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Paper No. ____

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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 No. IPR2025-00701
U.S. Patent No. 10,367,138

PATENT OWNER'S PRELIMINARY RESPONSE

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LISTING OF EXHIBITS

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2007	European Patent Application Publication No. EP 1 737 055 A1
2008	Petition for <i>Inter Partes</i> Review of U.S. Patent No. 9,608,198, Case No. IPR2024-01386, Paper No. 1
2009	Patent Owner’s Preliminary Response, Case No. IPR2024-01386, Paper No. 8
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2011	Petition for <i>Inter Partes</i> Review of U.S. Patent No. 7,884,403, Case No. IPR2024-01384, Paper No. 1
2012	Patent Owner’s Preliminary Response, Case No. IPR2024-01384, Paper No. 8
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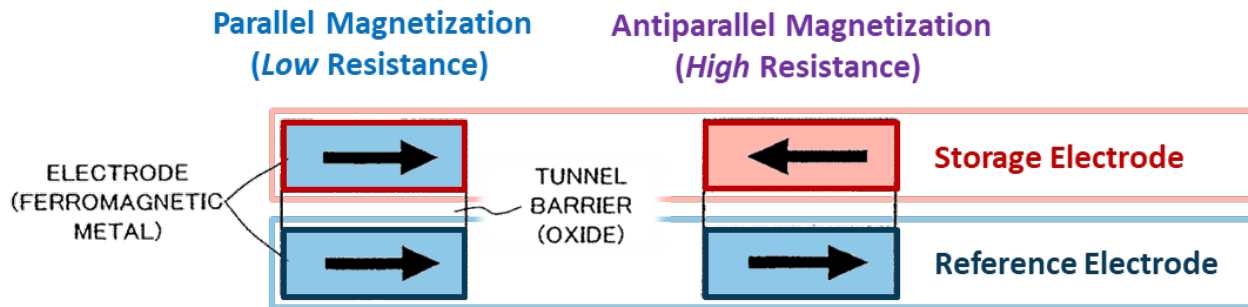
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2062	Deposition of Jeffrey Bokor, Ph.D. (June 24, 2025)
2063	Deposition of Jeffrey Bokor, Ph.D. (June 25, 2025)
2064	Saito, Y., et al., “Correlation between barrier width, barrier height, and dc bias voltage dependences on the magnetoresistance ratio in Ir-Mn exchange biased single and double tunnel junctions,” Jpn J. Appl. Phys. 39, L1035–L1038 (2000)
2065	Japanese Patent No. JP 5120680 B2 with certified English translation
2066	Errata to EX2062 - Deposition of Jeffrey Bokor, Ph.D. (June 24, 2025)

Exhibit	Description
2067	Errata to EX2063 - Deposition of Jeffrey Bokor, Ph.D. (June 25, 2025)
2068	Clearer version of EX2031
2069	Clearer version of EX2032
2070	Clearer version of EX2035

I. INTRODUCTION

The claims of the challenged patent, U.S. Patent No. 10,367,138 (the “’138 Patent”), are directed to a solid-state electronics device called a magnetic tunnel junction (“MTJ”) device. An MTJ has an insulator—called a tunnel barrier layer—between two ferromagnetic layers that form electrodes on either side of the barrier layer. MTJs are used in a number of applications, including solid-state memory. The inventor of the ’138 Patent, Dr. Yuasa, developed a better MTJ device and received extensive praise and industry-wide recognition for his invention, including for his use of a barrier layer formed of magnesium oxide (MgO) sandwiched between electrodes that each had a ferromagnetic material layer including cobalt (Co), iron (Fe) and boron (B).

When used for solid-state memory, one electrode of the MTJ, called the reference electrode, has its direction of magnetization fixed. An external field can cause the magnetization of the other electrode, called the storage electrode, to be either parallel or antiparallel to the reference electrode. The magnetization state of the MTJ can encode binary data—with each of the parallel and antiparallel states corresponding to a “0” or “1,” respectively.



Thus, a difference between the two electrodes is that the magnetization direction of the storage electrode should be switchable in response to being exposed to an external field but then remain constant after the external field is removed, whereas the magnetization direction of the reference electrode should remain constant even when exposed to the same external field that can switch the magnetization direction of the storage electrode.

Data is read by measuring the resistance between the electrodes. When the storage electrode's magnetic state is *parallel* to the reference electrode, the *resistance (R_p) is low*. When the storage electrode's magnetic state is *antiparallel* to the reference electrode, the *resistance (R_{ap}) is high*. An MTJ's tunnel magnetoresistance ratio ("TMR")¹ is equal to the difference in the resistance between the antiparallel (R_{ap}) and parallel states (R_p), divided by the parallel state resistance. An MTJ's TMR is thus like a signal-to-noise ratio—higher is better.

¹ The '138 Patent refers to this same metric as the "MR ratio." EX1011, 4:62-5:11.

The '138 Patent discloses that known MTJ devices had room-temperature TMRs of about 70%. An embodiment of the '138 Patent improved the room-temperature TMR significantly to 88%.

Every claim of the '138 Patent recites an MTJ device where each electrode comprises a layer of an “entirely crystallized” ferromagnetic material including Co, Fe and B, and wherein the barrier layer comprises a poly-crystalline magnesium oxide (“MgO”) layer of a particular crystalline structure (“a (001) crystal plane is preferentially oriented”).

The Petition implicitly admits that the claimed MTJs were novel—the Petition’s three grounds are based on alleged obviousness, not anticipation. The Petition fails to establish a reasonable likelihood of prevailing on any of the three obviousness grounds as explained below.

A. Ground 1 (Parkin in view of Wang and Soukup) Fails

Ground 1 relies on Parkin, which discloses an MTJ device with an upper storage electrode made from an *amorphous* (i.e., non-crystalline) cobalt-iron-boron alloy ((Co₇₀Fe₃₀)₈₀B₂₀) and a bottom reference electrode made of a different alloy of cobalt-iron (Co₇₀Fe₃₀) with no boron. The Petition alleges “[i]t would have been obvious to substitute CoFeB for Parkin’s lower CoFe reference electrode as described in Wang.” Petition, 11. Ground 1 fails for at least three independent reasons.

First, the Petition establishes no supportable reason why a POSA would have substituted CoFeB for Parkin's CoFe bottom reference electrode based on Wang. The Petition's sole reason for the proposed modification was to improve Parkin's TMR. But Wang's highest reported TMR was 70% – *far lower* than Parkin's TMR of “more than 220%.” EX1062, 18:45-46; EX1055, 2269.

Additionally, Wang discloses MTJs having an amorphous aluminum oxide (Al_2O_3) barrier layer – not a crystalline MgO barrier layer as used in Parkin. At deposition in a related proceeding, Petitioner's expert Dr. Bokor testified that teachings related to improving TMR for Al_2O_3 MTJs are “hardly applicable” to MTJs – like Parkin's – with MgO barrier layers. EX2062, 199:23-203:24.

Further, to the extent Wang has any relevance to Parkin's MTJ with an MgO barrier layer, Wang attempted a modification like Petitioner proposes and it did not work. Wang replaced a CoFe reference electrode with CoFeB, expecting that it would “increase the TMR value.” EX1055, 2270. But Wang's TMR did not increase. In fact, Wang found that “magnetic pinning was not achieved to allow the TMR measurement ... even after annealing.” *Id.* In other words, Wang's MTJ device with a CoFeB reference electrode substituted for a CoFe reference electrode failed so that its TMR could not even be measured. The Petition fails to explain why Wang would have motivated a POSA to make a similar substitution to

Parkin's device when Wang reported that such a substitution resulted in an MTJ that did not work.

Second, Parkin does not disclose a ferromagnetic material layer that includes Co, Fe and B and is “*entirely crystallized*,” as claimed. The Petition alleges that the claimed second electrode's second ferromagnetic material layer that includes Co, Fe and B is met by Parkin's “amorphous” (i.e., *non*-crystalline) storage layer 175 of CoFeB. *See e.g.*, Petition, 15-17 (re Limitation 1c)].² But then to meet the claimed requirement that the second ferromagnetic material layer is entirely crystallized, Petitioner points to disclosure in Parkin that refers to “the formation of a thin crystalline ferromagnetic layer which has the bcc structure of **CoFe**” with no boron. When Parkin tested its device by transmission electron microscopy, Parkin found that only a “*portion*” of the storage layer 175 crystallized. The plain meaning of a layer being “entirely crystallized” does not encompass a layer of which only a “portion” is crystallized. Ground 1 fails for this additional reason.

Third, the Petition alleges that it would have been predictable to substitute CoFeB for Parkin's CoFe reference electrode but no evidence supports that. Wang replaced a CoFe reference electrode with CoFeB, *expected* an increase in TMR but

² Patent Owner adopts Petitioner's claim limitation labelling. Petition, xviii-xx (“List of Challenged Claims”).

instead found that TMR could not even be measured. Wang shows that impact of replacing one electrode material with another was not predictable. The Petition fails to establish that a POSA would have reasonable expected success in achieving any Challenged Claim.

Ground 1 fails for at least those three independent reasons.

B. Ground 2 (Parkin in view of Wang, Soukup and Bowen) Fails

Ground 2 only challenges dependent claims and relies on Ground 1 for the independent claims from which the challenged dependent claims depend. Ground 2 thus fails for the same reasons as Ground 1.

C. Ground 3 (Bowen in view of Wang and Soukup) Fails

Ground 3's primary reference is Bowen. Bowen discloses an MTJ that uses *crystalline* iron (Fe) for one electrode and *crystalline* CoFe for the other. Indeed, Bowen's entire purpose was to test a theory advanced by others that an MTJ with crystalline electrodes well-matched to the crystalline structure of the MgO barrier layer would produce high TMR. Despite that, the Petition alleges that a POSA would have been motivated to completely reconfigure Bowen by replacing both crystalline electrodes with amorphous CoFeB. Ground 3 fails for multiple independent reasons.

First, the claims require a layer that includes Co, Fe and B and is "entirely crystalized." Neither Bowen nor Wang discloses a layer with Co, Fe and B that is even partially crystalized—Wang discloses amorphous CoFeB and Bowen does

not disclose boron at all. The claim limitations that require a ferromagnetic material layer that includes Co, Fe and B and is “entirely crystallized” is missing from all of Ground 3’s references and indeed from the prior art. The Petition seeks to meet these claim limitations based only on unsupported expert testimony. The law is clear that it is a rare circumstance where a limitation that is not disclosed by the prior art can be supplied through the say-so of an expert. Those rare circumstances do not apply here.

Second, the Petition fails to support any reason why a POSA would have changed Bowen’s FeCo electrode to use Wang’s CoFeB electrode for the same reason as in Ground 1. Once again, the Petition alleges that Wang would have motivated a POSA to make this modification to improve TMR. But Wang’s MTJs used an aluminum oxide (Al_2O_3) barrier layer, not an MgO barrier layer as Bowen did, and Petitioner’s own expert has testified that teachings related to improving TMR for Al_2O_3 MTJs are “hardly applicable” to MTJs with MgO barrier layers. EX2062, 199:23-203:24. Moreover, Wang tried to substitute CoFeB for a CoFe reference electrode and found that the resulting MTJ failed so completely that Wang could not even measure a TMR.

Third, the Petition cites no evidence establishing that a POSA would have expected that replacing Bowen’s ***Fe*** electrode with CoFeB would have improved TMR. The Petition relies on Wang’s disclosure that substituting CoFeB for a

NiFeCo electrode improved TMR. Petitioner provides no evidence of what a POSA would have been expected to happen if an Fe electrode were replaced with CoFeB. Petitioner does nothing more than speculate that there would have been an improvement in TMR. But when Wang replaced its CoFe electrode with CoFeB, the MTJ failed to work. The Petition failed to establish that a POSA had any reason to substitute CoFeB for Bowen's Fe electrode.

Fourth, the Petition alleges that a POSA would have expected that annealing the CoFeB layer would have yielded an entirely crystalline layer. No evidence supports that. Boron was well known to inhibit crystallization and Petitioner does not cite a *single reference* teaching an entirely crystallized layer with boron. Dr. Bokor's testimony cannot fill in the gap in the evidence. Indeed, he admitted at deposition in a related proceeding that "I'm no expert. I'm no crystal grower." EX2063, 77:19. Moreover, when the inventor achieved an entirely crystallized layer with Co, Fe and B he received widespread acclaim because this result was so unexpected and surprising. The Petition fails to establish that a POSA would have reasonably expected success in achieving a ferromagnetic layer that includes Co, Fe and B and is entirely crystallized as required by every Challenged Claim.

