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Paper 58
Date: April 28, 2026

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.

IPR2024-01494
Patent 11,968,909 B2

Before JUSTIN T. ARBES, SHEILA F. McSHANE, and JOHN D. HAMANN, *Administrative Patent Judges*.

ARBES, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining No Challenged Claims Unpatentable
Granting in Part Patent Owner's Motion to Strike
Dismissing Patent Owner's Motion to Exclude
35 U.S.C. § 318(a)

I. INTRODUCTION

A. Background and Summary

Petitioner Western Digital Technologies, Inc., filed a Petition (Paper 1, "Pet.") requesting *inter partes* review of claims 1–20 of U.S. Patent No. 11,968,909 B2 (Ex. 1017, "the '909 patent") pursuant to 35 U.S.C. § 311(a). Patent Owner Godo Kaisha IP Bridge 1 filed with the Office a statutory disclaimer of claims 1–4, 7, and 8 of the '909 patent pursuant to 37 C.F.R. § 1.321(a). *See* Paper 7, 3 n.1, 38–39; Ex. 2018.

On April 30, 2025, the Board instituted an *inter partes* review as to the remaining challenged claims 5, 6, and 9–20 on all grounds of unpatentability asserted with respect to those claims in the Petition. Paper 9 ("Decision on Institution" or "Dec. on Inst."); *see* 37 C.F.R. § 42.107(e) ("No *inter partes* review will be instituted based on disclaimed claims."). Patent Owner then filed a Patent Owner Response (Paper 18, "PO Resp."), Petitioner filed a Reply (Paper 24, "Reply"), and Patent Owner filed a Sur-Reply (Paper 31, "Sur-Reply").

With our authorization provided by email (Ex. 3001), Patent Owner filed a Motion to Strike (Paper 29, "Mot."), to which Petitioner filed an Opposition (Paper 30, "Opp.") and Patent Owner filed a Reply (Paper 33, "Mot. Reply").

Patent Owner also filed a Motion to Exclude (Paper 43, "Mot. to Exclude") certain evidence submitted by Petitioner, to which Petitioner filed an Opposition (Paper 44) and Patent Owner filed a Reply (Paper 45).

An oral hearing was held on January 23, 2026, and a transcript of the hearing is included in the record (Paper 52, "Tr.").

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a). For the reasons that

follow, we determine that Petitioner has not shown, by a preponderance of the evidence, that claims 5, 6, and 9–20 of the '909 patent are unpatentable. We also grant in part Patent Owner's Motion to Strike and dismiss Patent Owner's Motion to Exclude as moot.

B. Related Matters

The parties indicate that the '909 patent is the subject of *Godo Kaisha IP Bridge 1 v. Western Digital Technologies, Inc.*, No. 24-cv-06555 (N.D. Cal.) (transferred from D. Del.) ("the district court case"), and *Godo Kaisha IP Bridge 1 v. Seagate Technology LLC*, No. 24-cv-03691 (D. Minn.) (transferred from D. Del.). *See* Pet. 71; Paper 38, 2. Petitioner filed petitions challenging patents related to the '909 patent in IPR2024-01384 (denied), IPR2024-01385 (denied), IPR2024-01386 (denied), IPR2024-01447 (instituted), IPR2024-01448 (denied), IPR2024-01449 (denied), IPR2024-01493 (instituted), and IPR2025-00701 (denied). Petitioner filed a request for reexamination of the '909 patent on March 29, 2026, which has been assigned Control No. 90/016,097.

C. The '909 Patent

The '909 patent discloses a "magnetic tunnel junction" (MTJ) device with a "high magnetoresistance." Ex. 1017, col. 1, ll. 37–40. The '909 patent describes that "[m]agnetoresistive random access memories (MRAMs) refer to a large-scale integrated memory circuit that is expected to replace the currently widely used [dynamic random-access memory (DRAM)] memories." *Id.* at col. 1, ll. 44–47. The patent further explains that an "MTJ device comprises a tunnelling junction structure in which a tunnel barrier (to be hereafter also referred to as a 'barrier layer') made of an

oxide is sandwiched between a first and a second electrode made of a ferromagnetic metal." *Id.* at col. 1, ll. 54–58, Figs. 8(A), 8(B). Objectives of the patent are to "increase the output voltage of a[n] MTJ device" and "provide a memory device with a high magnetoresistance for stable operation." *Id.* at col. 3, ll. 1–4.

Figure 1(B) of the '909 patent is reproduced below.

FIG. 1 (B)

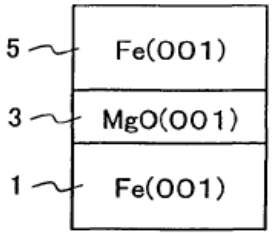

Figure 1(B) depicts the MTJ device comprising "a first Fe (001) layer 1, a second Fe (001) layer 5, and a single-crystalline MgOx (001) layer 3 or a poly-crystalline MgOx (0<x<l) layer 3 sandwiched therebetween, the polycrystalline layer having the (001) crystal plane preferentially oriented therein." Ex. 1017, col. 5, ll. 47–49, 51–57. Further, the patent explains, "[w]hen there are oxygen vacancy defects, the potential barrier height of the MgO tunnel barrier is thought to decrease (such as in the range of 0.10 to 0.85 eV; more specifically, 0.2 to 0.5 eV), which is thought to result in an increase in the tunneling current." *Id.* at col. 7, ll. 19–23. "Using the method according to the present embodiment of the invention, a tunnel barrier height of approximately 0.3 eV is expected, indicating that the resistance of the tunnel barrier can be lowered."[1] *Id.* at col. 7, ll. 28–31.

[1] Petitioner explains that "MTJ behavior is explained by quantum mechanics" and for an MTJ device, "the tunnel barrier height represents the difference between the bottom of the conduction band of the tunnel barrier

The ’909 patent notes that the “aforementioned tunnel barrier height ϕ was determined by fitting the electric conductance characteristics of the MTJ device (the relationship between tunnel current density J and bias voltage V) onto the Simmons’ formula . . . based on the WKB approximation, using the least squares method.” *Id.* at col. 7, ll. 39–45.

D. Illustrative Claims

Challenged claims 9 and 15 of the ’909 patent are independent. Claims 5 and 6 depend from disclaimed claim 1, claims 10–14 depend from claim 9, and claims 16–20 depend from claim 15. Claims 1, 5, and 6 recite the following (with letter designations used in the Petition to refer to the various limitations):

> 1. [pre] A magnetoresistive device comprising a magnetic tunnel junction structure comprising a multi-layer material stack including:
>
> [a] first and second ferromagnetic material layer; and
>
> [b] a tunnel barrier layer between the first and second ferromagnetic material layers such that the tunnel barrier layer is above the first ferromagnetic material layer and below the second ferromagnetic material layer,
>
> [c] wherein said tunnel barrier layer comprises crystalline MgO_x (001) with oxygen vacancy defects and ($0<x<1$).
>
> 5. The magnetoresistive device of claim 1, wherein a barrier height of the tunnel barrier layer is in a range of 0.1 eV to 0.85 eV.

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layer and the Fermi level of electrons in the conductor,” where “[e]lectrons that lie close to the Fermi level participate in tunneling.” Pet. 7–9 (citing Ex. 1024 ¶¶ 45–49); *see* Ex. 1017, col. 3, l. 62–col. 4, l. 8; Ex. 2053 ¶¶ 45, 148 (explaining that the tunnel barrier height depends on, for example, the choice of material for the layers of the MTJ and the processes used to make them).

> 6. The magnetoresistive device of claim 5, wherein the barrier height of the tunnel barrier layer is in a range of 0.2 eV to 0.5 eV.

E. Evidence

The pending grounds of unpatentability in the instant *inter partes* review are based on the following prior art:

> European Patent Application Publication No. EP1391942A1, published Feb. 25, 2004 (Ex. 1027, "Nagahama");
>
> M. Bowen *et al.*, *Large Magnetoresistance in Fe/MgO/FeCo(001) Epitaxial Tunnel Junctions on GaAs(001)*, 79 Appl. Phys. Letters 1655–1657 (2001) (Ex. 1026, "Bowen"); and
>
> R. J. Soukup & D. E. Speliotis, *Voltage-Current Characteristics for Electrical Conduction Through Thin MgO Films*, 41 J. Appl. Phys. 3229–3236 (1970) (Ex. 1028, "Soukup").

Petitioner filed declarations from Jeffrey Bokor, Ph.D. (Exs. 1024, 1105) with its Petition and Reply. Patent Owner filed declarations from Caroline A. Ross, Ph.D. (Exs. 2053, 2087) with its Response and Sur-Reply.[2] Also submitted as evidence are transcripts of depositions of Dr. Bokor (Exs. 2013, 2014, 2085, 2086) and Dr. Ross (Exs. 1102, 1107) in this proceeding and in related IPR2024-01447 and IPR2024-01493.

[2] The parties agreed and jointly requested that (1) Patent Owner be permitted to file a declaration from Dr. Ross with its Sur-Reply and (2) Petitioner be permitted to cross-examine Dr. Ross and file observations on cross-examination. Ex. 3001. We granted the parties' request. *Id.*; *see* Exs. 2087 (declaration), 1107 (deposition transcript); Paper 41 (observations).

F. Asserted Grounds

Petitioner asserts that claims 5, 6, and 9–20 of the '909 patent would have been obvious on the basis of prior art printed publications under 35 U.S.C. § 103(a):[3]

Claims Challenged	35 U.S.C. §	References/Basis
5, 6, 9–20	103(a)	Bowen, Soukup
5, 6, 9–20	103(a)	Nagahama, Soukup

II. ANALYSIS

A. Level of Ordinary Skill in the Art

In determining the level of ordinary skill in the art for a challenged patent, we look to "1) the types of problems encountered in the art; 2) the prior art solutions to those problems; 3) the rapidity with which innovations are made; 4) the sophistication of the technology; and 5) the educational level of active workers in the field." *Ruiz v. A.B. Chance Co.*, 234 F.3d 654, 666–67 (Fed. Cir. 2000). "Not all such factors may be present in every case, and one or more of them may predominate." *Id.* at 667.

[3] The Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) ("AIA"), amended 35 U.S.C. § 103. Because the challenged claims of the '909 patent have an effective filing date before the effective date of the applicable AIA amendment, we refer to the pre-AIA version of 35 U.S.C. § 103. *See* Pet. 16; Ex. 1017, codes (22), (63). Also, Petitioner asserted in the Petition that claims 1–4, 7, and 8 would have been obvious over various combinations of references, and Patent Owner subsequently disclaimed claims 1–4, 7, and 8. *See* Pet. 16; Ex. 2018; *supra* Section I.A. Accordingly, we consider only the grounds asserted with respect to claims 5, 6, and 9–20.

