

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.

IPR2025-00701
Patent 10,367,138 B2

Before SHEILA F. McSHANE, MONICA S. ULLAGADDI, and
JOHN D. HAMANN, *Administrative Patent Judges*

McSHANE, *Administrative Patent Judge.*

DECISION
Denying Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

Western Digital Technologies, Inc. (“Petitioner”) filed a Petition for *inter partes* review of claims 1–14 of U.S. Patent No. 10,367,138 B2 (Ex. 1011, “the ’138 patent”), along with the Declaration of Jeffrey Bokor, Ph.D.¹ Paper 1 (“Pet.”); Ex. 1024. Godo Kaisha IP Bridge 1 (“Patent Owner”) filed a Preliminary Response. Paper 7 (“Prelim. Resp.”).

Institution of an *inter partes* review is authorized by statute when “the information presented in the petition . . . and any response . . . shows that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition.” 35 U.S.C. § 314(a) (2018). Upon consideration of the Petition, the Preliminary Response, and the evidence of record, we determine that Petitioner has not established a reasonable likelihood of prevailing with respect to the unpatentability of at least one claim of the ’138 patent. Accordingly, for the reasons that follow, we decline to institute an *inter partes* review of claims 1–14 of the ’138 patent.

¹ The parties also filed briefs directed to discretionary denial issues. See Papers 6, 8. The Acting Director denied Patent Owner’s request for discretionary denial and referred the Petition to the Board. See Paper 9. We do not address discretionary denial issues here. See <https://www.uspto.gov/patents/ptab/interim-director-discretionary-processes>, Section I.C, Briefing (“The petitioner and patent owner should not present discretionary considerations in the petition or the Patent Owner Preliminary Response (POPR), respectively.”).

A. Related Matters and Real Parties in Interest

Petitioner indicates the '138 patent is the subject of the district court litigations: *Godo Kaisha IP Bridge 1 v. Western Digital Technologies, Inc.*, No. 24-cv-06555 (N.D. Cal.) (transferred from the District of Delaware); *Godo Kaisha IP Bridge 1 v. Seagate Technology LLC*, No. 24-cv-03691 (D. Minn.) (transferred from the District of Delaware). Pet. 70–71; *see also* Paper 4, 2. Patent Owner refers to several US patent applications that claim the benefit of the priority of the filing date of the '138 patent: US Application No. 16/443,875 (US Patent No. 10,680,167), US Application No. 16/862,598 (US Patent No. 11,233,193), US Application No. 17/560,922 (US Patent No. 11,737,372), US Application No. 18/219,320 (US Patent No. 11,968,909), US Application No. 18/232,576, and US Application No. 18/642,280.

Petitioner identifies itself and “related entity Western Digital Corporation” as real parties in interest. Pet. 70. Patent Owner identifies itself as the real party in interest. Paper 4, 1.

B. The '138 Patent (Ex. 1011)

The '138 patent is titled “Magnetic Tunnel Junction Device,” and issued on July 30, 2019, from an application filed on February 9, 2017, claiming priority to a PCT application filed on March 10, 2005. Ex. 1011, codes (22), (45), (63). The '138 patent also claims priority from Japanese Application Nos. 2004-071186 and 2004-313350, filed March 12, 2004 and October 28, 2004, respectively. *Id.* at code (30).

The '138 patent “relates to a magnetic tunnel junction device and . . . particularly to a magnetic tunnel junction device with a high

magnetoresistance.” Ex. 1011, 1:32–35. In particular, the ’138 patent explains that “a MTJ [magnetic tunnel junction] device comprises a tunnelling junction structure in which a tunnel barrier . . . made of an oxide is sandwiched between a first and a second electrode made of a ferromagnetic metal.” *Id.* at 1:47–51. An object of the patent is stated as “to increase the output voltage of a MTJ device.” *Id.* at 2:39–42.

According to the ’138 patent, “the MTJ device structure of [an] embodiment comprises 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 ($0 < x < 1$) layer 3 sandwiched there between, the polycrystalline layer having the (001) crystal plane preferentially oriented therein.” Ex. 1011, 5:39–45. This structure is shown in Figure 1(B), reproduced below.