Ground 3 fails for at least those four independent reasons.

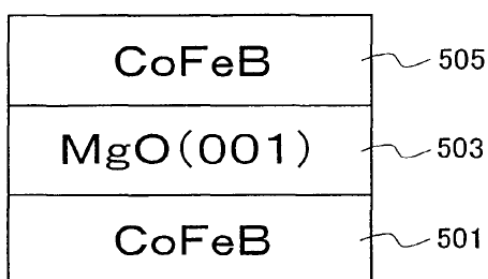
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As detailed below, Petitioner fails to carry its burden to demonstrate that it is reasonably likely to prevail in demonstrating any Challenged Claim unpatentable. Institution should be denied.

II. MAGNETIC TUNNEL JUNCTION DEVICES

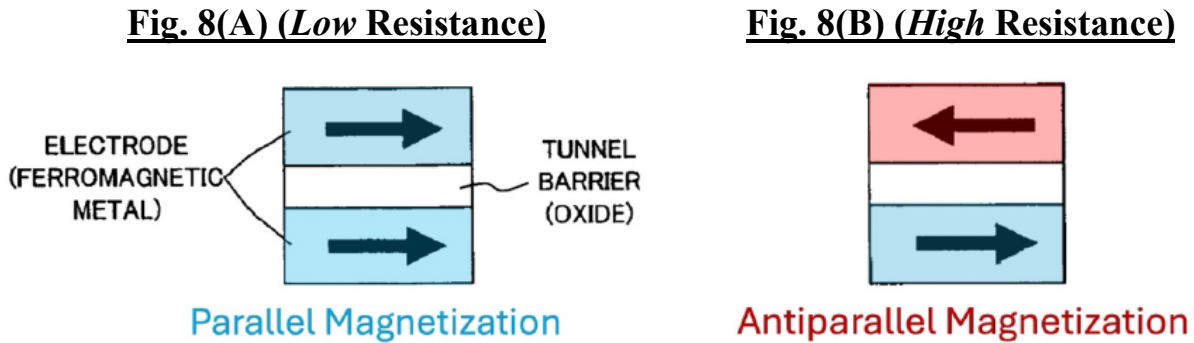
A. Overview

A magnetic tunnel junction device is a kind of solid-state electronics device that has an insulator—called a tunnel barrier layer—between two ferromagnetic electrodes. EX1011, 1:32-51. In '138 Patent Fig. 11, below, the ferromagnetic electrodes 501 and 505 are alloys of cobalt (Co), iron (Fe), and boron (B)—labelled CoFeB—and the barrier layer 503 is magnesium oxide (“MgO”). The “(001)” in Fig. 11 is conventional notation indicating the orientation of the crystalline MgO layer. EX2041, 14-15. Current flows through an MTJ device between electrodes using a quantum phenomenon called “tunnelling.” EX2058, 1.



When a storage electrode is subjected to an applied magnetic field, the electrode magnetization may be aligned with the applied magnetic field. EX2059, 748-49. Arrows in '138 Patent Figures 8(A)-8(B), annotated below, show the magnetization direction in each electrode. An MTJ device is in a “parallel” state

when its electrodes have the same magnetization (Fig. 8(A)) and in an “antiparallel” state when its electrode magnetizations point in different directions (Fig. 8(B)). EX1011, 1:53-2:2.



The MTJ device’s resistance to current flow depends on the electrode magnetization, making the MTJ device a magnetoresistive device. EX1011, 1:53-2:2. The resistance R_{ap} in the antiparallel state is **higher** than the resistance R_p in the parallel state. *Id.* By applying appropriate magnetic fields, an MTJ device can be configured in its parallel or antiparallel state. EX1062, 1:40-56. An MTJ device is thus a form of programmable resistor because its resistance can be changed by changing the relative magnetization of its electrodes.

B. Use in Non-Volatile Storage Devices

While an MTJ device has many applications, one use is in persistent non-volatile storage devices like a solid-state memory or hard drive.

A solid-state memory can be formed with an array of memory cells that each includes an MTJ device that can store a bit of data. EX1011, 1:32-2:31. The two resistive states of an MTJ device (the parallel low resistance state and the non-

parallel high resistance state) can encode a stored bit value as a binary “0” or “1,” respectively. EX1011, 1:53-2:2, 2:13-15.

C. “Magnetoresistance Ratio” and “Tunneling Magnetoresistance Ratio” (TMR) Describe the Same Parameter

It is desirable to increase the difference between the MTJ’s parallel (R_p) and antiparallel (R_{ap}) resistances. EX1011, 2:35-60. For the same current passing through the MTJ device when a stored data value is read, a greater difference between R_p and R_{ap} provides a larger difference between the read-out voltages representing a “1” and “0,” respectively. *Id.*, 4:62-5:3; 8:31-36. This reduces read-out errors by making it easier to distinguish between the voltages reflecting stored “1s” and stored “0s.” *Id.*, 2:50-56.

A parameter the ’138 Patent calls the “magnetoresistance ratio” (“MR ratio”) quantifies the difference between the MTJ device’s magnetoresistance in its antiparallel and parallel states. *Id.*, 4:64-5:3. The ’138 Patent represents this ratio as follows:

$$\text{MR ratio} = (R_{ap} - R_p) / R_p.$$

Id.

The MR ratio is called the “tunnel magnetoresistance ratio” (“TMR”) in the Petition and is represented using the same formula reproduced below. Petition, 2, citing EX1024 ¶37.

$$\text{TMR} = \frac{\Delta R}{R_p} = \frac{R_{ap} - R_p}{R_p}$$

EX1024 ¶37. Patent Owner primarily uses Petitioner’s TMR terminology herein so the parties refer to the same parameter using the same terminology.

III. THE ’138 PATENT

A. Disclosed Embodiments

Dr. Shinji Yuasa, the ’138 Patent inventor, discovered how to make an MTJ device with an increased TMR. EX1011, 8:4-11 (an MTJ device produced using the inventive method achieved “the highest MR ratios that have so far been obtained at room temperature”).

In one embodiment, Dr. Yuasa created an MTJ device with electrodes formed from a CoFeB alloy having a crystalline structure sandwiching a single-crystalline MgO(001) layer. *Id.*, 9:6-27; 5:39-6:34. Dr. Yuasa discovered that his MTJ devices had **increased** TMR as compared to conventional MTJ devices. *Id.*, 3:17-20 (“[t]hese features **increase the magnetoresistance**”).³ As discussed *supra* §§II.B-II.C, when the MTJ is used in a memory cell, increased TMR improves the read-out accuracy for a stored data bit by increasing the differentiation between the

³ Emphasis added throughout unless otherwise noted.

voltages that represent stored “0s” and “1s.” *Id.*, 3:17-20, Figs. 9(B), 9(C), 10 (“characteristics required for G bit-MRAM”).

B. Challenged Claims

The Petition challenges claims 1-14 (“Challenged Claims”). Claims 1, 7, and 12 are independent and claims 2-6, 8-11, and 13-4 depend from claims 1, 7, and 12, respectively.

IV. DR. YUASA’S AWARD-WINNING INVENTION THAT USED CRYSTALLINE MgO WITH CoFeB ELECTRODES ACHIEVED SURPRISING AND UNEXPECTED RESULTS

Dr. Yuasa produced MTJs with high TMRs by using CoFeB electrodes sandwiching a crystalline MgO tunnel barrier layer. His results were surprising and unexpected given that Butler and Mathon had theorized high TMRs using MgO barrier layers due to “symmetry matching” between *crystalline* electrodes and a crystalline MgO layer (Petition, 25) and it was well-known that boron inhibited crystallization (EX1030, [0025] (boron is added so that “crystallization is inhibited”)). Given his surprising and unexpected results, Dr. Yuasa received several awards and industry praise for his invention.

Shortly after filing patent applications to which the ’138 Patent claims priority, Dr. Yuasa disclosed the ’138 Patent’s embodiments in articles in the Japanese Journal of Applied Physics (“JJAP,” EX2016), Nature Materials (“Nature,” EX2017), and in Applied Physics Letters (“APL,” EX2018). For

example, the figures in JJAP and Nature are the same as the figures in the '138 Patent. *Compare* EX2016, 589 and EX2017, 870 *with* EX1011, Figs. 6 and 7(A). APL discloses “MTJs” with a “reference” ferromagnetic layer on a “substrate,” a second “free” ferromagnetic layer and “CoFeB” for the “reference and free layers.” EX2018, 1. APL discloses an “MgO layer” “sandwiched” between the “CoFeB ferromagnetic electrodes,” that “the MgO layer [had] a good crystalline structure with a (001) fiber texture” and that there was at least “partial crystallization” of the “CoFeB layers” and “local crystallization of a few monolayers of CoFeB at the electrode/barrier interfaces.” *Id.*, 1-2.

Dr. Yuasa’s unexpected success in making an MTJ with a crystalized MgO barrier layer sandwiched between electrodes including crystallized CoFeB drew attention and praise across the industry and earned Dr. Yuasa numerous awards.

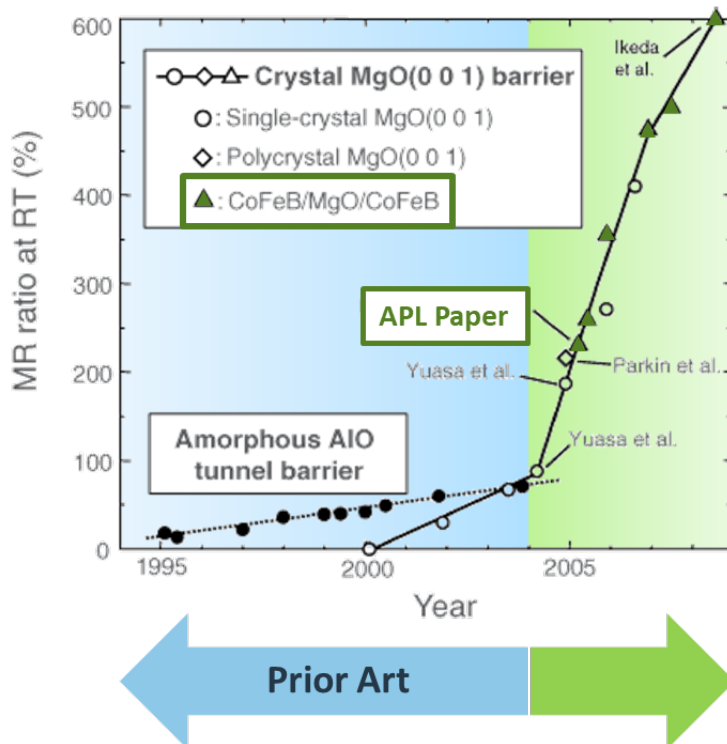
A. Dr. Yuasa’s Success in Using CoFeB Electrodes Surrounding a Crystalline MgO Tunnel Barrier Layer Was Unexpected

Butler and Mathon had theorized that high TMRs could be achieved by using MgO barrier layers due to “symmetry matching” between *crystalline* electrodes and a crystalline MgO layer. Petition, 25. It was well known that boron inhibited crystallization, so that CoFeB was amorphous. EX1030, [0025] (boron is added so that “crystallization is inhibited”). Petitioner’s own cited reference explained that successfully making an MTJ that used a crystalline MgO layer and

electrodes that include a layer with Co, Fe and B as claimed by the '138 Patent was “surprising[.]” EX1057 (“Dieny”), 47.

Dieny is a 2017 textbook including a chapter that was authored by Dr. Yuasa and that Petitioner repeatedly cites in Petitioner’s IPRs challenging other patents in the same family. *See e.g., Western Digital Technologies, Inc. v. Godo Kaisha IP Bridge 1*, IPR2024-01447, Petition (Paper 1), 7, 11, 13, 15 (citing EX1057). The textbook chapter cites as reference 33 the APL paper disclosing Dr. Yuasa’s invention. EX1057, 52. Figure 2.21 shows that the claimed invention disclosed in APL unleashed a new era of skyrocketing TMRs. EX1057, 46.