Petitioner argues that at the time of the '909 patent (2004), a person of ordinary skill in the art would have had "a Ph.D. in electrical engineering, physics, materials science, or a related field, and at least one year of experience in the research, design, and/or development of magnetic/spintronic devices, or the equivalent," or "a Master's degree in electrical engineering, physics, materials science, or a related field, and four years of experience in the research, design, and/or development of magnetic/spintronic devices, or the equivalent," where "[l]ess work experience may be compensated by a higher level of relevant education, and vice versa." Pet. 18–19. In the Decision on Institution, we agreed with and applied Petitioner's proposed definition. Dec. on Inst. 9. Patent Owner does not propose a different level of ordinary skill in the art in its Response. Both experts utilized Petitioner's proposed definition. *See* Ex. 1024 ¶ 25; Ex. 2053 ¶¶ 29–30. Based on the full record developed during trial, including our review of the '909 patent and the types of problems and solutions described in the '909 patent and cited prior art, we maintain the previously adopted definition of the level of ordinary skill in the art and apply it for purposes of this Decision.

B. Claim Interpretation

We interpret the claims of the challenged patent

> using the same claim construction standard that would be used to construe the [claims] in a civil action under 35 U.S.C. 282(b), including construing the [claims] in accordance with the ordinary and customary meaning of such [claims] as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.

37 C.F.R. § 42.100(b). Petitioner argues that "the claim terms should be given their plain and ordinary meaning and no claim construction is necessary." Pet. 15. We did not interpret any terms in the Decision on Institution. Dec. on Inst. 9–10. Patent Owner does not propose interpretations of any claim terms in its Response. We conclude, based on the full trial record, that no term requires express interpretation to determine whether Petitioner has met its burden to prove unpatentability of the challenged claims. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) ("Because we need only construe terms 'that are in controversy, and *only to the extent necessary* to resolve the controversy,' we need not construe [a particular claim limitation] where the construction is not 'material to the . . . dispute.'" (emphasis added) (citation omitted)).

C. Legal Standards

To prevail in its challenge to the patentability of claims 5, 6, and 9–20 of the '909 patent, Petitioner must demonstrate that the claims are unpatentable by a preponderance of the evidence. 35 U.S.C. § 316(e). "In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable." *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016). This burden of persuasion never shifts to the patent owner. *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015); *see also In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1376 (Fed. Cir. 2016) ("Where, as here, the only question presented is whether due consideration of the four *Graham* factors renders a claim or claims obvious, no burden shifts from the patent challenger to the patentee.").

A claim is unpatentable for obviousness if, to one of ordinary skill in the pertinent art, "the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007) (quoting 35 U.S.C. § 103(a)). The question of obviousness is resolved on the basis of underlying factual determinations, including "the scope and content of the prior art"; "differences between the prior art and the claims at issue"; and "the level of ordinary skill in the pertinent art." *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). Additionally, objective indicia of nonobviousness, such as "commercial success, long felt but unsolved needs, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented. As indicia of obviousness or nonobviousness, these inquiries may have relevancy." *Id.* When conducting an obviousness analysis, we consider a prior art reference "not only for what it expressly teaches, but also for what it fairly suggests." *Bradium Techs. LLC v. Iancu*, 923 F.3d 1032, 1049 (Fed. Cir. 2019).

A patent claim "is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art." *KSR*, 550 U.S. at 418. An obviousness determination based on a combination of references requires finding "both 'that a skilled artisan would have been motivated to combine the teachings of the prior art references to achieve the claimed invention, and that the skilled artisan would have had a reasonable expectation of success in doing so.'" *Intelligent Bio-Sys., Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1367–68 (Fed. Cir. 2016) (quoting *Kinetic Concepts, Inc. v. Smith & Nephew, Inc.*, 688 F.3d 1342, 1360 (Fed. Cir. 2012)); *see KSR*, 550 U.S. at 418 (for an obviousness analysis, "it can be

important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does").

"Although the *KSR* test is flexible, the Board 'must still be careful not to allow hindsight reconstruction of references . . . without any explanation as to *how* or *why* the references would be combined to produce the claimed invention.'" *TriVascular, Inc. v. Samuels*, 812 F.3d 1056, 1066 (Fed. Cir. 2016) (quoting *Kinetic Concepts*, 688 F.3d at 1368) (alteration in original). Further, an assertion of obviousness "cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *KSR*, 550 U.S. at 418 (quoting *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)); *accord In re NuVasive, Inc.*, 842 F.3d 1376, 1383 (Fed. Cir. 2016) (stating that "conclusory statements" amount to an "insufficient articulation[] of motivation to combine"; "instead, the finding must be supported by a 'reasoned explanation'" (quoting *In re Lee*, 277 F.3d 1338, 1342 (Fed. Cir. 2002))); *Magnum Oil*, 829 F.3d at 1380 ("To satisfy its burden of proving obviousness, a petitioner cannot employ mere conclusory statements. The petitioner must instead articulate specific reasoning, based on evidence of record, to support the legal conclusion of obviousness.").

D. Obviousness Ground Based on Bowen and Soukup

1. Bowen

Bowen discloses that the "magnetoresistance of magnetic tunnel junctions (MTJs) is of uncontested interest for important applications with, in particular, promising perspectives for the fabrication of nonvolatile

memories (Magnetic RAM)." Ex. 1026, 1655 (footnote omitted). Bowen "present[s] tunneling experiments on Fe(001)/MgO(20 Å)/FeCo(001) single-crystal epitaxial junctions of high quality grown by sputtering and laser ablation." *Id.*

Bowen discloses that "numerical calculations of spin-dependent tunneling and [tunnel magnetoresistance ratio (TMR)] have been developed for single crystal MTJs such as $Co/Al_2O_3/Co(100)$, Fe/ZnSe(100), or Fe/MgO(100)," and that "a correct depiction of the spin-dependent tunneling properties of epitaxial MTJs must transcend the simple potential barrier image and take into account the interplay of electronic structure between metal and insulator." Ex. 1026, 1655 (footnotes omitted). Bowen describes that "much work has been expended to characterize the growth and electrical behavior of ultrathin MgO layers," and presents "experimental results showing large TMR values in Fe(001)/MgO(001)/FeCo(001) epitaxial tunnel junctions." *Id.*

Tests were performed on single-crystal epitaxially grown structures in a Fe(001)/MgO(001)/FeCo(001) tunnel junction. Ex. 1026, 1655. With a barrier layer of 20 Å thickness, Bowen determined a barrier height of 0.9 eV, and calculated a barrier height using "Simmons' equations" of 1.1 eV for a barrier thickness of 15 Å. *Id*. at 1656.

2. Soukup

Soukup is an article published in 1970 titled "Voltage-Current Characteristics for Electrical Conduction Through Thin MgO Films." Ex. 1028, 3229. Soukup addresses the "voltage-current characteristics of Au-MgO-Au thin-film emission diodes formed by electron beam evaporation of Au and MgO." *Id.* Soukup describes that the

"voltage-current characteristics" of these diodes "are consistent with an expression derived for Schottky field emission into the conduction band of the oxide," but test results "indicate a potential barrier height of about 0.72 eV when determined from the zero-field intercept of the straight line log$I$ vs $V^{1/2}$ plot and about 0.33 eV when obtained from an Arrhenius plot." *Id.* Soukup's measurements were based on "samples . . . fabricated by evaporation of the Au and MgO to form films on a glass substrate." *Id.* at 3229–3230. Soukup states that "[t]he apparent barrier height determined from the zero-field intercept went up for increasing oxygen pressure and the barrier height determined from the Arrhenius plot went down." *Id*. at 3229.

3. Claim 5

a) Scope of Petitioner's Unpatentability Arguments

An important issue we must first decide is the scope of Petitioner's unpatentability arguments. Patent Owner moves to strike portions of Petitioner's Reply and related evidence as allegedly presenting a new theory of unpatentability—namely, a different theory from that presented in the Petition as to why a person of ordinary skill in the art would have been motivated to lower Bowen's barrier height to be within the range recited in claim 5. Mot. 1, 3.

We begin by summarizing Petitioner's arguments in the Petition, then compare them to what Petitioner argues in the Reply. For the reasons explained below, we agree with Patent Owner that Petitioner raises an improper new theory of unpatentability in its Reply and, therefore, is limited to the positions it originally took in the Petition.

(1) Petitioner's Arguments in the Petition

(a) Claim Limitations

Regarding parent claim 1 (which has been disclaimed), Petitioner contends that Bowen teaches an MTJ device having a "first and second ferromagnetic material layer" (i.e., the "Fe bottom electrode" and "FeCo top electrode") and a "tunnel barrier layer" (i.e., the "MgO barrier" layer) between the first ferromagnetic material layer and second ferromagnetic material layer. Pet. 19–23. With respect to the limitation that "said tunnel barrier layer comprises crystalline MgO_x (001) with oxygen vacancy defects and (0<x<1)," Petitioner argues that Bowen teaches "single-crystalline MgO_x (001) where 0<x<1, a mathematical notation indicating less than a one-to-one stoichiometric ratio of oxygen to magnesium (i.e., oxygen vacancy defects) in the MgO layer." *Id.* at 23. Petitioner further contends that "MgO with oxygen vacancy defects was inherently MgO_x where 0<x<1 because x has to be greater than 0 to constitute MgO and less than 1 to constitute nonstoichiometric MgO with oxygen vacancies." *Id.* at 23–24. And Petitioner asserts that Bowen attributed its 0.9 eV barrier height to "oxygen vacancy defects (stoichiometric inhomogeneities) in the MgO barrier." *Id.* at 23 (citing Ex. 1026, 1656). Petitioner "[a]lternatively" relies on Soukup, arguing that a person of ordinary skill in the art "would have understood that Bowen's and/or Soukup's stoichiometric inhomogeneities in the MgO barrier referred to oxygen vacancy defects in the MgO crystal" and "would also have been motivated to apply Soukup's teachings about oxygen vacancy defects to Bowen's MgO MTJ to improve tunneling current, increase TMR, and enhance MRAM performance for the same reasons as explained" for claim 5. *Id.* at 24–25 (emphasis omitted).

Claim 5 depends from claim 1 and recites that "a barrier height of the tunnel barrier layer is in a range of 0.1 eV to 0.85 eV." Petitioner argues that Bowen teaches a barrier height of 0.9 eV for its MgO barrier device and Soukup teaches a barrier height of "about 0.33 eV" as well as an "inverse relationship" where "a higher level of oxygen vacancy defects lower[s] the barrier height." Pet. 33–35 (emphasis omitted) (citing Ex. 1024 ¶¶ 167–168; Ex. 1026, 1656; Ex. 1028, 3229, 3231–3232, Fig. 5, Table I).

(b) Motivation to Combine

Petitioner contends that a person of ordinary skill in the art "would have been motivated to apply Soukup's teachings about an MgO thin-film barrier with a 'barrier height' of 'about 0.33 eV' to Bowen's MgO barrier" because, "[a]ccording to the equation for TMR,[4] lowering the resistance (barrier height) for parallel electrons (R_p) *would improve TMR*." Pet. 34 (emphasis added) (citing Ex. 1017, col. 5, ll. 10–16; Ex. 1024 ¶ 169; Ex. 1027 ¶ 2; Ex. 1035 ("Moodera"),[5] 3273). Petitioner contends that "TMR was an 'important parameter' for improving MRAM performance," and skilled artisans, including the authors of Bowen, "had long been interested in increasing TMR to enable better performing MRAM." *Id*. (citing Ex. 1024 ¶ 170; Ex. 1026, 1655; Ex. 1055, 2269, 2271).