FIG. 1 (B)



Figure 1(B), above, “shows the structure of a MTJ device according to” an embodiment of the ’138 patent. Ex. 1011, 3:66–67. The ’138 patent additionally discloses a variation—Figure 11 reproduced below—of the structure shown in Figure 1(B). *Id.* at 4:33–34.

FIG. 11

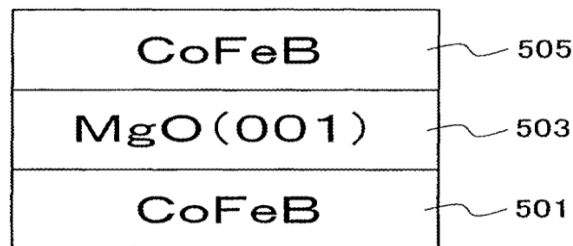


Figure 11, above, shows “the MTJ device of the variation is characterized in that . . . the electrodes disposed on either side of a single-crystal MgOx(001) layer 503 or an oxygen-deficit poly-crystal MgOx (0<x<1) in which the (001) crystal plane is preferentially oriented comprises an amorphous ferromagnetic alloy, such as . . . layers 501 and 505,” which consist of Co, Fe, and B. Ex. 1011, 9:11–17. The ’138 patent further discloses that “amorphous magnetic alloy, FeCoB, FeCoBSi, FeCoBP, FeZr, and CoZr may be used” and an “anneal process after the preparation of the MTJ device might cause the amorphous magnetic alloy in the electrode layer to be partially or entirely crystallized.” *Id.* at 9:20–24.

C. Illustrative Claim

Claims 1, 7, and 12 are independent claims. Claim 1 is reproduced below, with bracketed letters added to limitations for reference purposes.

1[pre] A magnetic tunnel junction (MTJ) device, comprising:

1[a] a first electrode comprising a first ferromagnetic material layer that includes Co, Fe, and B;

1[b] a barrier layer disposed over the first electrode, the barrier layer comprising a magnesium oxide (MgO) layer that is formed of a

polycrystalline MgO in which a (001) crystal plane is preferentially oriented; and

1[c] a second electrode disposed over the barrier layer and comprising a second ferromagnetic material layer that includes Co, Fe, and B, and

1[d] wherein each of the first and second ferromagnetic material layers is entirely crystallized,[] and

1[e] wherein a value of x in MgO_x for the MgO layer is greater than 0 and less than 1.

Ex. 1011, 9:56–10:2.

D. Asserted Grounds of Unpatentability

Petitioner asserts that claims 1–14 are unpatentable based on the following grounds:

Claim(s) Challenged	35 U.S.C §	Reference(s)/Basis
1–4, 7–10, 12, 13	103(a) ²	Parkin ³ , Wang ⁴ , Soukup ⁵
5, 6, 11, 14	103(a)	Parkin, Wang, Soukup,

² The Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) (“AIA”), amended 35 U.S.C. § 103, and was effective on March 16, 2013. Because the ’138 patent has an effective filing date prior to the effective date of the applicable AIA amendments, we refer to the pre-AIA version of 35 U.S.C. § 103.

³ US 7,270,896 B2, issued September 18, 2007. Ex. 1062.

⁴ D. Wang, “70% TMR [“Tunneling Magnetoresistance Ratio”] at Room Temperature for SDT Sandwich Junctions With CoFeB as Free and Reference Layers,” IEEE Transactions On Magnetics, Vol. 40, No. 4, July, 2004. Ex. 1055.

⁵ 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.

Claim(s) Challenged	35 U.S.C §	Reference(s)/Basis
		Bowen ⁶
1–14	103(a)	Bowen, Wang, Soukup

Pet. 6.

II. ANALYSIS

A. *Level of Ordinary Skill in the Art*

Petitioner asserts that one of ordinary skill in the art as of 2004 would have had

a Ph.D. or master’s degree in electrical engineering, physics, materials science, or a related field, and at least one year or four years, respectively, of experience in the research, design, and/or development of magnetic/spintronic devices, or the equivalent.