Figure 2.21 (Annotated)



The chapter explains that a “fundamental problem” with the prior art was “a problem concerning crystal growth.” EX1057, 46-47. The chapter credits the method disclosed in APL as “solv[ing] this problem” “by using a sputtering deposition technique” to make a “CoFeB/MgO/CoFeB” “MTJ structure,” where the “as-grown state” of the CoFeB was “amorphous.” *Id.*, 47. The chapter explains that, “[s]urprisingly,” the MgO barrier became “a (001)-oriented polycrystal” despite being grown on an “amorphous CoFeB” underlayer. *Id.* As can be seen in Figure 2.21, others then applied the claimed device structure, “(001)-textured CoFeB/MgO/CoFeB,” to achieve increasingly higher TMRs of “up to 600%.” *Id.*, 48.

Thus, Petitioner’s own reference (EX1057) shows that it was surprising at the time of the invention that Dr. Yuasa was able to achieve an MTJ with a crystallized MgO barrier layer sandwiched between electrodes with crystallized CoFeB.

B. Dr. Yuasa’s Unexpected Success Won Awards and Drew Praise

Dr. Yuasa’s surprising and unexpected results won many awards, some examples of which are described below. In 2009, Dr. Yuasa was awarded the “Inoue Harushige Prize” for his invention of “an original method of growing a *crystalline layer [MgO] on an amorphous layer [CoFeB]*.” EX2034, 1; *see also* EX2035, 1. In the same year, he was awarded the Tsukuba Prize, including a

monetary award of 5 million yen, for his development of an MTJ using a crystalline MgO tunnel barrier that “achieved a huge MR ratio of 180% at room temperature” and for his work “developing mass production technology for crystalline MgO-MTJ elements.” EX2069, 1; *see also* EX2033, 2.

In 2016, Dr. Yuasa won the “Science and Technology Prize” for his “new type of tunnel magnetoresistance element ... using crystalline magnesium oxide (MgO) as the tunnel insulating film,” for which “*a giant tunnel magnetoresistance effect of approximately 200% at room temperature was realized for the first time in the world.*” EX2029, 2. The award noted that “mass production technology was developed that *combines MgO and the magnetic alloy CoFeB*, making industrial applications of MgO tunnel magnetoresistance elements possible.” *Id.*

In 2021, Dr. Yuasa was made an “IEEE Fellow” for his “contributions to MgO-based magnetic tunnel junctions” (EX2026, 1) and awarded the “Future Creative Invention Prize” for his “invention of ... [JP] patent no. 5120680,” a foreign counterpart of the ’134 Patent (EX2027; EX2065). IEEE honored Dr. Yuasa as a Magnetics Society Distinguished Lecturer in 2021, noting that his “MTJs with a *CoFeB/MgO/CoFeB* structure were developed for practical application and found to have MR ratios of above 200% and other practical properties.” EX2030, 3. The IEEE Magnetics society profile notes “[Dr. Yuasa’s] most important scientific achievements are the development of MgO-based MTJs

including *CoFeB/MgO/CoFeB-type MTJs* and their applications to read heads of hard disk drives and STT-MRAM.” EX2068, 1.

In 2022, Dr. Yuasa was awarded the “Japan Society of Applied Physics Achievement Award,” for his “*invention of MTJs combining MgO and cobalt iron boron (CoFeB) alloys*.” EX2024, 2-3; EX2025, 2.

Dr. Yuasa has been awarded numerous other awards for his MTJ work, including the JSPS Prize in 2010 for “Development of High Performance Magnetic Tunnel Junction Devices,” the Asahi Award in 2008 for his “Studies on development and application of tunnel magnetoresistive effect,” the IBM Japan Science Prize in 2007 for “Studies on tunnel magnetoresistive effects and their application,” the Tokyo Techno Forum 21 Gold Medal Prize in 2006 for “Study on spintronics technology for MRAM,” the Marubun Science Prize in 2006 for “Study on tunnel magnetoresistance effect,” and the Ichimura Science Prize in 2005. EX2028, 4.

Dr. Yuasa’s unexpected success drew significant industry praise, including from Petitioner’s employees. For example, Chando Park co-authored a 2006 review on MTJs that identified Mr. Park as working for “Western Digital Corporation.” EX2021, 36. The article cites APL as reference 21. *Id.*, 45. The article recognizes the “*CoFeB/MgO/CoFeB* tunnel junctions” disclosed in the APL paper “provide[] a practical solution to overcome this difficulty [of crystal

growth]” and characterizes the solution as “epitaxially” induced crystallization of *CoFeB layers with “well matched” to the “MgO lattice” with “(001) texture.” Id.*, 39-40. As another example, “Zheng Gao, Recording Head Development Group, Western Digital Corporation” co-authored a 2018 paper that cited APL as reference 10. EX2022, 106, 110. The paper credited the “even higher TMR ratio of 230%” disclosed by APL and the “significance” of making that MTJ using “*amorphous (a)-CoFeB ... to promote strong (001) MgO texture* in the as-deposited state” where “post annealing transforms” the CoFeB layer to a polycrystalline layer. *Id.*, 107-108.

Others praised Dr. Yuasa’s invention too. Employees of TDK, a competitor to Petitioner, authored a 2023 paper recognizing the importance of the ’138 Patent’s claimed invention in MTJ development. EX2023, 1. The TDK paper cites APL as reference 20 (*id.*, 7) and lauded the claimed device as having “made the technology transition from [Al₂O₃] to MgO barrier much easier thanks to the use of simple CoFeB amorphous magnetic electrodes ... *Upon annealing CoFeB and MgO can be crystallized.*” *Id.*, 2. “After demonstrating superior performance ... MgO TMR became the state-of-art technology for all future spintronic devices including HDD recording read heads.” *Id.*

Even Nobel laureate, Albert Fert, when providing a historical overview of spintronics in a 2012 textbook, characterized Dr. Yuasa’s work disclosed in Nature

(EX2017) as “[t]he important breakthrough” and “the most important step [of] the transition from MTJ with amorphous tunnel barrier (alumina) to ... MTJ with MgO barrier.” EX2020, 8, 15, f.n. 30. This is among the more than **4,100 times** that Dr. Yuasa’s Nature paper has been cited. EX2002.

C. Conclusion: Dr. Yuasa’s Invention Was an Award-Winning Unexpected Success; Not Obvious

The above evidence shows that Dr. Yuasa’s success in making an MTJ with a crystalized MgO barrier layer sandwiched between electrodes with crystallized CoFeB was both unexpected and award-winning. Petitioner’s assertion now – two decades after Dr. Yuasa’s invention – that what he did would have been obvious is baseless and refuted by the extensive objective evidence of non-obviousness.

V. PERSON OF ORDINARY SKILL IN THE ART (“POSA”)

For purposes of this Preliminary Patent Owner Response only, Patent Owner does not challenge Petitioner’s POSA definition (Petition, 8-9) because the Petition fails even if Petitioner’s POSA definition is adopted.

VI. THE PETITION’S GROUNDS FAIL

A. Ground 1 Fails for At Least Three Reasons

1. The Petition Failed to Establish that a POSA Would Have Replaced Parkin’s CoFe Reference Electrode with CoFeB Based on Wang’s Teachings

Parkin discloses that its bottom reference electrode 115 is made of a CoFe alloy (Petition, 10), which has no boron (“B”). The Petition argues a POSA would

have “substitute[d] CoFeB for Parkin’s lower CoFe reference electrode” based on Wang’s teachings to “increase TMR, which was the driving purpose for most research in this field.” *Id.*, 11-13. The Petition advances no other reason to substitute CoFeB for Parkin’s CoFe reference electrode other than increasing TMR. *Id.*

But Wang’s MTJs all use an amorphous aluminum oxide (“Al₂O₃”) barrier layer, not a crystalline MgO barrier layer as Parkin does. The Petition fails to establish that a POSA would have applied Wang’s teachings regarding improving the TMR of a MTJ with an amorphous Al₂O₃ barrier layer to Parkin’s MTJ that had a crystalline MgO barrier layer. Indeed, in another proceeding, Petitioner’s expert testified that teachings related to improving TMR for Al₂O₃ MTJs are “hardly applicable” to MTJs with MgO barrier layers like Parkin. EX2062, 199:23-203:24.

Even if a POSA had looked to Wang, the Petition fails to establish that a POSA had any reason to have made the proffered substitution. Wang’s highest reported TMR was 70%—***far lower*** than Parkin’s “more than 220%” TMR. EX1062, 18:45-46; EX1055, 2269. The only other reference cited by the Petition that discloses using CoFeB for both electrodes, Cardoso, disclosed a TMR of 42% — again, far less than Parkin’s “more than 220%” TMR. EX1061, 2272. The Petition thus fails to establish that a POSA looking to increase TMR would have

made a substitution based on Wang and Cardoso that disclosed TMRs far worse than what Parkin achieved.

a. The Petition Failed to Establish that a POSA Would Have Applied Wang's Teachings to Parkin's MTJs

Wang's and Parkin's MTJs used dramatically different barrier layers.

Wang's MTJs use an aluminum oxide ("Al₂O₃") barrier layer (EX1055, 2269-2270), which is "amorphous" (EX1024, ¶65). In contrast, Parkin used an "MgO" barrier layer, which was "crystalline." Petition, 13-14. The art taught that it was the interplay between the electrodes and barrier material that determined the TMR, not either component in isolation. For example, the art taught that the TMR of an MTJ "depends on the actual electronic structure of the entire electrode/barrier system." EX1026, 1655. The art also taught that MgO barrier layers showed promise because the "alignment between the *crystal* of the ferromagnetic electrodes and the MgO barrier layer facilitates electron tunneling, increasing TMR." EX1024, ¶56, citing EX1044, 1 (disclosing the "symmetry" between the crystalline electrodes and barrier material "are *crucial* to determining the tunneling conductance").

The Petition fails to establish that a POSA would have looked to Wang's teachings regarding MTJs with an amorphous Al₂O₃ barrier layer to improve the TMR of Parkin's MTJ that had a crystalline MgO barrier layer. Petition, 9-13. The Petition fails to address the dramatically different barrier layers that Wang and Parkin have. *Id.* The Petition fails to address the art's teaching that it was the

interplay between the electrodes and barrier material that determined the TMR, not either component in isolation. *Id.* And the Petition fails to establish that a POSA would have applied teachings regarding an MTJ with an amorphous Al₂O₃ barrier layer to improve the TMR of an MTJ with a crystalline MgO barrier layer. *Id.*

The declaration from Petitioner's expert, Dr. Bokor, also fails to address these issues (EX1024, ¶¶105-116) and thus cannot save the Petition. Moreover, Dr. Bokor testified in another proceeding that teachings regarding MTJs with an amorphous Al₂O₃ barrier layer are "hardly applicable" to MTJs that had a crystalline MgO barrier layer. EX2062, 199:23-203:24. There, Dr. Bokor testified regarding a paper authored by Saito (attached hereto as EX2064). EX2062, 193:5-22. Dr. Bokor testified that Saito disclosed an MTJ with an "aluminum oxide barrier," just like Wang. *Id.*, 197:22-198:4. When asked if Saito's teachings could be applied to the MgO-based MTJ disclosed by Bowen (EX1026), Dr. Bokor testified that teachings regarding MTJs with an amorphous Al₂O₃ barrier layer, like Saito and Wang have, are "hardly applicable" to MTJs that had a crystalline MgO barrier layer, like Bowen and Parkin have. EX2062, 199:23-201:2.

Dr. Bokor explained that "Bowen uses MgO," and "[t]he whole point about using MgO for a tunnel barrier is because it has special properties ... [that are] not described by the – either the data or the theory in this experiment for aluminum oxide barrier," "[i]t's hardly – it's hardly applicable." *Id.* Dr. Bokor further

testified that “I don’t see how a POSA has a reasonable expectation to accept any of this [about an MTJ with an Al₂O₃ barrier] for the Bowen MTJ” (*id.*, 201:3-12) which “uses MgO” (*id.*, 200:16). Thus, Petitioner’s own expert testified that a POSA would not have applied teachings regarding MTJs with an amorphous Al₂O₃ barrier layer like Wang’s to improve the TMR of an MTJ with a crystalline MgO barrier layer like Parkin’s.

