at the top"); EX1101 (Ross Depo. Tr.) at pages 178:19-179:13 (Dr. Ross: "Well, it's intended to be an antiferromagnetic pinning layer."). Barrier layers and pinning layers are distinct aspects of an MTJ. Unlike the barrier layer, which acts as an insulator for the electrons to tunnel through, the pinning layer fixes (or pins) the magnetic orientation of one of the ferromagnetic electrodes in a particular direction so it does not change and maintains proper operation of the MTJ.

EX1057 (Dieny) at page 29; *see also* EX1055 (Wang) at page 2270 (discussing the "free and pinned layers" in an MTJ).

D. Yuasa's 2004 *Nature Materials* article (EX2008)

13. Dr. Yuasa's 2004 *Nature Materials* article also stated that "[e]ven textured Fe/MgO/Fe MTJs with (001) orientation… can be prepared on any kinds of substrates by using a highly oriented MgO(001) seed layer." EX2008 (2004 Nature Materials) at page 870. In support of that statement, he cited to a 2000 Inaba publication, *id.* at page 871 n.21, which I will discuss in the following paragraphs. The import of Dr. Yuasa's statement to one of skill in the art is that MgO(001) can be formed on any substrate and used as a model to form crystalline layers in the (001) orientation above the MgO(001) seed layer. In other words, one of skill understood that MgO is so flexible in forming a crystalline structure that it can be used to create the (001) orientation on any substrate to act as a pattern for that structure for the rest of the MTJ. Although the MgO(001) seed layer is not a tunnel barrier layer, it proves that one of skill in the art understood that MgO(001) can be formed on any kind of substrate, and one of skill in the art would understand that MgO(001) is the same crystalline substance and structure, whether used as a seed layer or a tunnel barrier layer.

E. Inaba's 2000 *IEEE Transaction on Magnetics* publication (EX1098)

14. Inaba was a 2000 *IEEE Transaction on Magnetics* article that investigated crystallographic and magnetic properties of Co-Cr-Pt longitudinal thin-film media prepared on MgO seedlayers that were deposited using electron cyclotron resonance (ECR) sputtering. EX1098 (Inaba) at page 2372. ECR "sputtering is reported to be effective to prepare high quality insulator thin films with smooth surfaces at relatively low substrate temperatures." *Id.* A skilled artisan would have known about and consulted Inaba (as evidenced at least by Dr. Yuasa's citation to it in EX2008) including because Inaba was in the same field of art, *i.e.*, thin-film magnetic media.

15. Inaba's Section II.B. discusses "Sample Preparation" and describes using ECR to grow MgO seedlayers "on glass substrates." EX1098 (Inaba) at page 2372. One of skill knew that glass substrates were typically amorphous. *See, e.g.*, EX1104 (Renault) at page 3732 ("The MgO thin films have been deposited on amorphous substrate (soda-lime glass)…."); *id*. at pages 3731-32 ("deposition has been carried out on amorphous substrates," including "[s]oda-lime glass substrates"); EX1101 (Ross Depo. Tr.) at page 118:8-11 (Dr. Ross: "Q. And glass substrates are amorphous, correct? A. Presumably."). Then, in Section III, Inaba describes the results of those samples, which are the samples A, B, and C that were

used to obtain the data (X-ray diffraction spectra) shown in Figure 2, reproduced below: "The specimens A, B, and C are the Co–Cr–Pt/Cr–Ti thin films deposited at room temperature with the ECR-sputtered MgO seedlayer, the RF-sputtered MgO seedlayer, and no MgO layer, respectively." EX1098 (Inaba) at page 2373. Inaba noted that the MgO peak from Sample A "shows strong 200-CrTi and 11.0-CoCrPt peaks, even when the film was deposited at room temperature," and that the "200-MgO peak is also observed from the seedlayer." *Id.*

16. Inaba then compared the diffraction peaks from Sample C, which had no MgO layer, to the peaks from Sample A, which had an MgO layer. Inaba concluded from its Figure 2 data that "[t]hese results mean that the ***10 nm-thick MgO seedlayer*** deposited by ECR sputtering shows ***well developed {100} texture***, on which Cr–Ti (100) and Co–Cr–Pt (11.0) planes can grow epitaxially to lie the *c*-axis on the film plane." EX1098 (Inaba) at page 2373 (emphases added). Thus, Inaba also showed that MgO grown on an amorphous substrate would crystallize in the equivalent (100) or (001) orientations. '134 IPR, EX1024 (First Declaration) ¶53; '167 IPR, EX1024 (First Declaration) ¶53; *see also* EX1005 ('134 Patent) at col. 4:30-32 (acknowledging (100) and (001) crystal planes are the same); EX1013 ('167 Patent) at col. 4:39-41.