Pet. 8 (citing Ex. 1024 ¶¶ 25–29). Petitioner contends that less work experience can be compensated for by a higher level of experience and *vice versa*. *Id.* (citing Ex. 1024 ¶ 25). Petitioner also asserts that the proposed level of skill would be the same under any of the United States, Japanese, or PCT application dates. *Id.* at 8–9 (citing Ex. 1024 ¶¶ 24–25).

Patent Owner does not challenge Petitioner’s proposed level of qualifications for one of ordinary skill in the art. Prelim. Resp. 20.

At this stage of the proceeding, we adopt Petitioner’s assessment of the level of skill in the art, which is consistent with the ’138 patent and the asserted prior art of record.

⁶ M. Bowen, “Large magnetoresistance in Fe/MgO/FeCo(001) epitaxial tunnel junctions on GaAs(001),” *Appl. Phys. Lett.*, Vol. 79, No. 11, 1655–1657 (2001). Ex. 1026.

B. Claim Construction

In this *inter partes* review, claims are construed 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). 37 C.F.R. § 42.100(b) (2021). Under the principles set forth by our reviewing court, the “words of a claim ‘are generally given their ordinary and customary meaning,’” as would be understood by a person of ordinary skill in the art in question at the time of the invention. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312 (Fed. Cir. 2005) (en banc) (quoting *Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1582 (Fed. Cir. 1996)). “In determining the meaning of the disputed claim limitation, we look principally to the intrinsic evidence of record, examining the claim language itself, the written description, and the prosecution history, if in evidence.” *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 469 F.3d 1005, 1014 (Fed. Cir. 2006) (citing *Phillips*, 415 F.3d at 1312–17).

Petitioner states that “the claim terms should be given their plain and ordinary meaning and no claim construction is necessary to find the claims unpatentable.” Pet. 6. Patent Owner does not address claim construction. *See generally* Prelim. Resp.

We determine that we need not expressly construe any claim terms to resolve the parties’ disputes on the current record. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (“[W]e need only construe terms ‘that are in controversy, and only to the

extent necessary to resolve the controversy.’” (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999))).

C. Principles of Law

A patent claim is unpatentable under 35 U.S.C. § 103(a) if “the differences between subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.” 35 U.S.C. § 103 (2011); *see also KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) when in evidence, objective indicia of nonobviousness.⁷ *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

D. Asserted Obviousness of Claims 1–4, 7–10, 12, and 13 over Parkin, Wang, and Soukup

Petitioner contends that claims 1–4, 7–10, 12, and 13 are unpatentable under 35 U.S.C. § 103(a) because they would have been obvious over the combination of Parkin, Wang, and Soukup. Pet. 9–32. Patent Owner argues

⁷ Patent Owner asserts that the invention, which is associated with the production of MTJs with high TMRs by using CoFeB electrodes and with a crystalline magnesium oxide tunnel barrier layer, achieved surprising and unexpected results, won awards, and drew praise. Prelim. Resp. 13–20. In view of our determinations herein, we need not reach these issues here.

that the Petition fails to establish that a person of ordinary skill in the art would have replaced Parkin's CoFe electrode with one of CoFeB; that Parkin does not disclose a layer that includes Co, Fe, and B and is "entirely crystallized" as claimed; and that there is no reasonable likelihood of success established for the replacement of Parkin's electrode. Prelim. Resp. 20–49.

We begin our discussion with brief summaries of Parkin, Wang, and Soukup, and then address evidence and arguments presented.

1. *Parkin (Ex. 1062)*

Parkin is titled "High Performance Magnetic Tunnel Barriers with Amorphous Materials." Ex. 1062, code (54). Parkin discloses a "magnetic tunneling element is constructed from a MgO or Mg-ZnO tunnel barrier and an amorphous magnetic layer in proximity with the tunnel baffler," where the "amorphous magnetic layer includes Co and at least one additional element selected to make the layer amorphous." *Id.* at code (57).

Parkin "relates to magnetic tunnel junction (MTJ) magnetoresistive (MR) devices for use as magnetic field sensors such as read heads for reading magnetically recorded data, as memory cells in nonvolatile magnetic random access memory (MRAM) cells, and for magnetic logic and spintronic applications." Ex. 1062, 1:13–18. Parkin explains that "[f]or applications of magnetic tunnel junctions for either magnetic recording heads or for non-volatile magnetic memory storage cells, high TMR values are needed for improving the performance of these devices." *Id.* at 2:65–3:1.