In sum, the Petition fails to establish that a POSA would have looked to Wang to improve Parkin’s MTJ in the first place given the significant differences between their MTJs and the absence of any evidence that the teachings of Wang would have been applicable to improving Parkin’s TMR.

b. Wang’s Highest TMR of 70% Was Far Lower than Parkin’s TMR of “More Than 220%”

If a POSA considered Wang to have any relevance to Parkin’s TMR, the Petition fails to establish that a POSA would have substituted CoFeB for Parkin’s CoFe reference electrode based on Wang given that Parkin’s TMR was far higher than the highest TMR disclosed by Wang. Parkin achieved a TMR of “more than 220%.” EX1062, 18:45-46. The highest TMR Wang reported was less than a third of that – only “70.4%.” EX1055, 2270. The Petition fails to explain why a POSA would have modified Parkin based on Wang to purportedly improve TMR when Parkin achieved a dramatically higher TMR (“more than 220%”) than Wang (“70.4%”). Petition, 9-13.

The Bokor declaration also fails to address this issue (EX1024, ¶¶105-116) and thus does not save the Petition.

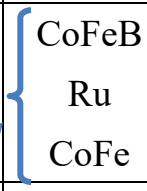
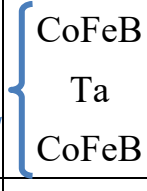
In sum, the Petition fails to establish that a POSA would have looked to Wang's teachings to improve Parkin's TMR when Wang's highest TMR was dramatically lower than the TMR Parkin had achieved.

c. Wang Disclosed that Substituting CoFeB for a CoFe Reference Electrode Led to an MTJ with No Measurable TMR

Wang performed a substitution like the one the Petition proposes making in Parkin, as Wang substituted CoFeB for a CoFe reference electrode. Wang disclosed that the substitution resulted in an MTJ with no measurable TMR. The Petition and the Bokor declaration both fail to explain why Wang would have motivated a POSA to make this substitution in Parkin's MTJ when Wang teaches that such a substitution yielded an MTJ that did not work.

i. Wang Disclosed that Substituting CoFeB for CoFe in a Reference Layer Resulted in No Measurable TMR

Wang discloses four different MTJ structures along with their respective TMR values, summarized below.

Junction No.:	①	②	③	④
Layer Function	Material Used			
Antiferromagnetic pinning layer	CrMnPt	CrMnPt	CrMnPt	CrMnPt
Pinned ferromagnetic layer (a.k.a. reference electrode)	CoFe	CoFe	CoFeB	 CoFeB Ru CoFe
Tunnel barrier layer	Al ₂ O ₃	Al ₂ O ₃	Al ₂ O ₃	Al ₂ O ₃
Free ferromagnetic layer (a.k.a. storage electrode)	NiFeCo	CoFeB	CoFeB	 CoFeB Ta CoFeB
Buffer layer	n/a	Ru	Ru	Ru
Substrate	Si ₃ N ₄ Si(100)	Si ₃ N ₄ Si(100)	Si ₃ N ₄ Si(100)	Si ₃ N ₄ Si(100)
TMR Value	41-42%	60.8%	zero	65-70%

Junction No. 1 used NiFeCo for the storage electrode and CoFe for the reference electrode, resulting in a TMR of 42.7%. EX1055, 2269.

Junction No. 2 “chang[ed] the free [a.k.a. storage] layer from NiFeCo to CoFeB” resulting in an “increased” TMR of 60.8%. *Id.* (disclosing a “stack structure of Si(100)—Si₃N₄—Ru—CoFeB—Al₂O₃—FeCo—CrMnPt”). *Id.*

Junction No. 3 replaced the “pinned [a.k.a. reference] layer[]” of CoFe with CoFeB, resulting in “a stack structure of Si(100)—Si₃N₄—Ru—CoFeB—Al₂O₃—CoFeB—CrMnPt.” *Id.*, 2270. But that structure failed. Specifically, Wang disclosed that “*magnetic pinning was not achieved to allow the TMR*

measurement for these junctions even after annealing.” *Id.* As discussed above, one difference between the reference and storage electrodes is that the magnetization direction of the storage electrode should be switchable using an external field but then remain constant after the external field is removed, whereas the magnetization direction of the reference electrode should remain constant even under the same external field that can switch the magnetization direction of the storage electrode. *See* EX1030, [0019] (explaining how the magnetization of one electrode changes with an applied field but the other should not), [0027] (explaining the problems associated with the magnetization direction of the storage electrode becoming unstable); *see also* EX1056, [0010] (explaining the difference between the storage and reference electrodes), [0016] (explaining the desire for lowering coercive force of the storage electrode to lower the write current), [0067]-[0068].

Thus, because Wang’s CoFeB reference electrode could not be pinned in one direction, when the external field changed the magnetization of the storage electrode, the magnetization of the reference electrode undesirably changed its direction of magnetization too. As a result, the structure worked so poorly that it did not even “allow the TMR measurement.” EX1055, 2270. Wang explained that this occurred because the “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.” *Id.*

Junction 4 involved a change in which Wang eventually solved the failure of the third junction by using “[s]ynthetic antiferromagnet (SAF) sandwich structures of CoFeB-Ru-CoFeB and CoFeB-Ru-FeCo” for the pinned and free layers, resulting in a TMR of “65.4%” and “70.4%” after “[f]urther optimization” (*id.*). Junction 4’s SAF sandwich structures are not relevant to Ground 1 because the Petition does not propose using them, as explained below.

ii. The Petition’s Combination Substitutes Parkin’s CoFe Pinned Electrode for CoFeB – the Modification that Wang Taught Failed

The modification the Petition proposes in its Ground 1 analysis is “to substitute CoFeB for Parkin’s lower CoFe reference electrode as described in Wang.” Petition, 11. Notably, the Petition does **not** propose substituting Wang’s SAF sandwich structures for Parkin’s lower CoFe reference electrode. Neither the Petition nor the Bokor declaration ever mentions Wang’s SAF sandwich structures. The Petition’s Ground 1 combination “substitute[s] CoFeB for Parkin’s lower CoFe reference electrode,” just as it states. Petition, 11; *see also* EX1024 ¶110 (alleging “One of skill would have found it obvious to replace Parkin’s lower magnetic CoFe layer 115 with a CoFeB layer.”).

But as explained in the prior section, Wang made that substitution and found that it did not work. EX1055, 2270. Wang states that a “further increase [in] the TMR value” was expected by “replac[ing] both the free [a.k.a. storage] and pinned [a.k.a. reference] layers to CoFeB,” but when Wang ran the experiment, Wang found that “magnetic pinning was not achieved to allow the TMR measurement for these junctions even after annealing.” *Id.* Wang thus disclosed that substituting CoFeB for a reference CoFe electrode failed so completely that a TMR measurement could not even be made.

The Petition alleges that “Wang compared an MTJ device using a CoFeB free electrode and a CoFe reference electrode, like Parkin’s, to an MTJ device using CoFeB for both the free and reference electrodes and concluded that ‘[t]he TMR value is indeed improved to be 65.4%, comparing to 60.8% with CoFeB on only one side of the tunnel barrier.’” Petition, 12. That misinterprets Wang’s disclosure. TMR improved from 60.8% to 65.4% only after both electrodes were replaced with “[s]ynthetic antiferromagnet (SAF) sandwich structures.” EX1055, 2270. As explained above, the Petition does not propose using Wang’s SAF sandwich structures. Indeed, Petitioner ignored Wang’s SAF sandwich structure because the CoFeB in them is amorphous, not crystalline as the claims require. EX1055, 2270 (“***crystallinity is not required*** to have a strong indirect exchange coupling through Ru in a SAF structure...”). Instead, the Petition proposed a

straight substitution of CoFeB for Parkin's CoFe reference electrode. Petition, 11. The performance of Wang's SAF sandwich structures is irrelevant to whether a POSA had any reason to make the modification to Parkin that the Petition proposed.

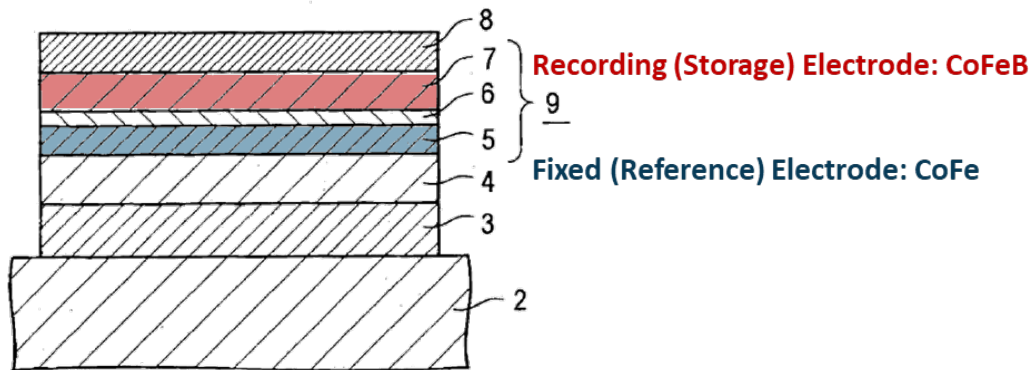
The Petition also quotes Wang as stating "[w]ith such a large increase of TMR value by changing the free layer from NiFeCo to CoFeB, it is natural to replace both the free and pinned layers to CoFeB to further increase the TMR value." Petition, 12 (quoting EX1055, 2270). But that was Wang's ***prediction before*** running the experiment. ***After*** running the experiment, Wang discovered that substituting CoFeB for the CoFe pinned electrode did not work, resulting in a structure that had no measurable TMR. EX1055, 2270 ("magnetic pinning was not achieved to allow the TMR measurement for these junctions even after annealing").

The Petition alleges that "[o]ther researchers had also observed higher TMRs with CoFeB layers," citing EX1061 (Cardoso) and EX1056 (Hosomi) (*see* Petition, 12). The Petition's assertion is unsupported.

Hosomi only tested an MTJ with a CoFe reference electrode, like Parkin's CoFe reference electrode, and is thus uninformative of what a POSA would have expected to happen if the reference electrode was replaced with CoFeB as the Petition proposes. Specifically, Hosomi discloses an MTJ structure with a

reference layer (“magnetization fixed layer 5”) comprising CoFe (EX1056, [0111]) and only changed “the material, thickness, and aspect ratio of the information recording [a.k.a. storage] layer,” “layer 7” (*id.*, [0118]-[0119]).

Hosomi Figure 1 (Annotated)



Critically, *Hosomi never changed the composition of the reference layer, which remained CoFe* (*id.*, [0111]) even though Hosomi changed the information storage layer from CoFe to CoFeB. (*id.*, [0103]). Again, the difference between the storage and reference layers is material because while the storage layer takes on the direction of magnetization from an external field to which the MTJ is exposed, the reference layer must resist that and must maintain a consistent direction of magnetization despite being subjected to the same external magnetic field. Thus, at best, Hosomi discloses a benefit of using CoFeB instead of CoFe for the **storage** information recording layer (consistent with Wang’s disclosure), but the Petition proposed replacing Parkin’s “CoFe **reference** electrode,” which Hosomi never

tried. Petition, 11. Hosomi is thus uninformative of what a POSA would have expected to happen if a CoFe *reference* electrode was replaced with CoFeB.

Cardoso did substitute CoFeB for both electrodes but Cardoso discloses a vastly lower TMR than Parkin achieved. Parkin's TMR was "more than 220%." EX1062, 18:45-46. Cardoso disclosed that CoFeB electrodes yielded a TMR of only 42% - less than a quarter of Parkin's TMR. EX1061, Abstract. Cardoso thus provided no reason for a POSA to have substituted CoFeB for Parkin's CoFe reference in an attempt to increase TMR, which is the only reason the Petition proposes for why a POSA allegedly would have modified Parkin to use a lower CoFeB electrode. Petition, 9-15.