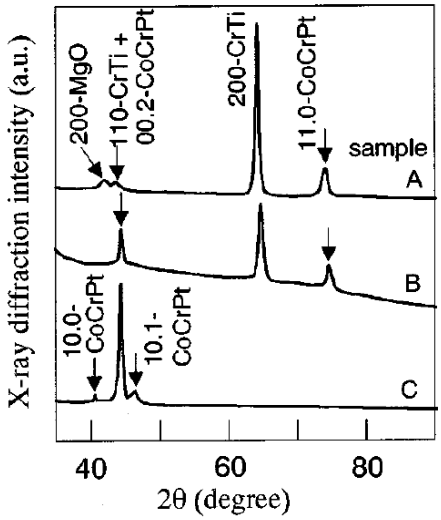


Fig. 2. X-ray diffraction spectra of Co–Cr–Pt/Cr–Ti specimens with MgO seedlayers deposited by ECR (sample A) and RF sputtering methods (B), and with no MgO layers (C).

EX1098 (Inaba) at Fig. 2.

F. Tonouchi's 1987 *Journal of Applied Physics* publication (EX1099)

17. I discussed the Wulff article in my prior declaration, EX1036 (Wulff) at Abstract, page 148; *see also* '134 IPR, EX1024 (First Declaration) ¶¶70, 127 (discussing Wulff); '167 IPR, EX1024 (First Declaration) ¶¶70, 175 (discussing Wulff). Wulff explains that "[a]part from epitaxy, MgO grows with strong preferential <100> orientation regardless of the substrate selection." EX1036 (Wulff) at page 148. In support, Wulff cites Tonouchi, EX1036 (Wulff) at pages 148, 154 n.8, which says the same thing: "MgO is known to grow with strong preferential (100) orientation regardless of substrate selection." EX1099 (Tonouchi) at page 962. As I explain in the following paragraphs, Tonouchi confirmed that MgO(100) layers were observed for 0.5- to 1-nm-thick MgO layers as well.

Tonouchi confirms there is no material difference regarding the ability to grow MgO with a (001) crystalline structure between MgO layers of 100 nm in Wulff (EX1036) and Yoon (EX1040), that I discussed in my First Declarations, and MgO layers less than 10 nm.

18. Tonouchi reported growing 5 Å (0.5 nm) thick MgO with (100) orientation on crystalline Si with "large lattice mismatch." EX1099 (Tonouchi) at page 964. To further investigate the mechanism for MgO crystal growth, Tonouchi also performed an additional experiment growing NbN on "MgO thermally oxidized Si substrate." *Id.* One of skill would understand that an oxidized silicon substrate is amorphous. EX1100 (Silicon VLSI Technology) at page 262 ("Oxide layers grown on silicon are amorphous. … [T]here are no crystalline forms of SiO_2 whose lattice size closely matches the silicon substrate."). This comports with Tonouchi's expressed interest in investigating MgO crystal growth without the influence of a crystallized underlayer. EX1099 (Tonouchi) at page 964.

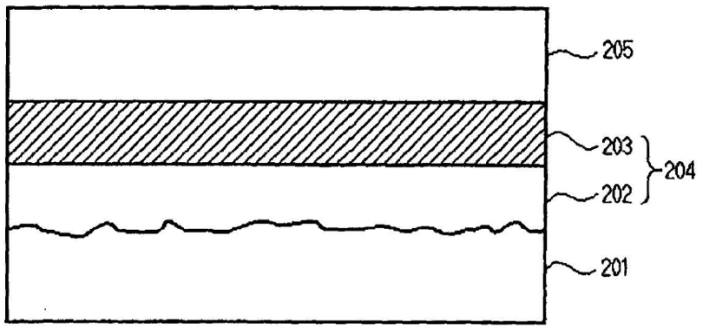
19. Tonouchi also reported that when grown on the "MgO thermally oxidized Si substrate," the NbN epitaxial layer was observed "even on a 10-Å" (1 nm) thick MgO with (100) orientation on the amorphous "oxidized Si substrate." EX1099 (Tonouchi) at page 964. Tonouchi explained that this result "suggest[ed] that the mechanism of the epitaxy cannot be explained by the epitaxial growth of MgO but rather by the natural orientation or the graphoepitaxy of MgO." *Id.* Thus,

Tonouchi also taught growing MgO(001) that is less than 10 nm thick on an amorphous substrate well before the '134 and '167 Patents' earliest priority date.

G. Nagahama patent (EX1027)

20. In describing Figure 12, Nagahama explains that "MgO grows amorphous to be the amorphous MgO layer 202 in the early stage and then, to be the MgO(001)-oriented highly oriented crystal layer 203." EX1027 (Nagahama) ¶58. Nagahama further describes that "[p]referably, the thickness of the amorphous MgO layer 202 is 3 to 10 nm, and the thickness of the MgO(001) crystal layer 203 is also 3 to 10 nm," and that the MgO double underlayer "can be provided on an amorphous substrate, such as that of SiO_2…." *Id.* ¶¶58-59. Nagahama also described forming MgO(001) on an amorphous MgO layer.