To address this, Parkin discloses "a structure that includes at least one tunnel barrier selected from the group of tunnel barriers consisting of MgO and Mg-ZnO, preferably a tunnel barrier that is oriented in the (100)

direction.” Ex. 1062, 6:20–24. This structure is disclosed as including “an amorphous magnetic layer of Co and at least one additional element selected to make the layer amorphous, in which the amorphous layer is in proximity with the tunnel barrier, thereby permitting spin-polarized current to pass between the tunnel barrier and the magnetic layer.” *Id.* at 6:24–29. Parkin states that a ferromagnetic layer may be comprised of $(\text{Co}_{73}\text{Fe}_{27})_{74}\text{B}_{26}$. *Id.* at 17:40–44. Parkin also discloses that the “structure may further include a crystalline layer sandwiched between the amorphous layer and the tunnel barrier.” *Id.* at 6:35–37.

2. Wang (Ex. 1055)

Wang presents the experimental results for spin dependent tunneling (SDT) wafers with a typical stack structure of Si(100)-Si₃N₄-Ru-CoFeB-Al₂O₃-CoFeB-Ru-FeCo-CrMnPt. Ex. 1055, 2269, Abstract. The tunnel junctions were annealed and tested for magneto-transport properties. *Id.* More specifically, CoFeB-Al₂O₃-CoFeB junctions were formed and tested. *Id.* at 2270.

3. Soukup (Ex. 1028)

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.* (Abstract). 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 (Abstract).

4. Discussion

In view of our determination below, we need only address issues related to limitations 1[a], 1[c], and 1[d], which are similar to limitations in independent claim 7 (limitations 7[a], 7[c], and 7[e]) and independent claim 12 (limitations 12[a], 12[c], and 12[d]). *See* Pet. xviii–xx.

Limitation 1[a] is directed to “a first electrode comprising a first ferromagnetic material layer that includes Co, Fe, and B.” The Petition relies on Parkin’s disclosure of lower ferromagnetic layer 115 (depicted in dark purple) as the “first ferromagnetic material layer,” which is composed of $\text{Co}_{70}\text{Fe}_{30}$ that is deposited on top of antiferromagnetic layer 116, as shown in annotated Figure 3A of Parkin, reproduced below. Pet. 9–10 (citing Ex. 1062, 17:14–19; Ex. 1021 ¶ 109).