Cardoso is also uninformative because it discloses that *oxidized* CoFe electrodes had lower TMR than oxide-free CoFeB, not that CoFeB electrodes are better than oxide-free CoFe electrodes. Specifically, Cardoso discloses that its junctions using CoFe electrodes exhibited lower TMR ("~35%) than its junctions using CoFeB electrodes ("42% of tunneling magnetoresistance") (EX1061, Abstract), but Cardoso explains that the lower TMR of the junctions using CoFe electrodes was "related to the partially oxidized CoFe electrode found by TEM" (*id.*, 2274). Cardoso also disclosed that "the top CoFe electrode showed oxidized regions extending over several micrometers," that were so severe that "the top CoFe can barely be distinguished from the AlOx barrier." *Id.*, 2272-73. Moreover,

Cardoso disclosed that, in some regions, “segregation of Fe–O and very little Co presence is clearly seen.” *Id.*, 2273. Thus, in essence, Cardoso’s fabrication method created oxidized CoFe electrodes, making the TMR worse because of it, whereas the CoFeB electrodes did not oxidize. *Id.* (“No evidence of these oxidized regions were observed in NiFe and CoFeB-based junctions.”). Thus, Cardoso taught that oxidized CoFe electrodes were worse than CoFeB electrodes, not that CoFeB was better than rust-free CoFe electrodes.⁴

To demonstrate any claim obvious, Petitioner needed to establish some supportable ***reason why*** a POSA “would have selected and combined [the] prior art elements” in a manner “yield[ing] the claimed invention.” *Unigene Labs. v. Apotex*, 655 F.3d 1352, 1360 (Fed. Cir. 2011); *see also KSR*, 550 U.S. at 418 (same); *TQ Delta v. Cisco Sys.*, 942 F.3d 1352, 1359 (Fed. Cir. 2019) (reversing the Board’s obviousness determination because the Board “fails to identify any actual ***reason why*** a skilled artisan would have combined the elements in the manner claimed.”) (internal citations omitted)).

⁴ Cardoso’s teachings are consistent with Parkin’s description of the prior art that the “surface of the lower Fe electrode [could become] oxidized perhaps resulting in much lower TMR than theorized.” EX1062, 12:16-19. Parkin was plainly aware of the risk and was able to avoid oxidation issues with its CoFe reference electrode.

As detailed above, the only alleged reason the Petition provides for substituting CoFeB for Parkin's CoFe reference electrode was to purportedly increase TMR (Petition, 11-13), but all the references Petitioner cites had far worse TMR than Parkin. Petitioner's hindsight assertion that a POSA would have modified Parkin in the manner alleged to achieve a higher TMR is unsupported by any *evidence*. Thus, Petitioner fails to establish any supportable reason for combining the references in Ground 1 in the manner alleged. That is fatal to Ground 1.

2. The Petition Failed to Establish that Parkin Discloses a Layer that Includes Co, Fe and B and Is “Entirely Crystalized” as Claimed

Every challenged independent claim (claims 1, 7, and 12) recites an MTJ device comprising first and second electrodes comprising first and second ferromagnetic material layers, respectively, that include Co, Fe and B, wherein each of the first and second ferromagnetic material layers “is *entirely crystallized*.” See Limitations 1[d], 7[e], and 12[d].

The Petition identifies Parkin's CoFeB storage layer 175 as the alleged second ferromagnetic material layer. See e.g., Petition, 16 (Limitation 1[d]). But the Petition admits that Parkin discloses that the layer 175 is “amorphous” (i.e., *not* crystalline). Petition, 16.

To meet the additional claim requirement that the second ferromagnetic layer is “entirely crystallized” (*see e.g.*, Limitation 1[d]), the Petition never even alleges that the storage layer 175 (i.e., the alleged second ferromagnetic layer) is “entirely crystallized” as claimed. Instead, the Petition alleges that Parkin discloses that “a ***portion*** of the storage layer 175 ... has crystallized.” *Id.*, 17-18, (citing EX1062, 18:51-55). A layer of which only a “portion” is crystallized is not a layer that is “entirely crystallized” under the plain meaning of “entirely crystallized.” Petition, 6 (alleging that the plain meaning applies for all terms). Ground 1 fails for this additional reason.

a. The Petition Failed to Construe “Entirely Crystallized”

Each of the three independent challenged claims requires an MTJ with a first and second electrode that, respectively, have a first and second ferromagnetic material layer containing Co, Fe, and B, where each of those layers is “***entirely crystallized***.” Specifically, independent claim 1 recites a “magnetic tunnel junction (MTJ) device” (1[pre]) comprising a first and second electrode comprising a first and second “ferromagnetic material layer that includes Co, Fe, and B” (1[a] and 1[c]), “wherein each of the first and second ferromagnetic material layers is ***entirely crystallized***” (1[d]). Independent claim 7 requires “the first and second CoFeB layers are ***entirely crystallized***” (7[e]). Independent claim 12 requires that

each of the “first and second ferromagnetic material layers” that comprise Co, Fe and B “is *entirely crystallized*” (12[d]).

Petitioner’s Claim Construction section alleges that “the claim terms should be given their plain and ordinary meaning and no claim construction is necessary.” Petition, 6. But the Petition never explains what Petitioner alleges to be the “plain meaning” of “entirely crystallized.”

The Petition identifies Parkin’s storage layer 175 as the second ferromagnetic material layer. Petition, 16 (Limitation 1[c]), 29 (Limitation 7[c]), 32 (Limitation 12[c]). To meet the claims, this alleged second ferromagnetic layer must be “entirely crystallized.” *See* Limitations 1[d], 7[e] and 12[d]. The Petition does not even allege that this is so.

The Petition alleges that “Parkin taught that annealing resulted in an entirely crystallized ferromagnetic layer,” but on the same page the Petition admits that after annealing, Parkin’s testing of its MTJ showed that only “a *portion* of the [CoFeB] storage layer 175 ... crystallized.” Petition, 17. The Petition fails to explain how storage layer 175, which the Petition identified as the second ferromagnetic material layer, can be “entirely crystallized” as claimed when the Petition admits that Parkin taught that only a “portion” of it crystallized. *Id.*, 17-18. That is fatal to Ground 1.

b. No Evidence Supports Petitioner’s Assertion that an Allegedly Crystallized “Portion” of Parkin’s CoFeB Layer 175 Makes It “Entirely Crystallized”

The Petition also fails to cite evidence that supports its conclusory assertion that an allegedly crystallized “portion” of Parkin’s CoFeB layer 175 makes layer 175 “entirely crystalized.” By statute, the Petition “*may be considered only if*” it identifies its grounds “with particularity.” 35 U.S.C. § 312(a)(3). To be considered, the Petition’s “[c]ontent” “must include” “a detailed explanation of the significance of the evidence.” 37 C.F.R. § 42.22(a)(2). The Petition fails to meet these requirements. The Petition provides *no* explanation – let alone a “detailed” one – of how or why the allegedly crystallized “portion” of Parkin’s CoFeB layer 175 makes layer 175 “entirely crystallized” as claimed.

The Petition argues that Parkin teaches that the “crystalline MgO layer ... provides a template for the formation of a thin crystalline ferromagnetic layer” and that “[t]he highly (100) textured MgO layer is likely to form an excellent template layer for the formation of a thin crystalline layer of CoFeB.” Petition at 17-18.⁵ But

⁵ Patent Owner does not concede that Parkin discloses the “portion” of storage layer 175 that crystalizes includes boron. But the Petition still fails for the reasons explained in this POPR even if Parkin is read as disclosing that there is boron in the “portion” of layer 175 that crystallized.

when Parkin tested the MTJ of Figure 3A that the Petition relies upon, Parkin found that “transmission electron microscopy reveals that a ***portion*** of the storage layer 175 adjacent to the MgO tunnel barrier 120' has crystallized” but “the bulk of the storage layer 175 remains amorphous.” EX1062, 18:55-62. Thus, the “bulk of storage layer 175” is amorphous, *i.e.*, ***not crystalline***.

The Petition argues that the crystallized “portion” of layer 175 is a “layer” that is “entirely crystallized,” but that argument fails. The “portion” of layer 175 is not the layer that the Petition identified as mapping to the claimed second ferromagnetic layer to meet Limitations 1[c], 7[c], and 12[c]. Petition, 16, 29 and 32. When mapping Parkin to Limitations 1[c], the Petition identified the ***entirety*** of storage layer 175 as meeting that Limitation (*id.*, 16) and the Petition’s claim 7 and 12 analysis merely cross-references that claim 1 analysis (*id.*, 29 and 32). The Petition thus must establish that storage layer 175 is “entirely crystallized” to meet Limitations 1[d], 7[e] and 12[d]. The Petition does not establish storage layer 175 is “entirely crystallized” because Parkin is explicit that the “bulk of the storage layer 175 remains amorphous.” EX1062, 18:55-62.

The Petition cites other prior art that allegedly discloses “CoFeB films [that] are not amorphous” and annealing processes that “would allow the first and second ferromagnetic layers to be entirely crystallized based on the annealing process.” Petition, 18-20 (citing EX1061, 2273; EX1012, 200). But the Petition relied on

Parkin’s express disclosure of a CoFeB layer that is “entirely crystalized,” not an assertion that it would have been obvious for some unstated reason to modify Parkin’s CoFeB storage layer 175 to make it entirely crystallized.

Even if the Petition had relied on such an obviousness argument, it would have failed because Parkin discloses a preference for the bulk of the CoFeB electrode to be *amorphous*, not *crystallized*. Parkin’s invention was to “include[] an *amorphous* magnetic layer of Co and at least one additional element selected to make the layer amorphous.” EX1062, 6:24-26. Parkin’s preferred embodiments “are directed to structures using *amorphous* magnetic materials.” *Id.*, 9:1-3. Parkin discloses “an *amorphous* alloy of CoFeB” that “shows high tunneling magnetoresistance of more than 130%.” *Id.*, 16:47-50. And Parkin discloses that the “bulk” of the storage layer 175 “*remains amorphous*” even after annealing. *Id.*, 18:59-60. The Petition thus fails to provide any reason why a POSA would have attempted to make Parkin’s CoFeB layer “entirely crystallized” as claimed when Parkin taught the reason behind adding boron in the first place was to make the storage electrode amorphous.

The Petition cites other annealing processes, such as the one disclosed by Parkin-555 (EX1091) – which has a different disclosure than the Parkin reference relied upon in Ground 1 – and various patents cited in Patent Owner’s infringement contentions. Petition, 19. Petitioner argues that these references have “at least as

much detail” as Parkin so Parkin’s level of detail is sufficient to allegedly disclose an entirely crystallized layer. *Id.* But the Petition fails to explain why any of those annealing processes are informative of Parkin’s disclosure. They are not. The other prior art disclosures are irrelevant to whether Parkin’s storage layer 175 is “entirely crystallized.” Parkin is quite clear that storage layer 175 is not entirely crystallized, even after annealing, because Parkin teaches that the “bulk” of the CoFeB “remain[ed] amorphous.” EX1062, 18:59-60.

The Petition cites the ’138 Patent’s specification, alleging that it “contains far less disclosure on this subject than Parkin.” Petition, 19. That is neither accurate nor informative of Parkin’s disclosure. The Petition’s statement is not accurate because the ’138 Patent plainly discloses an annealing process that causes “the amorphous magnetic alloy in the electrode layers to be partially or *entirely crystallized*,” and that “such a crystallized amorphous magnetic alloy may be used in the electrode layers” (EX1011, 9:20-27), as the Petition admits (Petition, 19). The ’138 Patent’s disclosure is also not informative of Parkin’s disclosure because the ’138 Patent expressly discloses an electrode layer that is “entirely crystallized” (EX1011, 9:20-27), whereas Parkin expressly discloses that only a “portion” of its CoFeB layer 175 crystallized and that the “bulk” of the layer “remain[ed] amorphous” because Parkin expressly wanted the bulk of the layer 175 to be amorphous (EX1062, 6:24-26, 9:1-3, 16:47-50, 18:59-60).

In sum, while the Petition makes allegations that “Parkin taught that annealing resulted in an entirely crystallized ferromagnetic layer” (Petition, 17), the Petition cites no evidence that substantiates that allegation. To the contrary, the Petition admits that Parkin disclosed that only a “portion” of the storage layer 175 crystallized (*id.*),⁶ while the “bulk” “remain[ed] amorphous” (EX1062, 18:59-60). Ground 1 fails for all Challenged Claims for this additional reason.

c. The Expert Declaration Cannot and Does Not Save Petitioner

Nothing in the expert declaration can save Petitioner from the Petition’s failures to explain how and why a “portion” of Parkin’s storage layer 175 being crystalized discloses that the layer 175 is “entirely crystalized” as claimed. This is “content” the *Petition* must have, and arguments cannot be incorporated by reference into the Petition from the expert declaration. 37 CFR §§ 42.22, 42.104(b)(5), and 42.6(a)(3); *Instrumentation Lab. v. Hemosonics*, IPR2017-00855, Paper 55, 20 (Feb. 13, 2019) (citing 37 C.F.R. § 42.6(a)(3) and explaining: “Arguments and information that are not presented and developed in the Petition, but instead are incorporated by reference, are not entitled to consideration, as it is

⁶ Ground 1’s analysis for Limitations 7[e] (Petition, 30) and 12[d] (*id.*, 32) merely cross-reference that analysis for claim 1 without more.

improper to incorporate by reference arguments from one document into another document.”).