[4] A mathematical equation for TMR is "*ΔR/Rp=(Rap-Rp)/Rp*," where *Rap* is the antiparallel resistance and *Rp* is the parallel resistance in an MRAM. *See* Ex. 1017, col. 5, ll. 8–16; Pet. 5–6.

[5] J.S. Moodera *et al.*, *Large Magnetoresistance at Room Temperature in Ferromagnetic Thin Film Tunnel Junctions*, 74 Phys. Rev. Lett. 3273–3276 (Apr. 17, 1995) (Ex. 1035).

Petitioner further argues that "Butler[6] and Mathon[7] taught that MgO barriers would achieve higher TMRs due to improved symmetry matching between the MgO barrier and ferromagnetic electrodes, facilitating tunneling of parallel electrons across the barrier compared to antiparallel tunneling." Pet. 34 (citing Ex. 1024 ¶ 170; Ex. 1044, 1; Ex. 1046, 1). Petitioner contends that an ordinarily skilled artisan "looking to increase TMR of an MgO barrier would have been motivated to explore lower barrier heights to facilitate tunneling of parallel electrons," so one "seeking to improve Bowen's MgO MTJ would have looked to Soukup's teachings about MgO barriers and how defects lowered the barrier height." *Id*. at 34–35 (citing Ex. 1024 ¶ 171) (emphasis added).

Petitioner makes two additional arguments. First, Petitioner asserts that the claimed barrier height range of 0.1–0.85 eV "would have been obvious" because the range is "only slightly below" Bowen's 0.9 eV barrier height and a person of ordinary skill in the art would have understood, based on Soukup, that "oxygen vacancy defects impacted the barrier height." Pet. 35–36 (citing Ex. 1024 ¶¶ 173–174; Ex. 1026, 1656; Ex. 1028, 3232, 3236; Ex. 1038, 4725–4726). Therefore, according to Petitioner, "one of skill would have been motivated to adjust oxygen vacancy defects to *improve TMR by lowering the barrier height* as taught by Soukup." *Id*. at 36 (emphasis added).

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[6] W.H. Butler *et al.*, *Spin-Dependent Tunneling Conductance of Fe/MgO/Fe Sandwiches*, Phys. Rev. B, Vol. 63, 054416 (2001) (Ex. 1044).

[7] J. Mathon & A. Umerski, *Theory of Tunneling Magnetoresistance of an Epitaxial Fe/MgO/Fe(001) Junction*, Phys. Rev. B, Vol. 63, 220403(R) (2001) (Ex. 1046).

Second, Petitioner argues that "the tunnel barrier height limitation [of claim 5] is inherent when there are oxygen vacancy defects as disclosed by both Bowen and Soukup." Pet. 36 (citing Ex. 1026, 1656; Ex. 1028, 3232, 3236). As support for that contention, Petitioner cites the disclosure in the '909 patent that "[w]hen there are oxygen vacancy defects, the potential barrier height of the MgO tunnel barrier is thought to decrease (such as in the range of 0.10 to 0.85 eV . . .), which is thought to result in an increase in the tunneling current." *Id.* (quoting Ex. 1017, col. 7, ll. 19–22). Petitioner further contends that Patent Owner asserted in the district court case that "the similar requirement 'tunnel barrier height in a range of 0.2 to 0.5 eV' is satisfied by the mere 'presence of oxygen vacancy defects.'" *Id*. (citing Ex. 1064, 19 (citing Ex. 1001, col. 6, l. 47–col. 7, l. 2)).

Petitioner's primary theory in the Petition, therefore, was that a person of ordinary skill in the art would have been motivated to lower Bowen's barrier height (by introducing oxygen defects) because doing so would "improve" (i.e., increase) TMR, which was a known goal in the art. *See, e.g.*, Pet. 24–25 (arguing that "[o]ne of skill would . . . have been motivated to apply Soukup's teachings about oxygen vacancy defects to Bowen's MgO MTJ to . . . increase TMR"), 34 (arguing that lowering the barrier height "would improve TMR"), 36 (arguing that "one of skill would have been motivated to adjust oxygen vacancy defects to improve TMR by lowering the barrier height"). And we instituted an *inter partes* review on that basis. *See* Dec. on Inst. 18 ("At this stage, Petitioner has provided sufficient support for its contention that a person of ordinary skill in the art would have been motivated to lower the 0.9 eV barrier height of Bowen's device, which would lower R_p and in turn increase the TMR.").

(2) Patent Owner's Response

Patent Owner argues in its Response that no evidence supports Petitioner's contention that a person of ordinary skill in the art would have expected lowering the barrier height to increase TMR, and Petitioner's expert, Dr. Bokor, not only "refused to defend that assertion" during cross-examination, but testified that an ordinarily skilled artisan "would not have known whether reducing the barrier height would have increased TMR, decreased TMR or had no effect on TMR." PO Resp. 1–3, 34–37; *see infra* Section II.D.3.b.(1) (addressing Dr. Bokor's testimony on the merits).

(3) Petitioner's New Motivation Theory in the Reply

Petitioner offers a new theory in its Reply that a person of ordinary skill in the art would have expected that "TMR would change" when lowering the barrier height but it would be "uncertain" whether TMR would increase or decrease, which is a "legally sufficient motivation." *See* Reply 7–10; Mot. 3. In support of the alleged sufficient motivation, Petitioner cites Dr. Bokor's testimony that one would not be "certain which way it would go" and that there would be a "50/50 chance . . . to get the improvement that I'm looking for." Reply 7–10, 14, 24 (citing Ex. 2013, 50:9–51:5, 154:1–8, 188:11–189:6; Ex. 2014, 216:15–17). In making these arguments, Petitioner does not point to anywhere in the Petition where it argued that lowering the barrier height would have an uncertain impact on TMR or that such a fact would be a legally sufficient motivation to modify Bowen. *See id.* Indeed, the word "uncertain" does not appear in the Petition.

Petitioner also makes various arguments pertaining to Butler in support of its new theory. Petitioner contends that "Butler's predictions

about the behavior of parallel and antiparallel electrons crossing MgO rendered barrier height an identified and predictable (if *uncertain*) strategy to increase TMR." Reply 7, 24 (emphasis added). Petitioner also argues that "Butler provides data leading one of skill to conclude that lowering barrier height *would change TMR*." *Id.* at 14 (emphasis added). Figures 3 and 4 of Butler, according to Petitioner, show "the relationship between majority- and minority-spin-densities of states and the Fermi level and thus the potential impact of changing that level (by, for example, introducing oxygen defects)," so "an ordinarily skilled artisan of course *would have expected TMR to change* by introducing oxygen defects to adjust barrier height." *Id.* at 15–16 (emphasis added).

Again, Petitioner's position in the Reply is that a person of ordinary skill in the art would have expected TMR to change based on lowering the barrier height, not that it would be expected to increase, as argued in the Petition. *See* Reply 14–16. Petitioner does not cite anywhere in the Petition where it took that position. Petitioner instead relies on new evidence—namely, disclosures in Butler that were not cited in the Petition and Dr. Bokor's cross-examination testimony and reply declaration. *See id.* at 7–8, 14–16, 23–24 (citing Ex. 1044, 2–4, Figs. 3–4; Ex. 1105 ¶¶ 10–12; Exs. 2013, 2014). The Petition did not cite Butler in support of the argument that lowering the barrier height would increase TMR. *See* Pet. 34 (citing Moodera, Nagahama, Dr. Bokor's original declaration, and the '909 patent). The Petition only cited the first page of Butler for a different proposition: that Butler (and Mathon) teach that "MgO barriers would achieve higher TMRs due to improved symmetry matching between the MgO barrier and ferromagnetic tunneling of parallel electrons across the barrier compared to antiparallel tunneling." *Id.* (citing Ex. 1044, 1). As Patent Owner points

out, however, Butler's "symmetry matching" disclosure is unrelated to barrier height. *See* Mot. 5–6; Mot. Reply 3 (explaining how "Butler's Petition-cited teaching that MgO's 'symmetry matching' would increase parallel [versus] antiparallel tunneling" is a different argument than "the Reply's allegation that Butler said moving the Fermi level might . . . also achieve that result" (emphasis omitted)). The "symmetry matching" description in the Petition also differs substantively from Petitioner's contention in the Reply pertaining to "the relationship between majority- and minority-spin-densities of states and the Fermi level." *See* Pet. 34; Reply 15–16.

Pursuant to 37 C.F.R. § 42.23(b), "[a] reply may only respond to arguments raised in the corresponding . . . patent owner response." "'Respond,' in the context of 37 C.F.R. § 42.23(b), does not mean proceed in a new direction with a new approach as compared to the positions taken in a prior filing." Patent Trial and Appeal Board Trial Practice Guide § II.I, *available at* https://www.uspto.gov/patents/ptab/trial-practice-guide (last updated Dec. 12, 2025). "While replies . . . can help crystalize issues for decision, a reply . . . that raises a new issue or belatedly presents evidence may not be considered." *Id.* An indication that a new issue is improperly raised in a reply is where a petitioner submits "new evidence necessary to make out a *prima facie* case" of unpatentability, such as a "newly raised rationale to combine the prior art references that was not expressed in the petition." *Id.*

That is the case here. Petitioner's rationale in the Petition for why a person of ordinary skill in the art would have been motivated to lower Bowen's 0.9 eV barrier height to 0.33 eV based on Soukup was that such an artisan would have expected lowering the barrier height to increase TMR.

See Pet. 34–36. Faced with Dr. Bokor's testimony on cross-examination, Petitioner presents a new theory in its Reply that a person of ordinary skill in the art would *not* have known what impact lowering the barrier height would have (increase TMR, decrease it, or have no impact at all), but would have expected it to change in some "uncertain" way, which is a "legally sufficient motivation" in Petitioner's view. *See* Reply 6–10, 13–16, 23–25. In other words, "[r]ather than explaining how its original" position that lowering barrier height would increase TMR "was correct," Petitioner articulated "an entirely new theory . . . absent from the [P]etition" after Patent Owner cross-examined Dr. Bokor and "pointed out the flaws of [Petitioner's] position" in its Response. *See Wasica Finance GmbH v. Continental Auto. Sys., Inc.*, 853 F.3d 1272, 1286 (Fed. Cir. 2017). "Shifting arguments in this fashion is foreclosed by statute, [Federal Circuit] precedent, and Board guidelines." *Id.*

A similar situation occurred in *Intelligent Bio-Systems*, 821 F.3d at 1369, where the petitioner relied on a secondary reference, Zavgorodny, in arguing for a modification to either of two primary references, Tsien and Ju. After the patent owner argued in its response that "an ordinary artisan would not have considered Zavgorodny's conditions suitably mild for Tsien's sequencing purposes," the petitioner in its reply "argued, for the first time, 'that an ordinary artisan would have considered it obvious to use deprotecting conditions other than those described in Zavgorodny,'" relying on new evidence, including a reply expert declaration. *Id.* (emphasis omitted). The Court found that the Board did not err in refusing to consider the reply and new evidence because the petitioner "relied on an entirely new rationale to explain why one of skill in the art would have been motivated to combine Tsien or Ju with a modification of Zavgorodny." *Id.* at 1370.