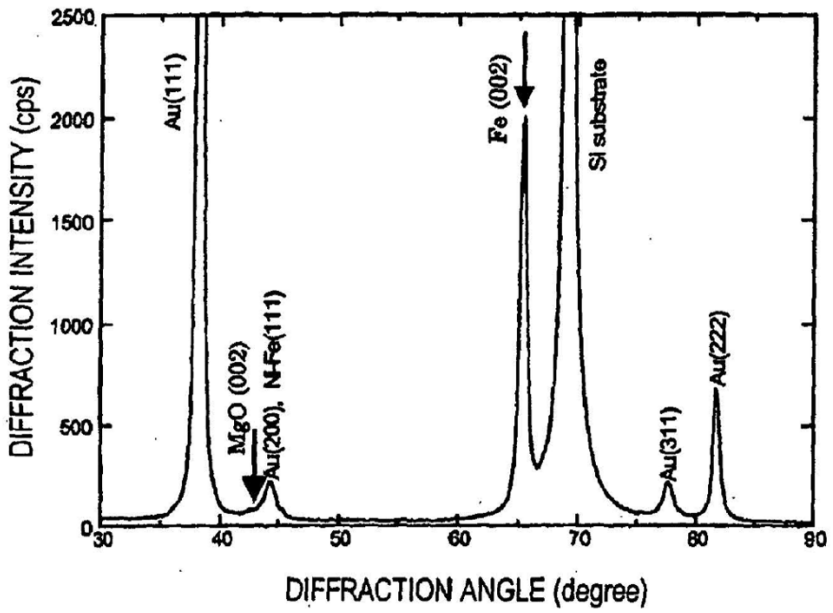
FIG. 12



EX1027 (Nagahama) at Fig. 12; *see also id.* ¶56 ("In this figure, reference numeral 201 designates a substrate (Si LSI, SiO_2, or the like)…").

21. Nagahama went further. It also described the formation of MgO on top of a silicon wafer with oxide film. In paragraph 62, Nagahama explained that the MgO is deposited (10 nm) by sputtering. EX1027 (Nagahama) ¶62. Then, in paragraph 64, it described the resulting structure through X-ray diffraction, stating: "Fig. 14 is an X-ray diffraction spectrum of the high-quality tunnel magnetoresistive element… which is formed on the amorphous/(001)-highly-oriented MgO composite underlayer that has grown on the Si substrate with the oxide film." *Id.* ¶64. As shown in Figure 14 reproduced below, "the MgO diffraction line forms only a (002) peak, hence exhibiting excellent (001) orientation." *Id.* ¶65.

FIG. 14



EX1027 (Nagahama) at Fig. 14.

22. One of skill understood that the Figure 12 Si substrate with the oxide film described in Nagahama was amorphous. EX1100 (Silicon VLSI Technology) at page 262 ("Oxide layers grown on silicon are amorphous."); EX1027 (Nagahama) ¶59 ("By forming the highly oriented, flat, ferromagnetic tunnel magnetoresistive element including the underlayer 204 composed of the amorphous MgO layer 202 and the MgO(001) crystal layer 203, as described above, the flat tunnel magnetoresistive element exhibiting quantum size effect, which, for the structures of the first and second groups of the present invention, can be formed only on a single crystal substrate, ***can be provided on an amorphous substrate, such as that of SiO_2***, and polycrystalline wires." (emphasis added)). Nagahama thus described another example of forming MgO(001) on an amorphous substrate. Nagahama confirms that one of skill in the art understood and knew how to grow MgO(001) on amorphous substrates such as CoFeB before the'134 and '167 Patents' earliest priority date.

V. RESPONSES TO DR. ROSS' OTHER OPINIONS

A. Sunai (EX1030)

23. I disagree with Dr. Ross' opinion that Sunai only achieved its benefits from amorphous CoFeB electrodes. '134 IPR, EX2053 (Ross Decl.) ¶¶216-18; *see also* '167 IPR, EX2053 (Ross Decl.) ¶219 (Dr. Ross: Sunai "teaches the importance that the bottom CoFeB layer be ***amorphous***."). According to Dr. Ross, Sunai

provides no reason "why a POSA would have sought a crystallized CoFeB electrode in an MTJ device with an MgO(001) layer." '134 IPR, EX2053 (Ross Decl.) ¶217; *see also* '167 IPR, EX2053 (Ross Decl.) ¶¶243-44 (opining that there is no "reason why a POSA would have done this" (emphasis omitted)). Sunai taught the advantages of adding boron (B) to obtain a CoFeB layer: "when B is added to Co_9Fe, a continuous film can be formed up to a film thickness of about 0.5 nm." EX1030 (Sunai) ¶28. Adding boron increased the magnetoresistance of the device. *Id.* (A "magnetoresistance change rate of 20% or more can be obtained."). "[W]hen B was added as element Y," Sunai observed that "an extremely thin continuous film can be formed." *Id.* ¶¶29-30. Absent boron, "when the film thickness is thinned, island structures are formed… and although each island is a ferromagnetic material, it exhibits superparamagnetism, in which the magnetization direction fluctuates, resulting in a significantly low magnetoresistance change rate." *Id.* ¶30. Sunai explained to a skilled artisan that CoFeB provided the benefit allowing deposition of a very thin layer and avoided crystallization during deposition. *Id.* ¶¶28-30. However, Sunai expressed no concern about the structure of the CoFeB layer once it had been deposited. And others, such as Parkin, recognized the benefit of some crystallization after the layer was deposited amorphous. EX1062 (Parkin) at col. 18:49-55. Nothing in Sunai would have dissuaded one of skill in the art from

Parkin's teachings about the benefits of subsequent crystallization of the amorphous CoFeB layer.