Even if the Board were to wade into the Bokor declaration, it does not remedy the Petition’s failures. The Petition’s purported mapping of Limitation 1[d] to Parkin cites Bokor ¶¶128-36. Petition, 17. Like the Petition, the Bokor declaration never explains what the alleged plain meaning of “entirely crystallized” is and never explains how or why Parkin’s disclosure that a crystallized “portion” of its storage layer 175 could somehow disclose that the layer 175 is “entirely crystallized.” Dr. Bokor’s conclusory assertion that Parkin discloses a CoFeB layer that is “entirely crystalized” is unsupported by any reasoned analysis or corroborating evidence, so it warrants no weight under the Board’s precedential *Xerox* decision. *Xerox v. Bytemark*, IPR2022-00624, Paper 9, 15 (Aug. 24, 2022) (precedential) (“[T]he cited declaration testimony is conclusory and unsupported, adds little to the conclusory assertion for which it is offered to support, and is entitled to little weight.”); *see also id.* (quoting 37 C.F.R. § 42.65(a): “Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight.”).

Moreover, in a pending IPR brought by Petitioner against another one of Dr. Yuasa’s patents in the same family as the ’138 Patent, Dr. Bokor recently admitted that “I’m no expert. I’m no crystal grower.” EX2063, 77:19. In that proceeding,

Dr. Bokor was asked how a crystalline MgO – which the claims of the '138 Patent also require (see Limitations 1[b], [7[b] and 12 [b]) – can be grown on a crystalline iron electrode. *Id.*, 76:4-21. When asked “what happens” when the “lattices do not match,” Dr. Bokor admitted that he did not know because he lacked the expertise to answer. *Id.*, 76:23-78:3 (“I’m no expert. I’m no crystal grower. And so the question of what happens in that scenario, I can’t really answer sitting here today.”). That is a stunning admission that casts considerable doubt on Dr. Bokor’s opinions in *this* case given that the claims of the '138 Patent all require an MTJ device with an MgO layer having a specific crystalline structure (“(001) crystal plane is preferentially oriented”) and with both electrodes comprising a ferromagnetic material layer that includes boron – which was well-known to inhibit crystallization – yet is “entirely crystallized.”

Dr. Bokor offers no credible explanation of how or why Parkin’s storage layer 175 could be considered “entirely crystalized” despite Parkin disclosing that the “bulk” of the layer 175 “remain[ed] amorphous.” EX1062, 18:59-60.

3. The Petition Fails to Establish a Reasonable Expectation of Success in Replacing Parkin’s CoFe Reference Electrode with CoFeB

Demonstrating obviousness requires establishing a reasonable expectation of success. *Medtronic v. Teleflex*, 70 F.4th 1331, 1345 (Fed. Cir. 2023) (“An obviousness determination *requires* finding that a person of ordinary skill in the art

would have been motivated to combine or modify the ... prior art and would have had a reasonable expectation of success in doing so.”). The Petition failed to establish a reasonable expectation of success in replacing Parkin’s CoFe electrode with a CoFeB electrode.

The Petition mentions predictability only once, outside of quoting *KSR*, and does so only in a conclusory fashion. Petition, 11-12 (“one of skill would have found it [replacing Parkin’s CoFe reference electrode with CoFeB] to be a straightforward, predictable, and desirable improvement”).⁷ Petitioner cites Wang (EX1055), Sunai (EX1030), Hosomi (EX1056), and the Bokor declaration (EX1024), but never explains the significance of any of that evidence. That is an explanation the Petition “must” have. 37 C.F.R. § 42.22(a)(2) (To be considered, the Petition’s “[c]ontent” “must include” “a detailed explanation of the significance of the evidence.”). The Petitions’ failure to explain how any of its cited evidence purportedly establishes a reasonable expectation of success is another reason why Ground 1 fails.

Even if the Board were to wade through each cited reference to evaluate its “significance” in the absence of the Petition including the required explanation, the

⁷ The Petition’s showings for the other independent claims rely entirely on the showing for claim 1. Petition, 28-30 (claim 7) and 32-33 (claim 12).

Board would find that none of this evidence establishes that the result of replacing Parkin's CoFe reference electrode with CoFeB would have been predictable.

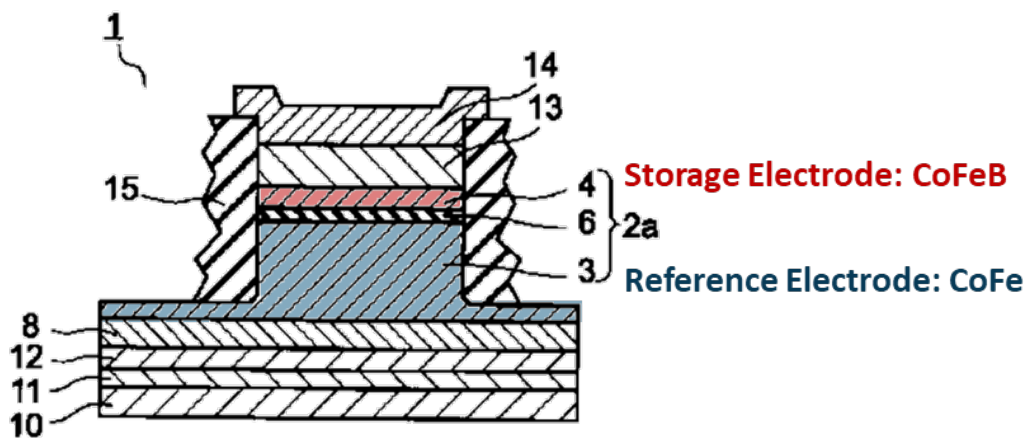
Because Wang had observed "a large increase of TMR value by changing the *free* [storage] layer from NiFeCo to CoFeB," Wang believed it would be "natural to replace both the free [storage] and *pinned [reference]* layers to CoFeB to further increase the TMR value." EX1055, 2270. But Wang's prediction proved to be unfounded because when Wang ran that experiment, Wang found that "magnetic pinning was not achieved to allow the TMR measurement for these junctions even after annealing." *Id.* Wang establishes that a POSA would not have reasonably predicted success in replacing a CoFe reference electrode with CoFeB because Wang had anticipated success, but testing showed that expectation was unfounded. Wang thus does not support that the result of the modification to Parkin would have been predictable as Petitioner alleges.

Sunai (EX1030) and Hosomi (EX1056) only ever use boron in their storage layers, not the reference layer, and are thus uninformative of whether a POSA would have had any expectation of predictably using CoFeB in the reference layer instead of CoFe. Again, the difference between the storage and reference layers is material because while the storage layer takes on the direction of magnetization from an external field to which the MTJ is exposed, the reference layer must resist

that and must maintain a consistent direction of magnetization despite being subjected to the same external magnetic field.

Sunai discloses that its ferromagnetic layer 3 is the reference layer because “the magnetization direction of the ferromagnetic layer 3 does not change even when the external magnetic field is applied.” EX1030, [0019].

Sunai Figure 1 (Annotated)

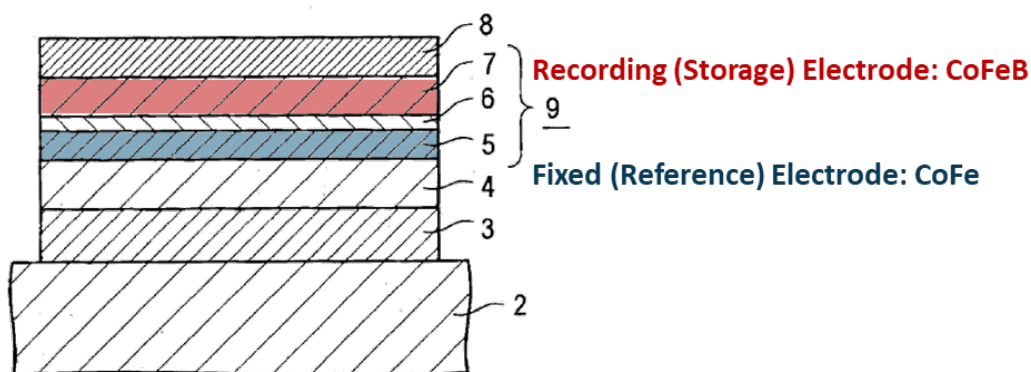


Sunai’s “second ferromagnetic layer 4” is the storage layer because that is the layer “that can change the direction of magnetization.” *Id.*, Abstract; *see also id.*, [0019] (“the magnetization direction of the ferromagnetic layer 4 can basically rotate freely depending on the external magnetic field”). While Sunai discloses using boron in the storage layer 4 (*id.*, [0026]-[0029]), Sunai discloses that the reference electrode layer 3 is made of “CoFe,” without any boron (*id.*, [0050] (“ferromagnetic layer 3 consisting of a 3 nm thick CoFe”). Thus, like Parkin,

Sunai does not disclose using CoFeB in the reference electrode (which is CoFe) and instead discloses using CoFeB only in the storage electrode.

Hosomi similarly used a reference electrode (CoFe) without boron and used boron only in the storage layer. Specifically, Hosomi discloses an MTJ structure with a reference layer (“magnetization fixed layer 5”) comprising CoFe (EX1056, [0111]) and then changed “the material, thickness, and aspect ratio of the information recording [i.e., the storage] layer” (*id.*, [0118]). Hosomi disclosed testing CoFeB only in the storage layer (*id.*, [0103]) and never changed the composition of the reference layer, which remained CoFe (*id.*, [0111]).

Hosomi Figure 1 (Annotated)



Thus, Sunai and Hosomi do not disclose what would have happened if CoFeB had been used instead of CoFe in a reference electrode. Only Wang conducted such an experiment and found that substituting CoFeB for a CoFe reference electrode resulted in an MTJ that had no measurable TMR. *See* §VI.A.1.c, *supra*.

Petitioner's expert declaration cannot and does not save Petitioner because arguments cannot be incorporated by reference into the Petition from the expert declaration. 37 CFR §§ 42.22, 42.104(b)(5), and 42.6(a)(3); *Instrumentation*, IPR2017-00855, Paper 55, 20 (Feb. 13, 2019). But even if the Board were to wade through paragraph 113 of the Bokor declaration, the only paragraph the Petition cites as allegedly supporting predictability (Petition, 12), the Board would only find citations to Sunai, Parkin, Hosomi, Cardoso, and Wang—none of which support that the result of replacing a CoFe reference electrode with CoFeB would have been predictable.

As discussed above in this section, Sunai, Parkin, and Hosomi only ever disclose using CoFeB for the storage layer, not the reference layer, which were all universally made of CoFe. As explained in §VI.A.2.c.ii, *supra*, Cardoso at best discloses that oxidized (rusty) CoFe electrodes were worse than rust-free CoFeB electrodes, not that CoFeB worked better than CoFe that is rust-free. The only reference cited by Dr. Bokor that directly replaced a CoFe reference electrode with CoFeB was Wang, which discloses that such a substitution resulted in an MTJ that failed so completely there was no measurable TMR. Bokor's opinion that replacing a CoFe reference electrode with CoFeB would have increased TMR is unsupported by any evidence and thus not entitled to any weight. *Xerox*, Paper 9 at 15 (“[T]he cited declaration testimony is conclusory and unsupported, adds little to the

conclusory assertion for which it is offered to support, and is entitled to little weight.”).

In sum, the Petition fails to establish that replacing Parkin’s CoFe reference electrode with CoFeB would have been predictable or that a POSA would have had a reasonable expectation of success in making the substitution. The only reference to make such a substitution was Wang, which taught that that the substitution resulted in a MTJ that failed to have any measurable TMR at all. Petitioner’s failure to establish a reasonable expectation of success is an additional reason why Ground 1 fails.