Petitioner here similarly relies on an entirely new rationale, and new evidence, for why a person of ordinary skill in the art would have been motivated to lower Bowen's barrier height. *See also Henny Penny Corp. v. Frymaster LLC*, 938 F.3d 1324, 1330–31 (Fed. Cir. 2019) ("[A]n IPR petitioner may not raise in reply 'an entirely new rationale' for why a claim would have been obvious.").

Petitioner's arguments to the contrary are not persuasive. Petitioner asserts that it presents the same theory in the Petition and Reply, which is that a person of ordinary skill in the art would have been motivated to "explore" lower barrier heights to increase TMR. Opp. 2–5. Petitioner points to the following sentence in its Petition as support: "One of skill in the art looking to increase TMR of an MgO barrier would have been motivated to explore lower barrier heights to facilitate tunneling of parallel electrons." *Id.* at 2–3 (quoting Pet. 34–35); Reply 6, 8–9, 13 (same); *see* Ex. 1024 ¶ 171 (similar testimony from Dr. Bokor in his original declaration that "[t]o increase TMR of an MgO barrier, skilled artisans would have been motivated to explore lower barrier heights to facilitate tunneling of parallel electrons"). Petitioner, however, ignores that the reason asserted for *why* one of ordinary skill in the art allegedly would have been motivated to explore lower barrier heights changed. In the Petition, Petitioner argued that it is because one would expect lowering the barrier height to increase TMR, whereas in the Reply, Petitioner contends that doing so would have an "uncertain" impact on TMR, which is a "legally sufficient motivation." *Compare* Pet. 34–36, *with* Reply 7–10. The single "explore" sentence in the Petition, therefore, does not identify, with sufficient particularity, Petitioner's later arguments in the Reply regarding an "uncertain" impact on TMR.

We also note that the "explore" sentence in the Petition only states that one would have been motivated to explore lower barrier heights to "facilitate tunneling of parallel electrons." *See* Pet. 34–35; Ex. 1024 ¶ 171. Tunneling conductance is inversely related to resistance. *See* Ex. 2053 ¶ 33. Thus, the assertion that lowering the barrier height would increase tunneling of parallel electrons is merely a restatement of Petitioner's theory in the Petition that lowering the barrier height would lower "the resistance (barrier height) for parallel electrons (R_p)" and "improve TMR." *See* Mot. Reply 1–2; Pet. 34.

Petitioner also contends that its Reply arguments regarding Butler, and Dr. Bokor's reply declaration, are properly responsive to Dr. Ross's declaration filed with the Response, in particular her testimony that "Butler's model predicts nothing about the effect of lowering the barrier height on TMR" and "Butler does not provide any data for any structure other than the ones the authors modeled and a [person of ordinary skill in the art] would not have drawn any conclusions beyond those reached by Butler." Opp. 4–5 (emphasis omitted) (quoting Ex. 2053 ¶¶ 92, 96; citing Reply 5–10; Ex. 1105 ¶¶ 7–12). Likewise, Petitioner asserts that Dr. Bokor cites Giordano[8] to respond to allegedly "inaccurate statements" made by Dr. Ross. *Id.* at 8. Petitioner states that "the introduction of new evidence in the course of the trial is to be expected in IPR trial proceedings" and "[p]arties are not barred from elaborating on their arguments on issues previously raised." *Id.* at 5, 7–8 (quoting *Rembrandt Diagnostics, LP v.*

[8] L. Giordano *et al.*, *Characteristics of Pd Adsorption on the MgO(100) Surface: Role of Oxygen Vacancies*, Phys. Rev. B, Vol. 64, 075417 (2001) (Ex. 1106).

Alere, Inc., 76 F.4th 1376, 1384 (Fed. Cir. 2023); *Apple Inc. v. Andrea Elecs. Corp.*, 949 F.3d 697, 706 (Fed. Cir. 2020)).

Even if Petitioner's arguments and new evidence could be considered responsive to statements in Dr. Ross's declaration, though, they cannot be part of a new theory of unpatentability. The Federal Circuit has explained that

> [t]he [Administrative Procedure Act], the IPR statute, the Board's regulations, and [Federal Circuit] precedents collectively impose two separate, but related, restrictions on what a petitioner may include in its reply. First, the arguments and evidence in the reply must not be part of a *new* theory of unpatentability. Second, the arguments and evidence in the reply must be *responsive* to the patent owner's contentions or the Board's institution decision.
>
> The "newness" restriction prohibits the petitioner from raising, in reply, "an entirely new theory of *prima facie* obviousness absent from the petition," *even if the new theory is responsive to the patent owner's response or the Board's institution decision*. . . . Determining whether a reply has improperly raised a new theory or argument requires a comparison between the petitioner's petition and the petitioner's reply.

Corephotonics, Ltd. v. Apple Inc., 84 F.4th 990, 1008 (Fed. Cir. 2023) (fourth emphasis added). Certainly, the fact that Petitioner relies on new evidence, such as portions of Butler not discussed in the Petition, does not alone demonstrate that Petitioner is improperly relying on a new theory of unpatentability. Patent Owner's explanation comparing the Petition to the Reply, though, persuasively shows that Petitioner's theory changed and that Petitioner's Reply arguments are not merely elaborating on arguments previously made. *See* Mot. 3–7; Mot. Reply 1–4; *Ariosa Diagnostics v. Verinata Health, Inc.*, 805 F.3d 1359, 1367 (Fed. Cir. 2015) (holding that a petitioner relying "on previously unidentified portions of a prior-art

reference to make a meaningfully distinct contention" impermissibly raised a new theory of unpatentability).

Next, regarding the discussion of "uncertain" TMR change in the Reply, Petitioner argues that Patent Owner "does not explain how Dr. Bokor's testimony about something one of skill could not predict amounts to a new obviousness theory." Opp. 6–7. Again, Petitioner never argued in the Petition that a person of ordinary skill in the art could not have predicted what impact lowering the barrier height would have on TMR. Instead, Petitioner expressly took the position that lowering the barrier height "would improve TMR." *See* Pet. 24–25, 34, 36.

Finally, Petitioner argues that because Patent Owner was permitted to submit an expert declaration with its Sur-Reply, Patent Owner "has now had a full and fair opportunity to respond to Petitioner's arguments" and the motion to strike is "moot[]." Opp. 10. Patent Owner, however, made various arguments in its Sur-Reply, and submitted Dr. Ross's sur-reply declaration, in the event that the Board were to find that the arguments in Petitioner's Reply and associated evidence at issue are proper. *See* Sur-Reply 7–9, 11–17 (citing Ex. 2087). As explained above, we conclude that Petitioner presented a new theory of unpatentability in its Reply, which is improper under our rules.[9] Petitioner's choice not to oppose Patent Owner's request to submit a sur-reply declaration does not retroactively make Petitioner's new theory proper. Nor does Petitioner point to anything

[9] Given that determination, we need not address the merits of Patent Owner's arguments in the Sur-Reply responding to Petitioner's improper new theory. *See* Tr. 14:23–26 (Petitioner agreeing that if the Board grants Patent Owner's motion to strike, "the sur-reply declaration becomes irrelevant").

in the record indicating that Patent Owner agreed, when seeking a sur-reply declaration, that the declaration would moot any arguments regarding the appropriateness of the Reply. To the contrary, Patent Owner sought authorization to file a motion to strike as well. *See* Ex. 3001 (stating that "[t]he parties agree, and jointly seek authorization for," a sur-reply declaration from Dr. Ross and that Patent Owner also seeks authorization to file a motion to strike, which Petitioner opposes).

(4) Conclusion

Patent Owner requests that we strike (1) the portions of Petitioner's Reply at pages 6–10, 13–16, and 23–25 where Petitioner presents its new theory of unpatentability; (2) paragraphs 7–12 of Dr. Bokor's reply declaration; (3) Giordano, cited for the first time on page 15 of the Reply; and (4) portions of Dr. Bokor's cross-examination testimony reflecting the new theory (Ex. 2013, 116:16–117:9, 119:15–124:11, 187:15–189:6, and Ex. 2014, 39:11–14, 39:22–40:5, 214:24–215:4, 216:15–17). Mot. 1. For the reasons explained above, we agree with Patent Owner that the cited portions of the Reply advance a new theory of unpatentability, and rely on new evidence to do so. Accordingly, we grant in part Patent Owner's motion to strike and do not consider those Reply arguments or the corresponding portions of Dr. Bokor's reply declaration and Giordano that Petitioner cites as support in the Reply. As to the transcripts of Dr. Bokor's depositions, we consider them only for purposes of determining whether Petitioner has met its burden to prove unpatentability, by a preponderance of the evidence, based on the theories originally advanced in the Petition.

b) Analysis

Having determined the scope of Petitioner's unpatentability contentions, we turn to the merits of those arguments. We find that a preponderance of the evidence does not support Petitioner's contention that a person of ordinary skill in the art would have been motivated to lower Bowen's 0.9 eV barrier height to 0.33 eV as disclosed in Soukup.

(1) Petitioner's Theory in the Petition for Why a Person of Ordinary Skill in the Art Would Have Been Motivated to Lower Bowen's Barrier Height is Unsupported by Evidence

Patent Owner argues that "no evidence supports Petitioner's assertion that a [person of ordinary skill in the art] would have expected that lowering the barrier height in Bowen . . . would have increased TMR." *See* PO Resp. 31–37. Based on our review of the submitted expert testimony and other evidence, we agree that Petitioner lacks sufficient evidence for its position that lowering the barrier height (by introducing oxygen defects) would increase TMR.

Dr. Bokor testified repeatedly that a person of ordinary skill in the art would not have known whether lowering the barrier height of Bowen's MgO barrier layer would increase or decrease TMR. For example, Dr. Bokor testified as follows:

> Q. . . . In 2004, if Bowen had achieved a barrier height of .85 electron volts, would a [person of ordinary skill in the art] have expected the TMR of Bowen's device to have increased from the 27 percent TMR that Bowen observed at room temperature?
>
> A. *It is my opinion that a [person of ordinary skill in the art] would not have had sufficient information to definitively decide what direction the TMR would have gone.*

Q. And would they have had an expectation on which direction TMR would have changed even if that expectation was not definitive?

A. What I'm saying is I think a person of ordinary skill in the art at the time would have had a reasonable expectation that the TMR would change. But it would be not – they would not be able to be certain which way it would go, whether it would go up or it would go down. I think it was understood that TMR could change as a function of barrier height. But the details – how it depended on the details of the MTJ structure, how it depended on a whole variety of parameters was not fully understood.

Q. What other –

A. So that – so that person of ordinary skill wouldn't be able to have a definite expectation one way or the other.

Q. *So a person of ordinary skill in the art in 2004 could not have said that the TMR would have increased or decreased; is that right?*

A. *That's what I'm saying.*

Q. So a person of ordinary skill in the art in 2004 could not state the TMR – could not exclude the possibility that the TMR would decrease; is that right?