B. Jimbo (EX1060)

24. I also disagree with Dr. Ross' opinion that Jimbo "does not teach that CoFeB crystallizes when annealed." '134 IPR, EX2053 (Ross Decl.) ¶¶225-28 (emphasis omitted); '167 IPR, EX2053 (Ross Decl.) ¶¶250-53 (emphasis omitted). To be precise, Dr. Ross claims that Jimbo's X-ray diffraction data cannot conclusively attribute peaks to CoFe as opposed to gold (Au). '134 IPR, EX2053 (Ross Decl.) ¶¶226-27; '167 IPR, EX2053 (Ross Decl.) ¶¶251-52. She testifies that Jimbo would have needed some additional test data (other than X-ray diffraction data) to get to the bottom of that question. EX1101 (Ross Depo. Tr.) at pages 170:17-171:5. It is odd then that Dr. Ross overlooked the fact that Jimbo based his conclusion on X-ray diffraction data as well as Extended X-ray Absorption Fine Structure Spectroscopy (EXAFS). EX1060 (Jimbo) at page 309 ("The ***results of EXAFS as well as XRD*** imply that the CoFeB layer of 10 nm thick is amorphous in the as-deposited state and start crystallizing after annealing at 250ºC." (emphasis added)). Dr. Ross does not mention the EXAFS data in her criticism of Jimbo at all. '134 IPR, EX2053 (Ross Decl.) ¶¶225-28 (discussing Jimbo's XRD data but failing to even mention Jimbo's EXAFS data, which Jimbo relied on to determine that CoFeB had crystallized); '167 IPR, EX2053 (Ross Decl.) ¶¶250-53 (same); EX1101

(Ross Depo. Tr.) at pages 173:20-174:3. Jimbo's EXAFS spectral data in Figures 4-5 support that "the CoFeB layer is confirmed to be amorphous in the as-deposited state and begin[s] to crystallize after annealing at 250ºC." EX1060 (Jimbo) at page 311. Jimbo's EXAFS data showed for the as-deposited CoFeB film, where the peaks are reported to be "very weak" for the cobalt. *Id.* By contrast, the cobalt in CoFeB was crystallized by annealing: "[a]fter annealing at 300°C, the shape of FT spectrum indicates fcc structure." *Id.* Jimbo's Figures 4-5 further support Jimbo's disclosure that CoFeB films crystallize by annealing. Although not addressed in her declaration, at her deposition Dr. Ross attempted to discredit Jimbo's EXAFS data. EX1101 (Ross Depo. Tr.) at pages 174:4-177:11. She essentially concedes however, that Jimbo's EXAFS data shows crystallization of the CoFeB layer: "It indicates to me and to a POSA that there's a change in the local environment of the cobalt. It doesn't tell the POSA exactly what happened." EX1101 (Ross Depo. Tr.) at page 176:6-11. One of skill would understand that the change in the local environment of the cobalt is crystallization. Jimbo's EXAFS data in Figure 4 plainly shows an increase in the regular ordering of cobalt atoms with the increase in the r2, r3, and r4 distances from the cobalt atoms, plainly indicating to one of skill and as stated by Jimbo that the CoFeB is crystallizing. Jimbo relied on well-understood EXAFS data for the conclusion that the CoFeB layer began to crystallize after annealing. A skilled artisan would interpret the peaks in Figures 4 as strong corroborating evidence of

Jimbo's XRD data indicating crystallization of CoFeB. One of skill would be unlikely to question Jimbo's conclusion that CoFeB crystallized upon annealing based on this combination of data.

C. Petrov ('134 IPR, EX2065/'167 IPR, EX2060)

25. I was asked to consider the Petrov article ('134 IPR, EX2065; '167 IPR, EX2060) cited by Dr. Ross in her declaration. '134 IPR, EX2053 (Ross Decl.) ¶¶156, 159-60; '167 IPR, EX2053 (Ross Decl.) ¶¶162-63. The Petrov article was published by the *Journal of Vacuum Science and Technology*. '134 IPR, EX2065 (Petrov); '167 IPR, EX2060 (Petrov). Dr. Ross relies on Petrov to opine that a skilled artisan "would not have been able to predict what crystal orientations would form (nucleate) on an amorphous surface in the thicknesses used for MTJ barriers (*i.e.*, less than 10 nm)." EX2053 (Ross Decl.) ¶159; *see also* '167 IPR, EX2053 (Ross Decl.) ¶162 (Dr. Ross: "nucleation on amorphous substrates resulted in randomly oriented or weakly textured islands of crystals that could develop a preferred texture with increasing film thickness" (emphasis omitted)). Petrov does not support Dr. Ross' opinion. Having reviewed Petrov, the publication neither references nor discusses MgO even once. '134 IPR, EX2065 (Petrov) at pages S117-S128; '167 IPR, EX2060 (Petrov) at pages S117-S128. The cited passages are also irrelevant. Dr. Ross cites a section on "Growth of Pure Elemental Polycrystalline Films" when it is elementary that the compound MgO is not a pure elemental film. '134 IPR, EX2053