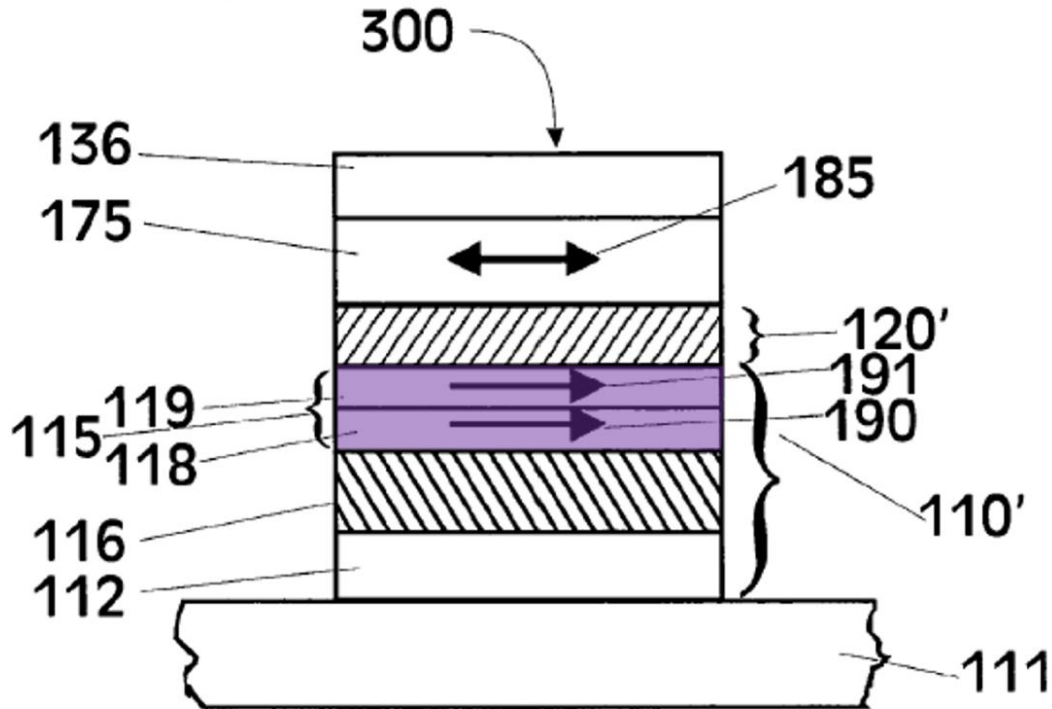


FIG. 3A

Figure 3A of Parkin, annotated by Petitioner, above, depicts lower ferromagnetic layer 115, which Petitioner asserts is the claimed first electrode, as modified by Wang’s use of CoFeB instead of Parkin’s use of CoFe. Pet. 10–11.

Limitation 1[c] is directed to “a second electrode . . . comprising a second ferromagnetic material layer.” Petitioner asserts that layer 175 (depicted in light purple), a top ferromagnetic electrode of Parkin, is the claimed second electrode and second ferromagnetic electrode, as shown in annotated Figure 3A below. Pet. 15–16 (citing Ex. 1062, 17:40–44; Ex. 1024 ¶¶ 123–127).

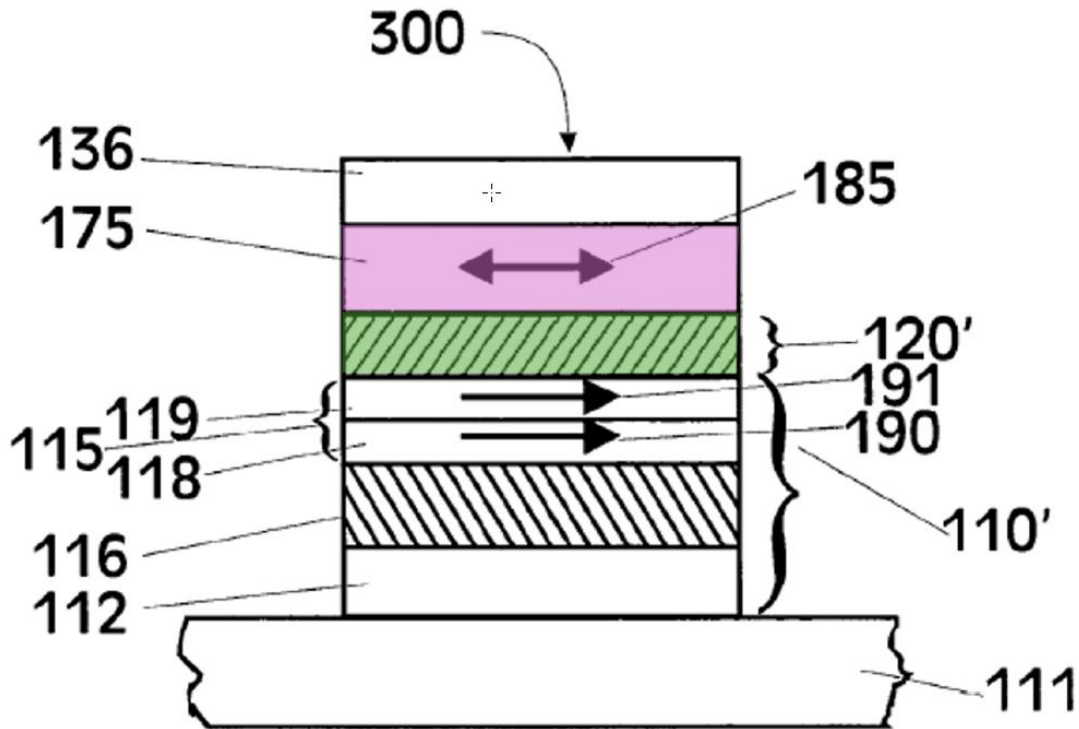


FIG. 3A

Annotated Figure 3A of Parkin, above, depicts Petitioner's identification of layer 175 as the "second" or top ferromagnetic electrode. Pet. 16. Petitioner points to Parkin's disclosure that layer 175 may be composed of $(\text{Co}_{73}\text{Fe}_{27})_{74}\text{B}_{26}$. *Id.* (citing Ex. 1062, 17:40–44).