A. That's right.

Q. And a person of ordinary skill in the art in 2004 could not say that TMR would have increased; is that right?

A. That's my opinion.

Q. So your testimony is that a person of ordinary skill in the art in 2004 would have thought something would have changed for the TMR value, but they wouldn't know if it would go up or down?

A. For Bowen's specific device?

Q. Right.

A. Right.

Ex. 2013, 50:7–52:5 (emphasis added); *see also id.* at 47:18–49:11 ("[I]t is reasonable to expect that the TMR would change" if Bowen's barrier height were lowered, but the direction it would change was "uncertain."), 52:6–20 ("A person of ordinary skill in the art in 2004, in my opinion, did not have the capability to make a calculation to determine which direction the TMR would go, even if they knew all the details of the . . . structure of the MTJ."), 55:3–57:6 ("It was not possible to predict with certainty or even some degree of probability which way" TMR would change, and a person of ordinary skill in the art could not have made "a determination of how much with any degree of confidence."), 57:25–58:4 (agreeing that a "person of ordinary skill in the art could not expect that the change would be up or down with any certainty"), 129:18–130:3; Ex. 2014, 214:13–17.

Dr. Bokor further testified that it was "equally likely" for TMR to either increase or decrease. *See* Ex. 2013, 53:14–18 (agreeing that a person of ordinary skill in the art would "have had a reasonable expectation that it was just as likely the TMR would go down as for the TMR to go up"), 54:4–20 ("A [person of ordinary skill in the art] at that time I think could not have determined what the likelihood is in either direction. So in that sense, it would be equally likely."), 189:3–11 ("50 percent chance"); Ex. 2014, 38:8–39:1 ("[A] person of ordinary skill in the art . . . wouldn't be able to determine whether it would go up or down. So in a very rough sense, the likelihood that it would go up or down is equal. So 50 percent chance for either . . . .").

And, although he testified numerous times that a person of ordinary skill in the art would have expected some change to TMR, Dr. Bokor acknowledged that changing the barrier height could potentially have

no impact on TMR.[10] *See* Ex. 2014, 39:2–40:15 ("[T]here is at least some possibility that for . . . two specific barrier heights, you could get the same TMR. It seems rather unlikely in the general case."), 214:18–216:19 ("I think a person of ordinary skill in the art, if they have the capability to change the barrier height over some reasonable range, . . . would have a very strong expectation that they would see some change in the TMR, not just zero. . . . [T]here might be a particular barrier height that would give a result of zero.").

Importantly, Dr. Bokor could not point to any prior art reference indicating that reducing barrier height would increase TMR:

> Q. So this testimony here, what you're saying is the [person of ordinary skill in the art] would have had a reasonable expectation that lowering the barrier height would increase TMR because the [person of ordinary skill in the art] knew that TMR had to change and, look, it was either up or down, so 50/50, one of those would have increased TMR. . . . [I]s that your testimony?
>
> A. That's my testimony.
>
> Q. Okay. . . . [J]ust to be clear, because it reads quite differently here. I want to be clear that your testimony – it is your opinion that a [person of ordinary skill in the art]

[10] Dr. Bokor also testified that because "there are only two choices" (increasing or decreasing TMR), "a person of ordinary skill in the art would have a reasonable expectation that if their goal was to increase the TMR, it would be worth a try to lower the barrier height." Ex. 2013, 52:21–53:9, 58:17–59:8, 188:2–189:2; *see also* Ex. 2014, 216:12–17 ("People will try to get an achievement of improvement with a high economic incentive, even with a low probability of success. So if I think that there's a 50/50 chance I'm going to get the improvement that I'm looking for, boy, oh, boy, I'm going to try that."). Petitioner acknowledged at the hearing, however, that it is not arguing that it would have been "obvious to try" lower barrier heights. Tr. 34:18–35:5, 83:6–84:13.

> did not actually know that reducing the barrier height would increase TMR?
>
> A. *I do not have evidence for that.*
>
> Q. . . . You do not have evidence that a [person of ordinary skill in the art] would have known that reducing barrier height would increase TMR; right?
>
> A. That's what I've been testifying.

Ex. 2013, 154:1–19 (emphasis added); *see also id.* at 143:1–5 (agreeing that "nothing in [Moodera] states that lowering the barrier height of a barrier layer will increase TMR"); Ex. 2014, 222:25–223:8 (agreeing that Soukup does not support "the proposition that to increase TMR of an MgO barrier, skilled artisans would have been motivated to explore lower barrier heights"). Dr. Bokor also testified that he referenced the evidence cited in the Petition only for the equation for calculating TMR, not to show that lowering the barrier height would increase TMR. *See* Pet. 34 (citing Ex. 1017, col. 5, ll. 10–16; Ex. 1027 ¶ 2; Ex. 1035, 3273); Ex. 1024 ¶ 169; Ex. 2013, 136:12–142:25.

Ultimately, the cross-examination testimony above is inconsistent with Dr. Bokor's opinions in his declaration that, for example, "[i]t was understood to one of skill that lowering the barrier height to increase tunneling *would have increased the TMR*," and "[o]ne of skill would have been motivated to adjust oxygen vacancy defects *to improve TMR by lowering the barrier height*." *See* Ex. 1024 ¶¶ 176, 277 (emphasis added); *see also id.* ¶ 172 ("[O]ne of skill in the art would have been motivated to use [Soukup's 0.33 eV] or similar height in an MgO MTJ to improve tunneling and hence TMR in Bowen."). Accordingly, we do not find Dr. Bokor's declaration testimony regarding a motivation to lower Bowen's barrier height credible.

It is Petitioner's burden to provide a reasoned, evidence-supported explanation for why a person of ordinary skill in the art would have been motivated to lower Bowen's 0.9 eV barrier height to 0.33 eV as disclosed in Soukup. *See NuVasive*, 842 F.3d at 1383; *Magnum Oil*, 829 F.3d at 1380; *TriVascular*, 812 F.3d at 1066. Petitioner's reasoning in the Petition that lowering the barrier height (by introducing oxygen defects) would increase TMR is unsupported by evidence.

(2) Evidence in the Record Supports the Opposite of What Petitioner Alleges

In addition to a lack of evidence for Petitioner's theory, there is persuasive evidence in the record that a person of ordinary skill in the art would have expected the opposite of what Petitioner alleges, i.e., that lowering the barrier height would *decrease* TMR. *See* PO Resp. 37–43.

First, Moodera is a 1995 paper that describes "[f]erromagnetic-insulator-ferromagnetic tunneling . . . measured in $CoFe/Al_2O_3/Co$ . . . junctions." Ex. 1035, 3273. It describes a

> theory of [ferromagnetic to ferromagnetic] tunneling . . . proposed by Slonczewski[]. This model analyzes the transmission of charge and spin currents through a rectangular barrier separating free-electron-like [ferromagnetic] metals. It predicts strong influence of tunnel barrier height on the orientation of the spins tunneling across the [ferromagnetic-insulator] interface, thereby affecting the spin polarization and also the exchange coupling between the ferromagnets, and was consistent with the low values of $\Delta R/R$ seen previously.

Id. (citing Slonczewski[11]). Moodera states that "[t]he Slonczewski theory[] predicts a decrease in the spin polarization with barrier height, but for the characteristics of the present junctions it seems to predict a value of $\Delta R/R < 1\%$." *Id.* at 3276.

Dr. Ross provides a detailed explanation of the Slonczewski model, explaining how it predicts that "[l]owering the barrier height scales down the effective spin polarization and thus decreases TMR until a theoretical point at a low barrier height where the effective spin polarization and the TMR go to zero" and "[f]urther decreasing the barrier height starts to increase TMR again," where "[t]he cross-over occurs at very low barrier heights." Ex. 2053 ¶¶ 68–74 (citing Ex. 1057, 10–16; Ex. 2041, 6995, 6997, 7000). Dr. Ross explains that the "strong influence of tunnel barrier height" mentioned in Moodera indicates that "barrier heights affected TMR," and Moodera's later statement that the Slonczewski model "predicts a decrease in the spin polarization with barrier height" shows "Moodera's understanding of lower barrier height yielding lower TMR." *Id.* ¶ 74. As further support, Dr. Ross cites another paper, Moodera II,[12] supporting the same relationship for MgO barrier layers. *Id.* (quoting Ex. 1038, 4728 ("MgO, with its smaller barrier height, is affected more than the Al_2O_3 barrier. This can increase the tunneling probability for the minority spins.

[11] J. C. Slonczewski, *Conductance and Exchange Coupling of Two Ferromagnets Separated by a Tunneling Barrier*, Phys. Rev. B, Vol. 39, No. 10, 6995–7002 (1989) (Ex. 2041).

[12] J. Moodera & L. Kinder, *Ferromagnetic-Insulator-Ferromagnetic Tunneling: Spin-Dependent Tunneling and Large Magnetoresistance in Trilayer Junctions*, 79 J. Appl. Phys. 4724–4729 (1996) (Ex. 1038).

The spin polarization of the tunneling current can then be expected to decrease, as discussed in Slonczewski's theory.")).

Notably, Petitioner relied on Moodera in its Petition for the proposition that "[a]ccording to the equation for TMR, lowering the resistance (barrier height) for parallel electrons (R_p) *would improve TMR*." Pet. 34 (emphasis added) (citing Ex. 1035, 3273). In its Reply, though, Petitioner does not dispute Dr. Ross's view that Moodera teaches the opposite. *See* Sur-Reply 4 n.2; Ex. 2013, 143:1–5 (Dr. Bokor agreeing that "nothing in [Moodera] states that lowering the barrier height of a barrier layer will increase TMR"), 146:7–148:9. Petitioner instead argues that Moodera, Moodera II, and Saito[13] are all "insufficient" to show how a person of ordinary skill in the art would have understood the relationship between barrier height and TMR for MgO barriers because they rely on the "outdated" Slonczewski model. Reply 10–13. We address those arguments below, after discussing Saito.

Second, Saito is a 2000 paper describing experiments involving "spin-valve-type single tunnel junctions (STJs) of Ir-Mn/CoFe/AlO_x/CoFe/ Ni-Fe . . . fabricated with various barrier heights." Ex. 2037, L1035.

[13] Y. Saito *et al.*, *Correlation Between Barrier Width, Barrier Height, and DC Bias Voltage Dependences on the Magnetoresistance Ratio in Ir-Mn Exchange Biased Single and Double Tunnel Junctions*, Jpn. J. Appl. Phys., Vol. 39, L1035–L1038 (2000) (Ex. 2037).

Dr. Ross provides the following annotated version of Figure 1 of Saito (Ex. 2053 ¶ 75).