(Ross Decl.) ¶159 (citing EX2065 (Petrov) at page S118); '167 IPR, EX2053 (Ross Decl.) ¶162 (citing EX2060 (Petrov) at page S118); EX1101 (Ross Depo. Tr.) at page 147:13-22 (Dr. Ross agrees MgO is not a pure elemental film.), 151:8-11 (Dr. Ross is unsure whether EX2065 mentions MgO.). She also cites a discussion regarding a particular example of TaN (Tantalum Nitride). '134 IPR, EX2053 (Ross Decl.) ¶159 (citing EX2065 (Petrov) at page S126); '167 IPR, EX2053 (Ross Decl.) ¶162 (citing EX2060 (Petrov) at page S126). As Petrov explains in the entire section on TaN deposition on pages S124-S126, "the incident ion-to-metal flux ratio can be used to selectively and controllably vary the preferred orientations of TM films." '134 IPR, EX2065 (Petrov) at pages S124-S125; '167 IPR, EX2060 (Petrov) at pages S124-S125. Meaning, TaN growth is highly dependent on how the Nitrogen atoms are brought to the growth surface. Petrov's disclosures regarding TaN have no relevance to MgO or forming MgO(001) because one of skill would not have extrapolated Petrov's results from TaN to another material, MgO. One of skill in the art would not have considered Petrov to describe the crystallization process of MgO when deposited on amorphous surfaces, especially when direct evidence of that process was available, such as that in Wulff, Wang 1997, Inaba, Tonouchi, etc. Dr. Ross comes to her conclusion by ignoring any directly relevant art, even art cited by Yuasa himself, which is not how one of skill would have reached a conclusion.

EX1101 (Ross Depo. Tr.) at page 152:2-19 ("I can't comment on whether the person skilled in the art would have read those without reading them myself.").

D. Aboelfotoh ('134 IPR, EX2067/'167 IPR, EX2062)

26. I was also asked to consider a second article by Aboelfotoh ('134 IPR, EX2067; '167 IPR, EX2062) that Dr. Ross cites in her declaration. '134 IPR, EX2053 (Ross Decl.) ¶¶157, 159-60; '167 IPR, EX2053 (Ross. Decl.) ¶159. Aboelfotoh was published in 1973 by the *Journal of Vacuum Science and Technology*. '134 IPR, EX2067 (Aboelfotoh); '167 IPR, EX2062 (Aboelfotoh). Dr. Ross also relies on Aboelfotoh to assert one of skill "would not have been able to predict what crystal orientations would form" in barriers less than 10 nm because Aboelfotoh reported that MgO films less than ~ 500 Å (or 50 nm) "show a random orientation." '134 IPR, EX2053 (Ross Decl.) ¶159 (quoting EX2067 (Aboelfotoh) at page 625); *see also* '167 IPR, EX2053 (Ross Decl.) ¶159 (Ross: "films thinner than 50 nm 'showed a random orientation'" (quoting EX2062 (Aboelfotoh) at page 621)). Aboelfotoh also does not support Dr. Ross' opinion, as I explain in the following paragraphs.

27. Dr. Ross acknowledges that Aboelfotoh also reported "MgO growth on amorphous substrates… [with] a (111) crystalline orientation at thicknesses greater than 50 nm." '134 IPR, EX2053 ¶160 (citing EX2067 at page 623); *see also* '167 IPR, EX2053 ¶159 (Dr. Ross: Aboelfotoh "reported that when thickness increased

above 50 nm MgO would form a (111) preferred orientation" (citing EX2062 (Aboelfotoh) at page 621)). Citing Aboelfotoh's 1974 paper ('134 IPR, EX2068), Dr. Ross acknowledges that "many variables affect crystal growth." '134 IPR, EX2053 ¶161 (Dr. Ross citing Aboelfotoh 1974 ('134 IPR, EX2068)).

28. More than twenty-five years after Aboelfotoh, Renault and Labeau also investigated the formation of polycrystalline MgO via deposition on amorphous substrates and published their findings in 1999 in the *Journal of The Electrochemical Society*. EX1104 (Renault) at page 3731. Renault's study looked at Aboelfotoh's 1973 and 1974 experiments and explained that the random orientations reported by Aboelfotoh were due to the deposition parameters Aboelfotoh used.