Limitation 1[d] recites: "wherein each of the first and second ferromagnetic material layers is entirely crystallized." Petitioner acknowledges that Parkin teaches that its CoFeB upper ferromagnetic layer 175 is "formed from an amorphous alloy of CoFeB." Pet. 17 (citing Ex. 1062, 16:47–50). Petitioner further asserts that if CoFeB were substituted for CoFe in the lower electrode, "it would be formed from the same amorphous CoFeB alloy." *Id.* (citing Ex. 1024 ¶ 136).

Petitioner contends that “Parkin taught that annealing resulted in an entirely crystallized ferromagnetic layer.” Pet. 17. Petitioner refers to Parkin’s disclosure that the magnitude of TMR increased with anneal temperature for the Figure 3A embodiment. *Id.* (citing Ex. 1062, 18:13–16, 18:45–48, Fig. 5; Ex. 1024 ¶¶ 129–130). Petitioner asserts that in explaining these results, “Parkin taught that ‘a portion of the storage layer 175 adjacent to the MgO tunnel barrier 120’ has crystallized.” *Id.* at 17–18 (citing Ex. 1062, 18:51–55). Petitioner refers to Parkin’s disclosure that “[t]he simple cubic crystalline MgO layer thus provides a template for the formation of a thin crystalline ferromagnetic layer which has the bcc structure of CoFe.” *Id.* at 18 (citing Ex. 1062, 18:55–59; Ex. 1024 ¶ 131). Petitioner argues that “[i]n short, Parkin’s ‘thin crystalline ferromagnetic’ layer is ‘entirely crystallized’ and forms a CoFeB layer as required by Claim 1[d].” *Id.* (citing Ex. 1024 ¶ 132). Petitioner further contends that although Parkin considers the possibility “that the B diffuses away from the interface with the MgO layer, during the thermal anneal treatments, to leave a thin interface layer at this interface which is much lower in B content,” the “‘lower’ B content is not zero, meaning that the crystallized layer remains CoFeB.” *Id.* at 18–19 (citing Ex. 1062, 19:19–22; Ex. 1024 ¶¶ 132–133).

In support, Dr. Bokor testifies that “[i]n my opinion, Parkin’s ‘thin crystalline ferromagnetic layer’ of CoFeB, EX1062 (Parkin) at col. 18:57, is ‘entirely crystallized’ as required by Claim 1[d].” Ex. 1024 ¶ 132. Dr. Bokor additionally testifies that “[l]ike Parkin’s top ferromagnetic layer 175, if Parkin’s lower ‘ferromagnetic layer 115 of 35 Å Co₇₀Fe₃₀’ were replaced with CoFeB as explained for Claim 1[a] . . . , the lower ferromagnetic layer

115 would also initially be an amorphous alloy . . . After annealing . . . one of skill would have understood that a thin crystalline layer including CoFeB would be formed . . . which would also satisfy the “entirely crystallized” requirement of Claim 1[d].”⁸ *Id.* ¶ 136.

Patent Owner argues that the Petition fails to establish that Parkin discloses a layer of CoFeB that is “entirely crystallized” as independent claims 1, 7, and 12 require. Prelim. Resp. 34. Patent Owner contends that the Petition identifies Parkin’s CoFeB storage layer 175 as the alleged second ferromagnetic material layer and admits that this layer is amorphous. *Id.* (citing Pet. 16 (limitation 1[d])); *see also id.* at 36. Patent Owner asserts that the Petition never alleges that the second ferromagnetic layer is “entirely crystallized,” as the claim requires, but rather only states that “a portion of the storage layer 175 . . . has crystallized.” *Id.* at 35 (citing Pet. 17–18; Ex. 1062, 18:51–55). Patent Owner also contends that “[t]he Petition fails to explain how storage layer 175 . . . can be ‘entirely crystallized’ as claimed when the Petition admits that Parkin taught that only a ‘portion’ of it crystallized.” *Id.* at 36 (citing Pet. 17–18).