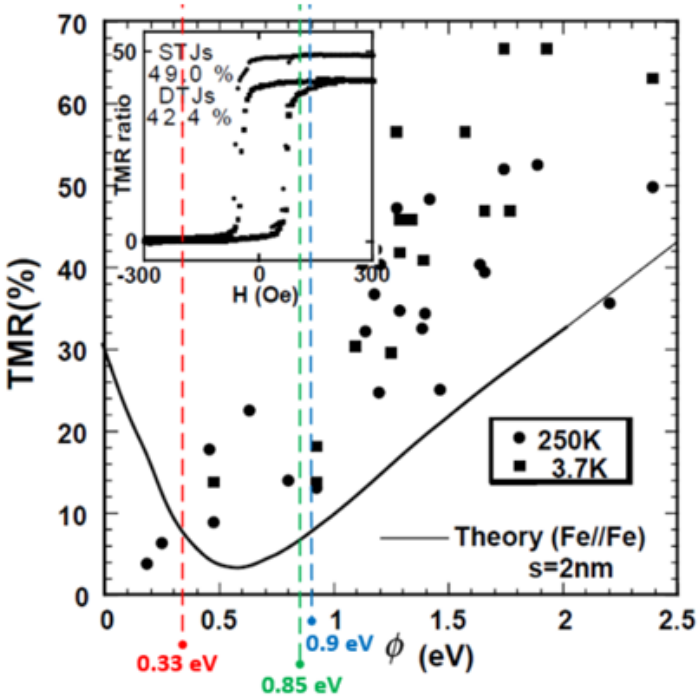

Fig. 1. Barrier height dependence on *TMR* ratio, measured at 3.7 K and 250 K, in STJs. The solid line represents the calculation result using the free electron model, assuming Fe electrodes. Inset shows minor hysteresis loops of magnetoresistance curves in the STJs and DTJs.

Annotated Figure 1 above depicts TMR plotted against barrier height, with data for Saito's measurements at 250 K (circles) and 3.7 K (squares), and added vertical lines for barrier heights of 0.33 eV (red), 0.85 eV (green), and 0.9 eV (blue). *See* Ex. 2037, L1036. The solid line in Figure 1 "represents the calculation result using the free electron model, assuming Fe electrodes," and Saito states that the results were "roughly consistent" with the Slonczewski model ("that is, transmission coefficients of up and down spin depend on the barrier height"). *Id.* (citing Slonczewski). Regarding the experimental data, Saito states that "[t]he *TMR* ratio increased with increasing barrier height." *Id.* The experimental data, therefore, did not conform to the Slonczewski model because TMR continued to trend downward at very low barrier heights rather than increase. *Id.* Saito

explains that "in STJs with low barrier heights, many defects in the barrier would exist," so TMR "would have the potential to be larger than the experimental data" if the devices could be made "without defects in the tunnel barrier." *Id.*

Dr. Ross explains Saito's findings in detail and testifies that "[a]ccording to Saito's model (which appears to be consistent with Slonczewski's theory as Saito said it was), whether the TMR of an aluminum oxide MTJ would increase or decrease in response to lowering barrier height depends where on the curve one begins, i.e., what is the starting barrier height value." Ex. 2053 ¶¶ 75–82. As shown in the annotated Figure 1 above, the predicted TMR in Saito's model decreases as barrier height decreases from Bowen's 0.9 eV (blue) to 0.85 eV (green), and is about the same for Bowen's 0.9 eV (blue) and 0.33 eV (green). *Id.* ¶¶ 78–79. And the experimental data shows a general downward trend from right to left as barrier height decreases.[14] *Id.*; Ex. 2037, L1036. In other words, whereas Petitioner asserts a motivation to lower Bowen's barrier height to increase TMR, "the theoretical models used by Saito and Slonczewski and Saito's actual data measured from devices that were fabricated would have motivated a [person of ordinary skill in the art] to do the opposite." Ex. 2053 ¶ 80. Dr. Ross cites two additional papers as further support that "the expectation [in the art] was that lowering the barrier height in MgO devices would have decreased TMR," just "as was the expectation for amorphous barriers such as aluminum oxide." *Id.* ¶¶ 57,

[14] Dr. Ross explains that the 250 K data (circles) "is more relevant to Bowen . . . who sought to make devices that would function around room temperature (approximately 293–298 K)." Ex. 2053 ¶ 75.

81–82 (citing Ex. 2017 ("Yuasa"),[15] 869 (citing Saito as showing that "for an Al-O tunnel barrier, a lower barrier height yields a lower MR ratio"); Ex. 1053 ("Mitani"),[16] 8042–43).

In response, Petitioner does not dispute that lowering the barrier height was expected to decrease TMR for MTJs with aluminum oxide (Al_2O_3) barrier layers, but asserts that the cited teachings were "inadequate" to predict behavior for MTJs with MgO barrier layers. *See* Reply 10–13 (citing Ex. 1105 ¶¶ 13–54, 57–58). Petitioner points to Butler's statements that "previous theories" were "completely inadequate for understanding tunneling" for MgO devices and that its "results indicate that tunneling is much more interesting and complicated than the simple barrier model used previously." Ex. 1044, 1–2; *see* Reply 10–12. Petitioner contends, with supporting explanation from Dr. Bokor, that "Butler predicted that MgO MTJs would use 'a different mechanism of tunneling compared to the simple models described by previous authors like Simmons.'" Reply 11 (citing Ex. 1105 ¶¶ 13–23, 50–51). Petitioner further argues that Slonczewski was published in 1989 but the first successful MgO MTJ allegedly was not built until 2000, so the cited evidence relying on "Slonczewski's outdated model" is "insufficient to show how one of skill, *after* Butler in 2001, would have predicted the impact of barrier height on TMR in MgO." *Id.* at 10–12 (citing Ex. 2041, 6995; Ex. 1105 ¶¶ 27–28, 40–52).

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[15] S. Yuasa *et al.*, *Giant Room-Temperature Magnetoresistance in Single-Crystal Fe/MgO/Fe Magnetic Tunnel Junctions*, Nature Materials, Vol. 3, 868–871 (Dec. 2004) (Ex. 2017).

[16] S. Mitani, T. Moriyama, & K. Takanashi, *Fe/MgO/FeCo(100) Epitaxial Magnetic Tunnel Junctions Prepared by Using In Situ Plasma Oxidation*, 93 J. Appl. Phys. 8041–8043 (2003) (Ex. 1053).

Petitioner's arguments are not persuasive. Certainly, as Patent Owner acknowledges, Al_2O_3 MTJs are not fully predictive of behavior for MgO MTJs because they lack the "crystallographic symmetry and . . . coherent tunneling enhancement" of MgO MTJs. *See* PO Resp. 12–13 (visually depicting the difference where MgO MTJ "[s]ymmetry coupling . . . increases the likelihood that an electron will tunnel from one electrode, through the barrier, to fill a vacancy of the same symmetry-state in the other electrode"); Sur-Reply 10 n.4. And Butler, being later in time from the other references, describes subsequent research on MgO MTJs. But we are not persuaded that a person of ordinary skill in the art at the time of the '909 patent (2004) would have found all Al_2O_3 MTJ teachings inapplicable to MgO MTJs. In effect, Petitioner argues that an ordinarily skilled artisan would have looked only to Butler (and its statement that previous theories were "completely inadequate for understanding tunneling") and disregarded all prior Al_2O_3 MTJ teachings when attempting to predict what would happen when changing the barrier height of an MgO MTJ. Notably, that is different than what Petitioner argued in various related proceedings. *See* Sur-Reply 10; IPR2024-01447, Paper 25 at 20 (arguing that Dr. Bokor "disagreed that findings on Al_2O_3 barriers were entirely 'irrelevant' to MgO MTJs"); IPR2024-01493, Paper 24 at 16 (arguing that Dr. Bokor "never opined that *all* teachings about alumina MTJs would be discarded by a skilled artisan" (emphasis added)).

Considering all of the evidence of record, we disagree that one of ordinary skill in the art would have ignored the previous teachings discussed by Dr. Ross. A number of facts support that conclusion. First, Slonczewski "was an early attempt to model the behavior of MTJs" with two ferromagnetic layers and a "generic tunneling barrier." Ex. 1105 ¶ 27.

Slonczewski only specified a "rectangular barrier," not Al_2O_3 or MgO specifically. Ex. 2041, 6995; Ex. 1102, 72:5–12.

Second, unlike other references like Slonczewski and Butler, which apply theoretical models, Saito discloses data "measured" from actual devices. Ex. 2037, L1035–L1036. Actual data of that nature would be considered relevant by a person of ordinary skill in the art.

Third, there is some contemporaneous evidence in the record suggesting that those of skill in the art expected the known Al_2O_3 relationship between barrier height and TMR to apply to MgO MTJs as well. *See* Ex. 1053, 8043 (Mitani discussing data "suggesting that TMR in the MgO based epitaxial MTJs depends on the barrier and interface structures as well as alumina-based MTJs"); Ex. 1038, 4728 (Moodera II stating that "[t]he spin polarization of the tunneling current can then be expected to decrease [for MgO MTJs], as discussed in Slonczewski's theory"); Ex. 2017, 869 (Yuasa citing Saito as showing that lowering the barrier height lowers TMR "for an Al-O tunnel barrier," and stating that it had been "surprising" that there was a high TMR "despite the low barrier height" for an MgO MTJ); Ex. 2053 ¶¶ 57, 74, 79, 81; Ex. 1105 ¶ 45 (Dr. Bokor acknowledging that Moodera II "studied MTJs with Al_2O_3 and with MgO barrier layers" and discussed "limited" studies and data for MgO barrier layers).

Fourth, although Petitioner is correct that Butler characterized the previous theories as "completely inadequate for understanding tunneling" and explained why, *see* Reply 12 (quoting Ex. 1044, 1), Dr. Bokor acknowledged that Butler does not "explore [the effect of changing barrier height on TMR] within the confines of the paper" and that a "person of ordinary skill in the art reading Butler could not draw any conclusion as to which direction TMR would go based on a change in barrier height," *see*

Ex. 2013, 71:22–72:7, 117:20–25. This is in contrast to the references cited by Dr. Ross, which discuss generic or Al_2O_3 barrier layers and collectively demonstrate a recognized expectation in the art as to which direction TMR would go, i.e., that lowering the barrier height would lower TMR (until the barrier height is very low) for such devices. For that reason as well, we disagree that an ordinarily skilled artisan would have only considered Butler and none of the prior research in the field, or would have thought that Butler superseded all previous findings.

The evidence cited by Patent Owner and explained in detail by Dr. Ross persuasively shows that, based on the available research at the time, a person of ordinary skill in the art would *not* have expected the relationship that Petitioner asserts in the Petition, i.e., that lowering Bowen's barrier height from 0.9 eV to 0.33 eV would increase TMR. *See* PO Resp. 37–43; Ex. 2053 ¶¶ 68–82.

(3) Soukup Would Not Have Motivated a Person of Ordinary Skill in the Art to Lower Bowen's Barrier Height to 0.33 eV

For the reasons explained above, we are not persuaded that a person of ordinary skill in the art would have been motivated to lower Bowen's barrier height. There is also persuasive evidence in the record that one of skill would not have been motivated to lower it to 0.33 eV specifically, based on Soukup. *See* PO Resp. 58–69.