29. Renault's study evaluated the influence of numerous deposition parameters on MgO crystallinity and orientation. EX1104 (Renault) at page 3731. Renault investigated a "large scale-adaptable modified CVD technique" for "MgO thin film growth" on "amorphous surfaces" and examined the resulting crystalline structure. *Id.* Renault found that by modifying the deposition parameters, they were able to obtain either an MgO(200) or MgO(111) crystalline structure on the amorphous glass substrate. *Id.* at Abstract, pages 3732-33, Fig. 6, Table 1. One of skill knew that MgO(200) is a different label for the same MgO(100) structure. EX1027 (Nagahama) ¶65; '134 IPR, EX2069 (Murr) at page 150 (noting Miller's crystalline plane notation allows for (*hkl*) where *h*, *k*, *l* are greater than one and

represent parallel planes with equivalent indices in the same crystal); '134 IPR, EX2069 (Murr) at page 159 (explaining the crystalline "(200) diffracting plane[is] parallel to (100)"). Thus, a person of ordinary skill in the art would understand MgO(200) represents the same crystalline structure as MgO(100).

30. In discussing their findings, Renault addressed earlier experiments including Aboelfotoh's two papers ('134 IPR, EX2067-EX2068; '167 IPR, EX2062). EX1104 (Renault) at page 3734 & nn.22-23. Renault explained that the "initial random orientation of small crystallites, as observed by Aboelfotoh" occurred because "the deposition rate is relatively high for those films," resulting in "insufficient surface diffusion [that] tends to form energetically unstable (111) planes of lower atomic density." *Id.* at page 3735 (citing EX2068 (Aboelfotoh 1974)). Both of Aboelfotoh's 1973 and 1974 publications report electron gun deposition rates exceeding 1 Å/sec. '134 IPR, EX2068 (Aboelfotoh 1974) at pages 347, 349 n.4 (deposition rate of "1-3 Å/sec with an electron gun"); '134 IPR, EX2067 (Aboelfotoh) at page 622 ("MgO films were deposited with a 6-kw electron gun… at a rate of 3-5 Å/sec."); '167 IPR, EX2062 (Aboelfotoh) at page 622 (same). Thus, a skilled artisan reading Renault (EX1104) and Aboelfotoh ('134 IPR, EX2067-EX2068; '167 IPR, EX2062), would have understood that Aboelfotoh's "random orientation" in the MgO films he deposited was attributable to the deposition parameters Aboelfotoh selected, including the deposition rate. Dr. Ross

agrees with me that deposition parameters impact film morphology. '134 IPR, EX2053 (Ross Decl.) ¶¶164-66; '167 IPR, EX2053 (Ross Decl.) ¶¶165-67. Aboelfotoh does not support Dr. Ross' opinion that a skilled artisan would be unable to predict the MgO orientation of thin film MgO on an amorphous substrate. '134 IPR, EX2053 (Ross Decl.) ¶159; '167 IPR, EX2053 (Ross Decl.) ¶159.

VI. THE PURPORTED SECONDARY EVIDENCE OF NON-OBVIOUSNESS DOES NOT CHANGE MY OPINIONS

31. When I prepared my First Declarations, IP Bridge had not provided its evidence pertaining to secondary considerations of non-obviousness. '134 IPR, EX1024 (First Declaration) ¶203; '167 IPR, EX1024 (First Declaration) ¶326. I was asked to respond to Dr. Ross' opinions regarding secondary considerations. '134 IPR, EX2053 (Ross Decl.) ¶¶255-76; '167 IPR, EX2053 (Ross Decl.) ¶¶285-326. My First Declarations set forth a straightforward obviousness case where each and every limitation was described in the prior art, and one of skill would have combined them with a reasonable expectation of success. As explained in Paragraph 5 of this Declaration, I understand that evidence unrelated to the specific claimed subject matter at issue, or relating to limitations of those claims already disclosed in the prior art, does not provide evidence of non-obviousness. I reviewed Dr. Ross' opinions on secondary considerations of non-obviousness, and in my view they are not

sufficient to change my opinion that the ’134 and ’167 Patent claims are obvious due to the overwhelming clarity of prior art disclosures of CoFeB-MgO MTJs.

32. I have considered the exhibits Dr. Ross cites, and I disagree that they suggest non-obviousness of the ’134 or ’167 Patents. None of the purported secondary evidence cited by Dr. Ross alters my opinions that the ’134 or ’167 Patents are obvious in view of the prior art. Even if Dr. Ross had established nexus, I believe that the prior art provides clear teachings leading one of skill to the conclusion that the claims would have been obvious. However, as explained below, I also disagree that there is any nexus between any allegedly novel aspects of the claims and the cited secondary considerations evidence. Dr. Ross relies on a common set of exhibits to argue secondary considerations of the tunnel barrier height claims in the ’909 IPR and for its CoFeB-MgO claims in these ’134 and ’167 IPRs. As shown in the table below, the numbering is different between the IPRs, but the exhibits are the same:

’134/’167 Patent IPRs	**’909 Patent IPR**	**Description**
EX2005	EX2005	Zhu et al., *Magnetic tunnel junctions*, 9 Materials Today 36-45 (2006)
EX2006	EX2015	Djayaprawira et al., *230% room-temperature magnetoresistance in CoFeB/MgO/CoFeB magnetic tunnel junctions*, 86 Appl. Phys. Letters 092502 (2005)
EX2007	EX2016	Yuasa et al., *High Tunnel Magnetoresistance at Room Temperature in Fully Epitaxial Fe/MgO/Fe Tunnel*

’134/’167 Patent IPRs	’909 Patent IPR	Description
		Junctions due to Coherent Spin-Polarized Tunneling, 43 Japanese J. Appl. Phys. L588 (2004)
EX2008	EX2017	Yuasa et al., *Giant room-temperature magnetoresistance in single crystal Fe/MgO/Fe magnetic tunnel junctions*, 3 Nature Materials, 868-871 (2004)
EX2019	EX2019	Marrows, *Spin-polarised currents and magnetic domain walls*, 54 Advances in Physics 585-713 (2005)
EX2020	EX2020	Tsymbal et al., *Handbook of Spin Transport and Magnetism* (Tsymbal et al. eds. 2012)
EX2022	EX2022	Nakatani et al., *Read sensor technology for ultrahigh density magnetic recording*, 43 MRS Bulletin 106-111 (2018)
EX2024	EX2024	*The 23rd (FY2022) Japan Society of Applied Physics Achievement Award Recipients* (with English translation), The Japan Society of Applied Physics
EX2026	EX2026	2021 New Fellows, IEEE Japan Council
EX2028	EX2028	Dr. Shinji Yuasa profile, Japan Science and Technology Agency
EX2029	EX2029	*AIST wins three Science and Technology Awards in the 2016 Minister of Education, Culture, Sports, Science and Technology Commendation for Science and Technology*
EX2032	EX2032	AIST: 20th Tsukuba Prize winner
EX2033	EX2033	Announcing the winners for “Tsukuba Prize,” “Esaki Leona Prize,” and “Tsukuba Encouragement Prize,” Ibaraki Prefectural Science and Technology Promotion Foundation (with English translation), https://www.tsukuba-sci.com/cms/?p=9853
EX2038	EX2038	Maat et al., *Physics and Design of Hard Disk Drive Magnetic Recording Read Heads*, Handbook of Spintronics (2014)
EX2052	EX2009	Yuasa citations 2, Google Scholar

’134/’167 Patent IPRs	’909 Patent IPR	Description
EX2057	EX2008	Yuasa citations, Google Scholar
EX1039	EX1039	Tehrani et al., *Progress and Outlook for MRAM Technology*, 35 IEEE Trans. Magn. 2814-2819 (1999)
EX1057	EX1057	Dieny et al., *Introduction to Magnetic Random-Access Memory* (IEEE Press 2017) (excerpts)

A. Praise By Others

33. Dr. Ross opined that Yuasa has been praised for his development of the ’134 and ’167 Patents. ’134 IPR, EX2053 (Ross Decl.) ¶¶258-72; ’167 IPR, EX2053 (Ross Decl.) ¶¶288-314. I disagree.

34. Dr. Ross cites several papers to argue Yuasa received industry praise. However, many of these papers were authored or co-authored by Yuasa himself, including Yuasa’s paper with Djayaprawira in Applied Physics Letters (EX2006), Yuasa’s paper in the Japanese Journal of Applied Physics (EX2007), Yuasa’s paper in Nature Materials (EX2008), and a chapter in the Dieny textbook (EX1057) that Ross admits “Dr. Yuasa authored.” ’134 IPR, EX2053 (Ross Decl.) ¶262; *see also* ’134 IPR, EX2053 (Ross Decl.) ¶¶258-60, 262-64; ’167 IPR, EX2053 (Ross Decl.) ¶¶288, 290-96, 300-04. One of skill would not have viewed Yuasa’s own publications to constitute industry praise or praise by *others*.

35. Dr. Ross also opines that publications by Zhu/Park (EX2005), Marrows (EX2019), Tsymbal/Fert (EX2020), Nakatani/Gao (EX2022), and TDK researchers

(EX2023) constitute praise by others of Yuasa's purported invention. '134 IPR, EX2053 (Ross Decl.) ¶¶261, 265-267; '167 IPR, EX2053 (Ross Decl.) ¶¶289, 298-99, 305-08. To the extent that Dr. Ross asserts these publications praise the development of CoFeB MgO MTJs, they cannot constitute industry praise of the '134 and '167 Patents because the prior-art Parkin patent (EX1062) previously disclosed CoFeB MgO MTJs.

36. Dr. Ross also cites Dr. Yuasa's various awards and prizes. '134 IPR, EX2053 (Ross Decl.) ¶¶268-72; '167 IPR, EX2053 (Ross Decl.) ¶¶309-13. Again, I see nothing in these awards addressing any novel aspects of the '134 and '167 Patent claims. And, to the extent that Dr. Ross asserts these publications praise the development of CoFeB-MgO MTJs or methods to manufacture them, they cannot constitute industry praise of the '134 and '167 Patents because (1) the patents do not describe or claim any specific manufacturing processes; and (2) the prior-art Parkin patent (EX1062) previously disclosed CoFeB MgO MTJs.