4. Conclusion: Ground 1 Fails

As detailed above, Ground 1 fails for three independent reasons because:

- The Petition failed to establish that a POSA would have replaced Parkin’s CoFe reference electrode with CoFeB based on Wang’s teachings. *See supra* §IV.A.1.
- The Petition failed to establish that Parkin discloses a layer that includes Co, Fe, and B and is “entirely crystallized” as claimed. *See supra* §IV.A.2.
- The Petition fails to establish a reasonable expectation of success in replacing Parkin’s CoFe reference electrode with CoFeB. *See supra* §IV.A.3.

B. Ground 2 Fails Because it Inherits Ground 1's Failures

Ground 2 challenges dependent claims 5-6, 11, and 14. Petition, 33. Ground 2 relies exclusively Ground 1's analysis to purportedly show how the proffered combination renders independent claims 1, 7, and 12 obvious, Petition, 33 (claim 5: cross-referencing Ground 1's analysis for claims 1 and 4), 38 (claim 6: cross-referencing Ground 1's analysis for claim 1), 44 (claims 11 and 14: cross-referencing Ground 1's analysis for claims 1, 10, and 13). Ground 2 thus inherits the above-described failures of Ground 1 and fails for the same reasons. *Supra* §VI.A.

C. Ground 3 Fails for Multiple Independent Reasons

Ground 3 alleges obviousness of claims 1-14 over Bowen in view of Wang and Soukup. Petition, 46-65. Ground 3 fails for multiple independent reasons discussed below.

1. Neither Bowen nor Wang Discloses a Layer that Includes Co, Fe and B and is "Entirely Crystallized" (Limitations 1[d], 7[e], and 12[d])

Independent claims 1, 7, and 12 all require first and second ferromagnetic material layers that each includes Co, Fe, and B and is "*entirely crystallized*." Limitations 1[d], 7[e], and 12[d]. The Petition relies on "Bowen in view of Wang" for these limitations, but neither Bowen nor Wang discloses a layer that includes Co, Fe and B and is "entirely crystallized" as claimed.

Bowen does not disclose using boron in a ferromagnetic material at all.

Wang discloses only “amorphous CoFeB” that remains amorphous “even after annealing.” EX1055, 2269-70. An amorphous substance is the opposite of a crystallized substance. EX2060, 44 (defining “amorphous” as “non-crystalline”); EX2061, 24 (defining “amorphous” as “not crystallized”).

Without citing a single prior art reference that discloses a ferromagnetic material layer that includes Co, Fe, and B and is “entirely crystallized,” the Petition seeks to use expert testimony to meet that claim limitation missing from the prior art. Petition, 53-56. Federal Circuit precedent, however, establishes that expert testimony can only be used to supply a limitation missing from the art if “the limitation in question [is] unusually simple and the technology particularly straightforward.” *Arendi S.A.R.L. v. Apple Inc.*, 832 F.3d 1355, 1362 (Fed. Cir. 2016); *see also DSS Tech. Mgmt., Inc. v. Apple Inc.*, 885 F.3d 1367, 1374 (Fed. Cir. 2018) (“we have invoked common sense to fill in a *missing* limitation only when the limitation in question was unusually simple and the technology particularly straightforward.”) (internal quotes and citations omitted). Petitioner did not even attempt to make that requisite showing. The limitation in question recites a ferromagnetic layer that includes boron (“B”) – which was well known to inhibit crystallization (EX1030, [0025]) – yet is “entirely crystallized.” That is the furthest thing from being “unusually simple” and the complex technology at issue in this case is the furthest thing from being “particularly straightforward.” *See e.g.*,

Petition, 8-9 (alleging that a POSA has a very high level of skill); *supra* §IV (the surprising and unexpected results the inventor achieved draw widespread acclaim); EX2063, 77:9-78:3 (Petitioner’s own expert admitted he was not an expert on crystal growing).

The Board routinely denies institution where the petitioner seeks to meet a missing limitation based solely on expert testimony. *See, e.g., Xerox*, IPR2022-00624, Paper 9 at 15; *Apple v. Mullen Indus.*, IPR2023-00087, Paper 10, 19-20 (May 3, 2023) (“*Apple*”); *Microsoft Corp. et al. v. LiTL*, IPR2024-00458, Paper 17, 17-21 (Aug. 23, 2024). The Board should do the same here.

a. Petitioner Relies on Expert Testimony to Supply a Missing Limitation

Because neither Bowen nor Wang discloses a layer that includes Co, Fe and B and is “entirely crystallized” as claimed, the Petition tries to meet this limitation based on a series of arguments purportedly supported only by the naked say-so of Petitioner’s expert.

First, Petitioner alleges that a POSA would have replaced Bowen’s Fe and FeCo electrodes with CoFeB layers and then would have annealed the structure. Petition, 53-54. Even if a POSA had been motivated to replace Bowen’s Fe and FeCo electrodes with CoFeB (which, as explained in §§VI.C.2-3, below, the Petition failed to establish), Petitioner cites no prior art reference to substantiate Petitioner’s assertion that a POSA would have annealed the CoFeB electrodes to

achieve crystallinity – Petitioner relies entirely on the naked say-so of Petitioner’s expert. Bowen does not disclose using CoFeB at all, let alone annealing it. Wang discloses annealing but teaches that its annealing does not crystallize the CoFeB. Wang teaches exactly the opposite, that its CoFeB was “amorphous” “even after annealing.” EX1055, 2269-70.

Petitioner’s assertion that a POSA would have annealed the CoFeB layer in the Bowen-Wang-Soukup combination to induce crystallinity cites testimony from Petitioner’s expert. Petition, 53 (citing EX1024, ¶277). But the cited paragraph of Dr. Bokor’s declaration cites no prior art to support his conclusory assertion that a POSA would have annealed the CoFeB layer to achieve crystallinity. EX1024, ¶277. Such unsupported expert testimony warrants no weight. *Xerox*, Paper 9 at 15. That is all the truer here given Dr. Bokor’s admission that he is **not** an expert on crystal formation. *Supra* §VI.A.2.c; EX2063, 77:19 (“I’m no expert. I’m no crystal grower.”).

Other prior art cited by the Petition explains that boron was introduced into ferromagnetic electrodes of an MTJ precisely because boron inhibited crystallization and resulted in a CoFeB electrode that was amorphous (i.e., **not** crystalline). EX1030, [0025] (boron is added so that “crystallization is inhibited”).

For example, Parkin “include[d] an **amorphous** magnetic layer of Co and at least one additional element selected to make the layer amorphous.” EX1062, 6:24-

26. Parkin's preferred embodiments "are directed to structures using *amorphous* magnetic materials." *Id.*, 9:1-3. And Parkin discloses "an *amorphous* alloy of CoFeB" that "shows high tunneling magnetoresistance of more than 130%." *Id.*, 16:47-50. Parkin discloses that the "bulk" of the storage layer 175 "remains *amorphous*" even after annealing. *Id.*, 18:59-60.

Hosomi also disclosed the benefits of an amorphous CoFeB layer, disclosing that "a ferromagnetic material having an *amorphous* structure ... can realize improvement of the spin polarizability, namely, improvement of the TMR ratio, and lowering the coercive force, i.e., ... the write current." EX1056, [0068].

Hosomi disclosed that amorphous CoFeB was an improvement "as compared to an element having a ferromagnetic layer comprised solely of a crystalline material." *Id.*, [0067].

Thus, the assertion by Petitioner's expert that a POSA would have looked to anneal CoFeB to try to crystallize it is not only unsupported, it is contradicted by the teachings in the art that boron had been introduced into a ferromagnetic electrode specifically so that the resulting CoFeB electrode would be amorphous because that was taught to yield improved TMR.

Second, the Petition argues that an annealing process would have resulted in a layer of CoFeB that was "entirely crystallized" as claimed. Petition, 55. The Petition cites Cardoso (EX1061) and Parkin (EX1062). Cardoso discloses that "X-

ray measurements of bulk CoFe and CoFeB 200 Å thick films ... confirmed that the CoFeB films are not amorphous.” EX1061, 2273. Something being “not amorphous” just means that there is some order to the layer. A layer with a tiny portion thereof that is crystalline is “not amorphous,” but such a layer is not “entirely crystallized” as claimed. Cardoso does not teach a layer that includes Co, Fe and B and is entirely crystallized. Parkin discloses that a “portion” of storage layer 175 was crystallized but that the “bulk” of it “remains amorphous.” EX1062, 18:51-60; *supra* §VI.A.2 (Ground 1). Thus, neither Cardoso nor Parkin supports the Petition’s assertion that annealing would have transformed an amorphous CoFeB layer to be “entirely crystallized” as claimed.

Dr. Bokor’s declaration cites Cardoso, Parkin and Jimbo. EX1024, ¶¶279-280. Cardoso and Parkin do not disclose a CoFeB layer that is “entirely crystallized” for the reasons discussed above. Jimbo discloses “the CoFeB layer is *confirmed to be amorphous* in the as-deposited state and begin[s] to crystallize after annealing.” EX1060, 311. But a layer that “begin[s]” to crystallize is not an “entirely crystallized” layer as claimed. And Dr. Bokor’ ignores the disclosure in Wang that its CoFeB layer remained amorphous even after annealing. EX1055, 2269-70. Dr. Bokor’s unsupported conclusory testimony that a POSA would have reasonably expected that annealing would have resulted in a layer of CoFeB that was “entirely crystallized” warrants no weight under the Board’s precedential

Xerox decision. *Xerox*, Paper 9 at 15; *see also* EX2063, 77:19 (“I’m no expert. I’m no crystal grower.”).

b. Expert Testimony Can Supply a Missing Limitation Only in Rare Circumstances Not Present Here

The Federal Circuit has repeatedly held that for expert testimony to supply a limitation missing from the prior art, “the limitation in question [must be] unusually simple and the technology particularly straightforward.” *Arendi*, 832 F.3d at 1362; *see also* *DSS Tech.*, 885 F.3d at 1374 (“we have invoked common sense to fill in a *missing* limitation only when the limitation in question was unusually simple and the technology particularly straightforward.”) (internal quotes and citations omitted). The Petition does not even attempt to establish either prerequisite.

The issues in this case are the furthest thing from “unusually simple and ... particularly straightforward.” *See, e.g.*, Petition, 8-9 (alleging that a POSA has a very high level of skill); *supra* §IV (the surprising and unexpected results the inventor achieved draw widespread acclaim); EX2063, 77:19 (“I’m no expert. I’m no crystal grower.”).

**c. The Board Routinely Denies Institution Where
Petitioner Fails to Justify Reliance on Expert
Testimony to Supply a Missing Limitation**

The Petition does not even attempt to establish that Petitioner’s reliance on expert testimony to supply a limitation missing from the cited prior art is consistent with Federal Circuit precedent. That is reason enough to deny institution.

Xerox involved a “mobile ticketing system for detecting fraudulent activity” and the claimed method required a step of “stor[ing] in a data record associated with the account a data value indicating the fraudulent activity.” *Xerox*, IPR2022-00624, Paper 9, 6. While the prior art (“Terrell”) taught that “the purchaser of the ticket could be blocked from further use of the system,” the petitioner did not allege that Terrell disclosed storing a data value indicating the fraudulent activity as claimed. *Id.*, 14. Instead, petitioner alleged that POSAs “‘would find it obvious’ that ‘blocking the account of the purchaser’ would includ[e] ‘storing a data value indicating the fraudulent activity in a data record associated with the user account.’” *Id.* But “[p]etitioner’s only evidence in support of its assertion ... [was] the opinion of its Declarant, Dr. Jones.” *Id.*, 15.

In denying institution, the Board not only found that Dr. Jones failed to adequately support his opinions, but that petitioner ran afoul of the principles articulated in the Federal Circuit’s *Arendi* decision. *Id.*, 16. The Board noted that “[p]etitioner has not alleged” that “the limitation in question [is] unusually simple

and the technology particularly straightforward,” “much less provided support for such an allegation.” *Id.* (quoting *Arendi*).

The Board reached a similar result in the more recent *Apple* decision. IPR2023-00087, Paper 10, 19-20. That case involved “systems and methods for determining a device’s location” (*id.*, 3) and the claims required the “device to display indicia of two locations other than its own” (*id.*, 15). The prior art (“Sheha”) disclosed “displaying the location of a caller and a called device on a screen, but [did] not disclose displaying multiple locations of other users.” *Id.*, 17. Petitioner alleged “it would have been obvious to display the locations of second and third devices simultaneously.” *Id.* Petitioner’s only evidence was “the opinion of its Declarant, Mr. Williams.” *Id.*, 17-18.