Soukup describes experiments on fabricated "Au-MgO-Au thin-film emission diodes." Ex. 1028, 3229–30. Soukup's purpose was to determine the current-flow mechanism for "metal-insulator-metal sandwich devices" because, at the time (1970), "[a] number of possible current flow mechanisms from metal to metal ha[d] been proposed" and "the electron

processes of importance in these devices [were] in some doubt and must surely depend on the materials used and the method of fabrication." *Id.* at 3229. Thirteen of the fabricated devices were "studied in detail" by measuring their electron emissions into a vacuum at different voltages and temperatures to obtain their "*I-V* characteristics," then comparing those characertistics to various known models. *Id.* at 3230. Also, "to determine the effect of nonstoichiometry on the device characteristics," three of the devices (PY-G-22(2), PY-G-25(3), and PY-G-38(1)) were "fabricated by depositing the oxide film with oxygen gas present in the vacuum system." *Id.* at 3232.

Soukup "ruled out" tunneling as the dominant current-flow mechanism for twelve of the thirteen devices because the devices' *I-V* characteristics "did not plot as a straight line on a $\ln(I/V^2)$ vs I/V plot," as would have been expected for tunneling. Ex. 1028, 3230, 3235. For the PY-G-38(1) device, Soukup found that "the injection mechanism could . . . be tunneling." *Id.* at 3232–33. For the twelve devices where tunneling was "ruled out," Soukup found that the devices' *I-V* characteristics were consistent with Schottky field emission (but stated that "no definite conclusion[]" could be made as to whether it was the dominant current-flow mechanism). *See id.* at 3230 ("It can be seen from [Figure 3] that the functional dependence of I upon V is the same as for Schottky emission."), 3232 ("[T]he functional dependence of I upon V indicates a Schottky mechanism . . . ."), 3235–36; Reply 20–21.

Soukup computed barrier heights of the devices using (1) "the zero-field intercept of the straight line log$I$ versus $V^{1/2}$ plot" and (2) "an Arrhenius plot." Ex. 1028, 3229–32.

Table I of Soukup is reproduced below.

TABLE I. Summary of device data.

Device No.	S[a]	S_0[b]	φ_1[c]	φ_2[d]	P_{O_2}[e]
PY-G-11(1)	80	200	0.714	0.33	
PY-G-16(3)	105	···	0.721	···	···
PY-G-17(1)	200	194	0.721	0.33	···
PY-G-18(1)	105	···	0.694	0.34	···
PY-G-18(2)	105	222	0.700	0.35	···
PY-G-19(2)	70	133	0.710	0.33	···
PY-G-20(1)	680	···	0.695	···	···
PY-G-20(3)	680	···	0.695	···	···
PY-G-21(3)	90	···	0.732	0.34	···
PY-G-22(2)	90	209	0.780	0.21	10^{-8}
PY-G-25(3)	60	200	0.823	0.11	10^{-7}
PY-G-38(1)	120	···	1.9, 1.74[f]	···	10^{-5}, ···

[a] S = oxide thickness, in Å.
[b] S_0 = overlayer thickness, in Å.
[c] φ_1 = barrier obtained by zero intercept method, in eV.
[d] φ_2 = barrier obtained from slope of Arrhenius plot, in eV.
[e] P_{O_2} = pressure of admitted O_2 during MgO deposition, in Torr.
[f] The barrier was obtained from the slope of the Fowler-Nordheim plot.

Table I includes the results of analyses of sample test data for the devices, with the φ_1 column showing the barrier heights obtained by the zero-field intercept method, the φ_2 column showing barrier heights obtained from the slope of an Arrhenius plot, and the last column (P_{O2}) showing the pressure of admitted O_2 during MgO deposition. Ex. 1028, 3233. As shown above, Soukup observed conflicting results between the two methods, particularly with respect to the three devices made with different oxygen pressures.

Petitioner has not shown sufficiently that a person of ordinary skill in the art would have been motivated to lower Bowen's barrier height to 0.33 eV specifically, based on Soukup's teachings. *See* Pet. 33–35 ("Soukup fabricated an MgO barrier that achieved a height of 0.33 eV, and one of skill in the art would have been motivated to achieve Soukup's barrier height in an MgO MTJ to improve tunneling and hence TMR." (citations omitted)). Soukup's devices were not magnetic and thus had no TMR. *See* Ex. 1028, 3229 ("Au-MgO-Au thin-film emission diodes"); Ex. 2053 ¶ 119. Thus,

Soukup does not support Petitioner's reasoning that an ordinarily skilled artisan would have been motivated to lower Bowen's barrier height to increase TMR. *See* Ex. 2014, 221:13–223:13 (Dr. Bokor agreeing that Soukup "was not concerned with tunneling magnetoresistance" and does not support "the proposition that to increase TMR of an MgO barrier, skilled artisans would have been motivated to explore lower barrier heights").

Also, contrary to Petitioner's contention that Bowen and Soukup were both "focused on improving tunneling devices," Soukup was not. *See* Pet. 35. Soukup "ruled out" tunneling as the dominant current-flow mechanism for all but one of its devices. *See* Ex. 1028, 3230, 3235; Ex. 2013, 185:11–17 (Dr. Bokor agreeing that "the dominant current mechanism in these devices was Schottky emission"). And for the one device where tunneling was a possibility, PY-G-38(1), the calculated barrier heights (1.74 eV and 1.9 eV) are well outside the claimed 0.1–0.85 eV range. *See* Ex. 1028, 3232–33. Petitioner relies on a barrier height of 0.33 eV that was calculated for other devices where tunneling was expressly "ruled out." *See id.* at 3230, 3235. We see no basis on which a person of ordinary skill in the art, when considering a potential modification to Bowen's MTJ (which achieves current flow with tunneling), would have chosen Soukup's 0.33 eV, when that value was calculated for devices where *tunneling was not the current-flow mechanism*.

Dr. Ross further provides a persuasive explanation that a person of ordinary skill in the art would not have adopted any of Soukup's barrier heights within the claimed 0.1–0.85 eV range because at those barrier heights, "current flow is dominated by Schottky emissions which would have *decreased* TMR, rather than increased it." *See* Ex. 2053 ¶¶ 134–142. According to Dr. Ross,

> lowering the barrier height to where the dominant current-flow mechanism is Schottky emission, or any mechanism other than spin-dependent tunneling, would disadvantageously decrease TMR because of the increased percentage of the MTJ's conductance being contributed by current-flow mechanisms that do not depend on the magnetic state of the MTJ—i.e., an increase in the conductance in both parallel and antiparallel states.

Id. ¶ 136 (citing Ex. 1033, 225–226; Ex. 1057, 13; Ex. 2005, 37). "Any additional thermionic current flow such as Schottky current (where, unlike tunneling, electrons have sufficient energy to surmount the energy barrier) . . . or any other spin-independent current flow (i.e., a current flow mechanism that does not depend on the magnetic state)" would add additional conductance in both states and thereby decrease TMR. *Id.* ¶ 137 (citing Ex. 1028, 3229; Ex. 1031, 1794); *see also* Ex. 2013, 88:1–15 (Dr. Bokor agreeing that a person of ordinary skill in the art "would be aware that the thermionic emission current would increase as the barrier height decreases" and reducing Bowen's barrier height to 0.33 eV would increase the thermionic emission current "compared to" 0.9 eV).

In response, Petitioner argues that Dr. Ross attributes Schottky emission becoming the dominant current-flow mechanism to "Soukup's thick barrier," not to lower barrier heights. Reply 25–26 (citing Ex. 2053 ¶ 129). The cited testimony, however, merely indicates that it was "unsurprising" that Schottky emission, not tunneling, was the dominant current-flow mechanism in Soukup because tunneling requires thinner barriers. *See* Ex. 2053 ¶ 129; Sur-Reply 21. Dr. Ross does not state that Schottky emission requires thick barriers, and instead explains why Schottky emission can be the result of "lowering the barrier height," which "would be expected to dramatically decrease TMR." *See* Ex. 2053 ¶¶ 134–142.

We credit Dr. Ross's testimony, which is explained sufficiently and supported by evidence in the record.[17]

Finally, we note an inconsistency that undermines Petitioner's reliance on Soukup. Petitioner argues that a person of ordinary skill in the art "would have been motivated to apply Soukup's teachings about an MgO thin-film barrier with a 'barrier height' of 'about 0.33 eV' to Bowen's MgO barrier." Pet. 33–35. Petitioner also asserts that Soukup teaches a specific relationship between the amount of oxygen vacancy defects in the barrier layer and the barrier height, i.e., "a higher level of oxygen vacancy defects lowered the barrier height." *Id.* at 34; *see* Ex. 1024 ¶ 168 (Dr. Bokor similarly testifying that "Soukup taught there was an inverse correlation between oxygen vacancy defects and the barrier height of the MgO layer"). As support for that conclusion, Petitioner relies on the following sentence in Soukup: "The zero-field intercept of the Schottky plots is a function of oxygen pressure with the lower intercept (higher barrier?) present for the devices fabricated with more oxygen present during MgO deposition, which could mean more stoichiometric oxide films." Ex. 1028, 3232; *see* Pet. 33–34. That sentence, however, expressly pertains to the zero-field intercept method of determining barrier height—not the Arrhenius plot method by which Soukup's 0.33 eV barrier height was determined, which Petitioner relies on for its obviousness combination. *See* Ex. 1028, 3229 ("These results . . . indicate a potential barrier height of about 0.72 eV when determined from the zero-field intercept [method] and about 0.33 eV when obtained from an Arrhenius plot."), 3232–33. Soukup indicates a different

[17] Dr. Bokor does not address this issue in his reply declaration or explain why Dr. Ross's view is factually incorrect. *See* Ex. 1105.

relationship between the amount of oxygen vacancy defects in the barrier layer and the barrier height, depending on which method is used. *See id.* at 3229, 3233 (Table I).

We agree with Patent Owner that Petitioner takes inconsistent positions in relying on one method as allegedly teaching a barrier height within the claimed range, while at the same time relying on the other method as part of its motivation to combine analysis. *See* PO Resp. 67–69. If a person of ordinary skill in the art would have understood that the Arrhenius plot method was the appropriate method for determining barrier height, as Petitioner argues in asserting that Soukup teaches a barrier height of 0.33 eV, that person would have understood that "adding oxygen vacancy defects would have increased barrier height" and Petitioner's obviousness theory of adding oxygen vacancies to lower Bowen's barrier height is incorrect. *See id.* at 68. If, however, a person of ordinary skill in the art would have understood that the zero-field intercept method was correct, that person would have looked to those barrier heights—not the 0.33 eV value that Petitioner relies on for its combination. *See id.* Petitioner cannot have it both ways.

Petitioner's only attempt to reconcile its different contentions is to argue that "[a] skilled artisan like Soukup would not have relied upon the Arrhenius plots for PY-G-22(2)/PY-G-25(3)" (which Soukup used to determine the effect of MgO nonstoichiometry) "due to their non-linearity." Reply 21–22 (citing Ex. 1028, 3232, 3236). But that does not refute that Soukup expressly reached a conclusion as to the relationship between oxygen vacancy defects and barrier height based on the Arrhenius plots. *See* Ex. 1028, 3229 ("[F]or increasing oxygen pressure" (i.e., less oxygen vacancy defects), "the barrier height determined from the Arrhenius plot

went down."). We agree with Patent Owner that Petitioner's arguments regarding Soukup are inconsistent.