- **JSAP Award** (EX2024 at pages 2-3): for "MTJs combining MgO and cobalt iron boron (CoFeB) alloys in collaboration with Canon ANELVA."
- **IEEE Fellow** (EX2026 at page 1): "for contributions to MgO-based magnetic tunnel junctions."
- **S&T Award** (EX2029 at page 2): Dr. Ross says this award is for MTJs with TMR of "approximately 200% at room temperature" and "mass production

technology… making industrial applications of MgO tunnel magnetoresistance elements possible." '134 IPR, EX2053 (Ross Decl.) ¶269; '167 IPR, EX2053 (Ross Decl.) ¶310.

- **IEEE Paper and Profile** (EX2030/EX2031): These exhibits are an announcement for announcing an IEEE paper Yuasa presented (EX2030) and Yuasa's IEEE bio (EX2031). Dr. Ross states that "IEEE honored" Yuasa for "MTJs with a CoFeB/MgO/CoFeB structure." '134 IPR, EX2053 (Ross Decl.) ¶270; *see also* '167 IPR, EX2053 (Ross Decl.) ¶311 ("IEEE… noting [Yuasa's] work with 'MTJs with a CoFeB/MgO/CoFeB structure'"). These exhibits do not definitively state why Yuasa was named an IEEE Distinguished Lecturer. *See* EX2030-EX2031.
- **Tsukuba Prize** (EX2032 at page 1): "experiments based on the theory that a very large MR ratio could be obtained by using crystalline magnesium oxide (MgO) instead of the conventional amorphous aluminum oxide."
- **Inoue Harushige Prize** (EX2034 at page 1): This exhibit states the "award was given to 'Magnesium oxide-based tunnel magnetoresistance element and its mass production technology,' and was shared with Ichikawa Jungi, chairman and president of Canon Anelva Corporation, which developed the technology for commercialization."

B. Long-Felt But Unmet Need

37. Dr. Ross opines for the '134 Patent that "[h]igher TMRs were needed, as was a method to make MTJs in mass quantities rather than one single crystal at a time." '134 IPR, EX2053 (Ross Decl.) ¶273; *see also id.* ¶¶274-75. She opines similarly for the '167 Patent that there "was a need to achieve TMRs using manufacturing method to make MTJs in mass quantities and rather than one single crystal at a time." '167 IPR, EX2053 (Ross Decl.) ¶317; *see also id.* ¶¶315-16, 318-26.

38. According to Dr. Ross, the need for higher TMR was met by MTJs "using CoFeB electrodes [that] achieved even higher 230% room temperature TMR." '134 IPR, EX2053 (Ross Decl.) ¶273; '167 IPR, EX2053 (Ross Decl.) ¶324 (same). Dr. Ross is wrong because it was Butler and Mathon who satisfied the need for improved TMR by proposing the adoption of MgO barrier layers in MTJs, not Yuasa. Dr. Ross admits Butler and Mathon accurately predicted that adopting MgO barrier layers would result in "large magnetoresistance," EX1044 (Butler) at page 1, "in excess of 1000%" TMR, EX1046 (Mathon) at page 1; *see* '167 IPR, EX2053 (Ross Decl.) ¶319 ("In 2001, Butler and Mathon speculated that higher TMRs could be obtained using crystalline MgO tunnel barriers…."); '134 IPR, EX2053 (Ross Decl.) ¶273 (similar). But again, the '134 and '167 Patents did not in fact achieve the highest TMR at that time because Parkin had achieved a higher TMR of 220%

at room temperature before the ’134 and ’167 Patents. EX1062 (Parkin) at col. 18:45-47. Nor does Dr. Ross explain why the 88% TMR at room temperature (293 K) that the ’134 and ’167 Patents reported, EX1005 (’134 Patent) at col. 7:55-59; EX1013 (’167 Patent) at col. 8:4-8, was surprising or unexpected in view of Butler’s and Mathon’s predictions of “large magnetoresistance,” EX1044 (Butler) at page 1, “in excess of 1000%,” EX1046 (Mathon) at page 1.

39. According to Dr. Ross, the manufacturing needs were met by using “conventional sputtering system[s].” ’134 IPR, EX2053 (Ross Decl.) ¶274; ’167 IPR, EX2053 (Ross Decl.) ¶323. None of the claims of the ’134 and ’167 Patents require “sputtering,” and thus Dr. Ross establishes no nexus for her alleged long-felt manufacturing need.

VII. CONCLUSION

40. In signing this Declaration, I recognize that the Declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be called upon to testify in deposition or before the Patent Trial and Appeal Board. If called upon to testify, I would testify truthfully and competently to all matters stated in this Declaration.

41. I reserve the right to supplement my opinions in the future to respond to any arguments that Patent Owner raises and to take into account new information as it becomes available to me.

42. I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true and that such statements are made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: October 8, 2025

Jeffrey Bokor