In addition to finding that Mr. Williams failed to adequately support his opinions (*id.*, 18), the Board found that petitioner ran afoul of the principles articulated in *Arendi*. *Id.*, 19. The Board noted that “[p]etitioner has not alleged” that “the limitation in question [is] unusually simple and the technology particularly straightforward,” “much less provided support for such an allegation” (*id.*, 19-20). The Board denied institution at least in part on that basis. *Id.* (quoting *Arendi*).

Just like the petitioners in *Xerox* and *Apple*, Petitioner did not even allege that the missing claimed limitation of a layer that includes Co, Fe and B and is

“entirely crystallized” is unusually simple or that the claimed technology is particularly straightforward. Neither is true.

Petitioner’s failure to establish that this is one of the rare exceptions to the rule forbidding reliance on expert testimony alone to meet a claim limitation missing from the prior art is reason enough to deny institution.

2. The Petition’s Assertion that a POSA Had Reason to Replace Bowen’s Fe Electrode with CoFeB Is Unsupported

Bowen discloses that its bottom electrode is made of iron (Fe). Petition, 47. The Petition argues that a POSA would have “been motivated to replace Bowen’s first, Fe ferromagnetic material layer with a CoFeB ferromagnetic layer to increase TMR.” *Id.* The Petition’s argument is entirely unsupported.

a. The Petition Failed to Establish that a POSA Would Have Applied Wang’s Teachings to Bowen’s MTJs

Wang’s MTJ and Bowen’s MTJ used dramatically different barrier layers. Wang’s MTJs use an aluminum oxide (“Al₂O₃”) barrier layer (EX1055, 2269-2270), which is “amorphous” (EX1024, ¶65). In contrast, Bowen used an MgO barrier layer, which was crystalline. EX1026, 1655.

The Petition fails to establish that a POSA would have looked to Wang’s teachings regarding MTJs with an amorphous Al₂O₃ barrier layer to improve the TMR of Bowen’s MTJ that had a crystalline MgO barrier layer. Petition, 49-51. The Petition fails to address the dramatically different barrier layers that Wang and

Bowen have. *Id.* The Petition fails to address the art's teaching that it was the interplay between the electrodes and barrier material that determined the TMR, not either component in isolation. *See supra* §VI.A.1.a. The Bokor declaration also fails to address these issues (EX1024, ¶¶247-258) and thus cannot save the Petition.

The failures of the Petition and Dr. Bokor to establish some reason why Wang's disclosures relating to MTJs with an amorphous Al₂O₃ barrier layer allegedly would have motivated a POSA to make any change to Bowen's MTJ with a crystalline MgO barrier layer to improve TMR is particularly glaring given Dr. Bokor's testimony in a related proceeding that teachings related to improving TMR for Al₂O₃ MTJs are "hardly applicable" to MTJs with MgO barrier layers like Bowen. EX2062, 199:23-203:24; *Supra* §VI.A.1.a.

In sum, the Petition fails to establish that a POSA would have looked to Wang to improve the TMR of Bowen's MTJ in the first place given the significant differences between their MTJs and the absence of any evidence that the teachings of Wang would have been applicable to the TMR in Bowen's MTJ.

b. Wang Provides No Support for Substituting CoFeB for an Fe Electrode

The Petition cites Wang (Petition, 47-49), but Wang never tested an MTJ with an Fe electrode. Wang replaced an FeCoNi free electrode with CoFeB and reported an improvement to TMR. EX1055, 2269 ("By changing the free [storage]

layer from NiFeCo to CoFeB, we have increased the TMR value from 42.7% to 60.8%”). Because Wang never compared an Fe electrode with CoFeB, Wang provides no information on how an Fe electrode would perform relative to a CoFeB electrode.

The Petition cites Dr. Bokor’s declaration. Petition 47-48, (citing EX1024 ¶¶253-258). But Dr. Bokor never cites any prior art reference comparing Fe and CoFeB electrodes either. Dr. Bokor never explains any reason why a POSA would have expected a similar increase in TMR when replacing an Fe electrode with CoFeB to what Wang reported from replacing a NiFeCo electrode with a CoFeB electrode. Consequently, Dr. Bokor’s conclusory assertions are entirely unsupported and thus entitled to no weight. *Xerox*, Paper 9 at 15.

The Petition argues that “Wang and others recognized CoFeB was known to increase TMR compared to CoFe alloys.” Petition, 48. But the Petition fails to explain why that would have been relevant to a proposed modification of an Fe electrode, rather than a CoFe electrode. The Petition cites Dr. Bokor’s declaration (Petition, 48, citing EX1024, ¶¶255-258) where Dr. Bokor just cites the same prior art references comparing CoFeB with CoFe, without explaining how or why that would have had any relevance to a purported reason to replace a Fe electrode rather than a CoFe electrode.

The Petition cites *KSR* and argues that replacing Bowen's Fe electrode with CoFeB would have been a "straightforward, predictable, and desirable improvement." But the Petition fails to explain how or why replacing Bowen's Fe electrode with CoFeB would have been straightforward, predictable, or desirable when none of the evidence compares an MTJ with an Fe electrode against one that has a CoFeB electrode. 37 C.F.R. § 42.22(a)(2) (To be considered, the Petition's "content" "must" include a "detailed explanation of the significance of the evidence."). Moreover, as explained *supra* §VI.A.1.c, Wang's disclosure that replacing a CoFe reference electrode with CoFeB resulted in a structure that failed so completely so as not to be able to measure the TMR shows exactly how unpredictable the result was when replacing an electrode material with CoFeB.

In sum, the Petition's argument that a POSA would have replaced Bowen's Fe electrode with CoFeB is unsupported by any credible evidence. Ground 3 fails for this additional reason.

3. The Petition Failed to Establish that a POSA Would Have Replaced Bowen's FeCo Electrode with CoFeB When Wang Disclosed that Such a Modification Failed

Ground 2 alleges that a POSA would have replaced both of Bowen's electrodes with CoFeB. Petition, 46-49, 52-53. In §VI.C.2 above, Patent owner explained why Petitioner failed to establish that a POSA would have replaced Bowen's lower Fe electrode with CoFeB based on Wang. This section explains

why Petitioner also fails to establish that a POSA would have replaced Bowen's upper FeCo electrode with CoFeB based on Wang for the same reasons.

The Petition characterizes Bowen's upper electrode as "CoFe" (Petition, 52) when it is "FeCo" (EX1026, 1655). The Petition argues that a POSA "would be motivated to substitute CoFeB for Bowen's upper CoFe electrode" because "CoFeB increased TMR compared to CoFe." *Id.*, 52-53.

Ground 3 advances no unique analysis to support the assertion that a POSA would have replaced a CoFe (or FeCo) electrode with CoFeB to increase TMR and merely cross-references its arguments from Ground 1. Petition, 53 (citing "*Supra* §VIII.A.2"). Thus, as discussed below, Ground 3 fails for two of the same reasons discussed *supra* §VI.A.1 for Ground 1 because Petitioner fails to establish that Wang would have motivated any modification to an MTJ with an MgO barrier layer (like Bowen) and because Wang taught that using CoFeB for the reference electrode yielded an MTJ that did not work.

a. The Petition Failed to Establish that a POSA Would Have Applied Wang's Teachings to Bowen's MTJs

As discussed *supra* §VI.C.2.a, Bowen uses a crystalline MgO barrier layer whereas Wang uses an amorphous Al₂O₃ barrier layer. Petitioner's own expert, Dr. Bokor, testified in another proceeding that teachings regarding MTJs with an amorphous Al₂O₃ barrier layer are "hardly applicable" to MTJs that had a crystalline MgO barrier layer like Bowen's. EX2062, 199:23-203:24. For the same

reasons discussed *supra* §VI.C.2.a, Petitioner fails to establish that a POSA would have looked to Wang to motivate any change to Bowen's MTJ in an attempt to improve TMR.

b. Wang Replaced an Upper CoFe Electrode with CoFeB and the MTJ Failed to Have a TMR

Wang discloses that replacing its upper CoFe electrode (Wang's reference electrode) with CoFeB resulted in an MTJ with no measurable TMR. *See supra* §VI.A.1.c; EX1055, 2270. Bowen does not say which electrode is its reference electrode but that does not matter because Ground 3's combination replaces both Bowen electrodes, and thus replaces the reference electrode, with CoFeB. Petition, 46-49. The assertion that Wang would have motivated a POSA to make a substitution that yielded an inoperable MTJ (with no TMR) in Wang fails for the same reasons discussed for Ground 1. *See supra* §VI.A.1.c.

4. The Petition Failed to Establish a Reasonable Expectation of Success

The Petition alleges that a POSA would have expected that annealing the CoFeB layer would have yielded an entirely crystalline layer. Petition, 53-56. No evidence supports that. Boron was well known to inhibit crystallization. EX1030, [0025] (boron is added so that "crystallization is inhibited"). The Petition does not cite a single reference teaching a layer that includes boron and is entirely crystallized.

The only prior art Petitioner cites to purportedly support that CoFeB would crystallize is Cardoso (EX1061) and Parkin (EX1062).⁸ Petition, 55. Cardoso only discloses that “X-ray measurements ... confirmed that the CoFeB films are not amorphous.” EX1061, 2273. Something being “not amorphous” just means that there is some order to the layer. A layer with a tiny portion thereof that is crystalline is “not amorphous,” but such a layer is not “entirely crystallized” as claimed. Parkin only discloses that a “portion” of storage layer 175 was crystallized and that the “bulk” of it “remains amorphous.” EX1062, 18:51-60; *supra* §VI.A.2 (Ground 1). Thus, neither Cardoso nor Parkin supports the Petition’s assertion that annealing CoFeB would have yielded a layer that includes Co, Fe and B and is “entirely crystallized” as claimed.

The only prior art that Dr. Bokor cites for the proposition that annealing CoFeB would create an “entirely crystallized” layer of Co, Fe and B is Cardoso, Parkin, and Jimbo. EX1024, ¶¶275-284. None of those references disclose a layer that includes Co, Fe and B and is “entirely crystallized” as claimed. *Supra*

⁸ Petitioner’s nonsensical assertion that PO’s infringement contentions demonstrate obviousness fails. Petition, 55-56. PO will carry its burden to prove infringement in the litigation. Petitioner bears the burden to demonstrate obviousness here and fails to do so.

§VI.C.1.a. Dr. Bokor’s unsupported conclusory testimony warrants no weight. *Xerox*, Paper 9 at 15; *see also* EX2063, 77:19 (“I’m no expert. I’m no crystal grower.”).

Moreover, when the inventor achieved a layer that included Co, Fe and B and was entirely crystallized he received widespread acclaim because this result was so unexpected and surprising. *See supra* §IV.

Demonstrating obviousness requires establishing a reasonable expectation of success. *Medtronic*, 70 F.4th at 345 (Fed. Cir. 2023) (“An obviousness determination ***requires*** finding that a person of ordinary skill in the art would have been motivated to combine or modify the ... prior art and would have had a reasonable expectation of success in doing so.”). The Petition fails to establish that a POSA would have reasonable expected success in achieving any Challenged Claim by modifying Bowen in the manner alleged in Ground 3.

VII. CONCLUSION

For at least the foregoing reasons the Petition fails to show a reasonable likelihood that any Challenged Claim is invalid. The Board should deny institution.

Respectfully submitted,
GODO KAISHA IP BRIDGE I

Date: July 16, 2025

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CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24, the undersigned certifies that the foregoing **PATENT OWNER'S PRELIMINARY RESPONSE** contains 13,975 words excluding; a table of contents, a table of authorities, a certificate of service or word count, or appendix of exhibits or claim listing. Patent Owner has relied on the word count feature of the word processing system used to create this paper in making this certification.

Date: July 16, 2025

/Dara Del Rosario/
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CERTIFICATE OF SERVICE UNDER 37 C.F.R. § 42.6 (e)(4)

I certify that on July 16, 2025, a copy of the foregoing document, including any exhibits filed therewith, is being served via electronic mail, as previously consented to by Petitioner, upon the following:

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