(4) Petitioner's Other Motivation Arguments Are Not Persuasive

Petitioner contends that the 0.1–0.85 eV barrier height range of claim 5 "would have been obvious" because it is "only slightly below" Bowen's 0.9 eV. Pet. 35–36 (citing Ex. 1024 ¶¶ 173–174; Ex. 1026, 1656; Ex. 1028, 3232, 3236; Ex. 1038, 4725–26); Reply 13. We disagree. It is the claim as a whole that must be proven obvious, not just the recited range. 35 U.S.C. § 103(a). Also, Petitioner never argues that a person of ordinary skill in the art would have been motivated to reduce Bowen's barrier height to 0.85 eV, instead only arguing for a reduction to Soukup's 0.33 eV value. *See* Pet. 33–35, 37.

Even if Petitioner had made such an argument, though, the mere proximity of Bowen's 0.9 eV to the 0.85 eV top of the claimed range is insufficient for Petitioner to meet its burden. "Depending on the technology, even small differences in formulations can be meaningful." *In re Patel*, 566 F. App'x 1005, 1010 (Fed. Cir. July 16, 2014) (nonprecedential). "Where differences clearly exist [between the prior art and the claim] and there is no evidence that they are either not meaningful or one of skill in the art would know to discard the limits set by the prior art, *proximity alone is not enough to establish a prima facie case of obviousness*." *Id.* (emphasis added) (determining that the Board "erred in finding that the examiner established a prima facie case of obviousness *solely* because the claimed range and the prior art range approach one another"). Differences exist, as Bowen (like many other references in the record) discloses a barrier height

outside the claimed range, and Petitioner does not point to any evidence that those differences are not meaningful.

Further, Dr. Ross explains how the difference between 0.85 eV and 0.9 eV is "not slight in the context of an MTJ" because an MTJ's resistance varies exponentially with barrier height:

> The difference between a 0.85 eV and an 0.9 eV barrier height results in a substantial change in *RA*[18] . . . because an MTJ's resistance increases as an exponential function of barrier height and barrier thickness. At a 2nm barrier thickness like Bowen's . . . , a change from 0.9 eV to 0.85 eV results in a change in RA by a factor of 68%—that device would not have the same properties as Bowen's.

Ex. 2053 ¶ 148 (citing Ex. 1026, 1656). We credit Dr. Ross's testimony on that point, which is unrebutted.

Petitioner also argues that the barrier height range limitation of claim 5 is "inherent when there are oxygen vacancy defects," but does not show that a barrier height of 0.1–0.85 eV is necessarily present in, or the natural result of, a tunnel barrier layer having some amount of oxygen vacancy defects. *See* Pet. 36; *Hospira, Inc. v. Fresenius Kabi USA, LLC*, 946 F.3d 1322, 1329 (Fed. Cir. 2020) ("When the prior art does not expressly disclose a claim limitation, 'inherency may supply a missing claim limitation in an obviousness analysis.' . . . Inherency is established in the context of obviousness when 'the limitation at issue necessarily must be present, or the natural result of the combination of elements explicitly

[18] "The resistance-area product (*RA*) of an MTJ device is the resistance *R* per unit area of the device in ohms (Ω) per μm^2. An MTJ's *RA* is an important consideration for an MTJ device used in a circuit because it impacts the output voltage across an MTJ at a given current under Ohm's law (*V=IR*)." Ex. 2053 ¶ 44 (citations omitted).

disclosed by the prior art.'"). Petitioner points to the '909 patent's statement that "[w]hen there are oxygen vacancy defects, the potential barrier height of the MgO tunnel barrier is thought to decrease (such as in the range of 0.10 to 0.85 eV; more specifically, 0.2 to 0.5 eV), which is thought to result in an increase in the tunneling current." Ex. 1017, col. 7, ll. 19–23; *see* Pet. 36. Bowen, however, has "oxygen vacancy defects" in its MgO layer and "[o]xygen vacancies are naturally present in every oxide" according to Petitioner, but Bowen discloses a barrier height of 0.9 eV, which is *outside* the claimed range. *See* Pet. 13, 23–24. Thus, at least Bowen contradicts Petitioner's assertion that a barrier height within the claimed range of 0.1–0.85 eV is inherent whenever there are oxygen vacancy defects.

Finally, Petitioner states in its Reply that Patent Owner "recently acquiesced to the Examiner's finding" that the prior art teaches the barrier height range of claim 5. Reply 1 (citing Ex. 1086, 257, 263), 5. The basis for that contention is a different prior art reference that was cited by the Examiner during prosecution of a continuation of the '909 patent and is not part of the record of this proceeding nor asserted in the Petition, and thus is not at issue in this proceeding.

c) Conclusion

Petitioner has not shown sufficiently that a person of ordinary skill in the art would have been motivated to combine the teachings of Bowen and Soukup to arrive at a magnetoresistive device with "a barrier height of the tunnel barrier layer . . . in a range of 0.1 eV to 0.85 eV," as recited in

claim 5.[19] Accordingly, based on all of the evidence of record, we determine that Petitioner has not proven, by a preponderance of the evidence, that claim 5 would have been obvious based on Bowen and Soukup under 35 U.S.C. § 103(a).

4. Claims 6 and 9–20

Claim 6 depends from claim 5 and recites that "the barrier height of the tunnel barrier layer is in a range of 0.2 eV to 0.5 eV." Petitioner refers to its earlier arguments for claim 5, where Petitioner asserts that Bowen teaches a barrier height of 0.9 eV and a person of ordinary skill in the art "would have been motivated to apply Soukup's teachings" of a barrier height of "about 0.33 eV" (which falls within the claim 5 range of 0.1–0.85 eV and the claim 6 range of 0.2–0.5 eV) to Bowen. Pet. 33–34, 37 (quoting Ex. 1028, 3229). Claims 9–11, 13, and 14 recite the 0.1–0.85 eV range, and claims 12 and 15–20 recite the 0.2–0.5 eV range. Petitioner again refers to its earlier arguments regarding claim 5. *Id.* at 42–44. The parties argue all of the claims together in their papers during trial. *See* PO Resp. 29–47, 58–70; Reply 5–6, 10–13, 20–23, 25–27; Sur-Reply 3–25. For the reasons explained above, we agree with Patent Owner that Petitioner has not shown sufficiently that a person of ordinary skill in the art would have been motivated to combine the teachings of Bowen and Soukup to arrive at a magnetoresistive device with a barrier height in the claimed ranges. *See supra* Section II.D.3. Accordingly, based on all of the evidence of record,

[19] Given this determination, we need not address Patent Owner's other arguments, including that Soukup is not analogous art or that objective indicia support a conclusion of nonobviousness. *See* PO Resp. 20–29, 51–58, 69–73; Sur-Reply 19–20, 25–27.

we determine that Petitioner has not proven, by a preponderance of the evidence, that claims 6 and 9–20 would have been obvious based on Bowen and Soukup under 35 U.S.C. § 103(a).

E. Obviousness Ground Based on Nagahama and Soukup

Petitioner contends that claims 5, 6, and 9–20 are unpatentable over Nagahama and Soukup under 35 U.S.C. § 103(a), citing the testimony of Dr. Bokor as support. Pet. 47–52, 57–59, 62–67 (citing Ex. 1024). Petitioner's arguments are similar to those for its asserted ground based on Bowen and Soukup. *Compare id.* at 19–25, 33–37, 42–46, *with id.* at 47–52, 57–59, 62–67. With respect to the 0.1–0.85 eV barrier height range recited in claim 5, Petitioner argues that Nagahama teaches "an MgO MTJ"; Soukup teaches a barrier height of "about 0.33 eV"; a person of ordinary skill in the art "would have been motivated to apply Soukup's teachings about an MgO thin-film barrier with a 'barrier height' of 'about 0.33 eV' to Nagahama's MgO barrier"; and "[f]or the same reasons explained" with respect to the asserted ground based on Bowen and Soukup, "the claimed tunnel barrier height range of 0.1 to 0.85 eV would have been obvious and is also inherent." *Id.* at 57–59 (citing Ex. 1024 ¶¶ 170–171, 175, 272–286). Dr. Bokor's testimony is similar to his testimony regarding the combination of Bowen and Soukup as well. *Compare* Ex. 1024 ¶¶ 166–180, *with id.* ¶¶ 273–286. The parties argue all of the claims together in their papers during trial, referring to each of Bowen and Nagahama as a base reference to be modified based on Soukup. *See* PO Resp. 29–47, 58–70; Reply 5–6, 10–13, 20–23, 25–27; Sur-Reply 3–25.

For the same reasons explained above regarding modifying Bowen based on Soukup, we agree with Patent Owner that Petitioner has not shown

sufficiently, based on the theories of unpatentability advanced in its Petition, that a person of ordinary skill in the art would have been motivated to modify Nagahama's device to have a barrier height of 0.33 eV as in Soukup (i.e., within the claimed ranges of 0.1–0.85 eV for claims 5, 9–11, 13, and 14, and 0.2–0.5 eV for claims 6, 12, and 15–20). *See supra* Section II.D.3. Accordingly, based on all of the evidence of record, we determine that Petitioner has not proven, by a preponderance of the evidence, that claims 5, 6, and 9–20 would have been obvious based on Nagahama and Soukup under 35 U.S.C. § 103(a).

F. Patent Owner's Motion to Exclude

The party moving to exclude evidence bears the burden of proof to establish that the material sought to be excluded is inadmissible under the Federal Rules of Evidence. *See* 37 C.F.R. §§ 42.20(c), 42.62(a). Patent Owner moves to exclude paragraphs 8 and 10–12 of Dr. Bokor's reply declaration (Ex. 1105) under Federal Rules of Evidence 701 and 702. Mot. to Exclude 1. Patent Owner contends that Dr. Bokor is "unqualified" to offer the new opinions in his reply declaration regarding Butler. *Id.* Because we grant in part Patent Owner's Motion to Strike paragraphs 7–12 of Dr. Bokor's reply declaration, as explained above, Patent Owner's Motion to Exclude is dismissed as moot. *See supra* Section II.D.3.a; Tr. 61:3–4 (Patent Owner acknowledging that granting the motion to strike "would moot [the] motion to exclude").

III. CONCLUSION

Petitioner has not demonstrated, by a preponderance of the evidence, that claims 5, 6, and 9–20 of the '909 patent are unpatentable based on the asserted grounds in this proceeding.

In summary:

Claim(s)	35 U.S.C. §	Reference(s)/ Basis	Claim(s) Shown Unpatentable	Claim(s) Not Shown Unpatentable
5, 6, 9–20	103(a)	Bowen, Soukup		5, 6, 9–20
5, 6, 9–20	103(a)	Nagahama, Soukup		5, 6, 9–20
Overall Outcome				5, 6, 9–20

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 5, 6, and 9–20 of the '909 patent are not determined to be unpatentable;

FURTHER ORDERED that Patent Owner's Motion to Strike (Paper 29) is *granted-in-part*;

FURTHER ORDERED that Patent Owner's Motion to Exclude (Paper 43) is *dismissed*; and

FURTHER ORDERED that, because this is a Final Written Decision, parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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