As discussed above, Petitioner relies upon Parkin, and its layers 115 and 175, as the claimed first and second ferromagnetic material layers, respectively. *See* Pet. 10, 16. Petitioner admits that these layers are

⁸ In the Petition, Petitioner refers to the lower electrode “ferromagnetic layer 110’ as discussed in Claim 1[a]” in the discussion of limitation 1[d]. Pet. 18. Petitioner’s reference to “layer 110” appears to be in error because the Petition’s discussion for limitation 1[a] refers to layer 115 of Parkin, as does Dr. Bokor’s testimony related to limitations 1[a] and 1[d]. Pet. 10; Ex. 1024 ¶¶ 109, 136.

amorphous, but contends that, as Parkin discloses, these layers may be annealed. *Id.* at 17. Petitioner, however, refers to Parkin’s disclosure that only “a *portion* of the storage layer 175” is crystallized after annealing. *Id.* at 17–18 (citing Ex. 1062, 18:51–55) (emphasis added). Petitioner also relies upon Parkin’s “*thin* crystalline ferromagnetic layer” that is crystallized to teach limitation 1[d]. *Id.* at 18 (citing Ex. 1062, 18:55–59; Ex. 1024 ¶¶ 131–132) (emphasis added). Dr. Bokor additionally testifies that it is “Parkin’s ‘thin crystalline ferromagnetic layer’ of CoFeB” that meets the “entirely crystallized” requirement of limitation 1[d]. Ex. 1024 ¶ 132. Parkin, however, states that a thin crystalline ferromagnetic layer is formed, but “*the bulk of storage layer 175 remains amorphous.*” Ex. 1062, 18:55–60 (emphasis added).

Petitioner fails to reconcile how its assertions that the first and second ferromagnetic layers, which are mapped to the totality of layers of 115 and 175, meet the limitation that the first and second ferromagnetic layers are each “entirely crystallized” when Petitioner relies only a thin layer, that is, a portion, of the 115 and 175 layers for the teaching that the respective layers are entirely crystallized. Put another way, Petitioner’s mapping is inconsistent: Petitioner relies upon the full depth of certain “layers” of Parkin for the teaching of the ferromagnetic layers, but then only relies upon thin portion of that depth for the assertion that the “layers” are entirely crystallized.

Additionally, although Petitioner also alleges that Parkin teaches an entirely crystallized ferromagnetic layer (Pet. 17), Petitioner does not explain the basis of this assertion or identify support for it in Parkin’s

disclosures.⁹ *See id.* at 17–18. Instead, as discussed above, Petitioner identifies Parkin’s disclosures that a portion of storage layer 175 is crystalline and a “thin crystalline” layer is “entirely crystalline.” *Id.* (citing Ex. 1062, 18:51–55; 18:55–59). We also do not discern that Dr. Bokor testifies that it is a full layer of the ferromagnetic layer that is crystallized in Parkin (see Ex. 1024 ¶¶ 128–133); rather Dr. Bokor’s testimony is that it is Parkin’s “thin crystalline ferromagnetic layer” of CoFeB means “entirely crystallized” (*id.* at ¶ 132) as recited in the claim.

Petitioner asserts that the ’138 patent contains far less disclosure on crystallization than Parkin. Pet. 18. Petitioner refers to the following ’138 patent disclosure:

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

Ex. 1011, 9:20–27 (emphasis added) (quoted at Pet. 19). Petitioner asserts that one of ordinary skill in the art “would recognize that Parkin teaches or suggests this limitation” as set forth in the ’138 patent. Pet. 19 (citing Ex.

⁹ Petitioner refers to Cardoso in support of Parkin’s teachings. Pet. 18 (citing Ex. 1061, 2273; Ex. 1024 ¶ 134). Petitioner states that the reference “had observed similar results” to Parkin (Pet.18), but neither Petitioner, nor Dr. Bokor’s testimony, explain how the teachings of this reference apply to Parkin and, more specifically, to Parkin’s explicit teaching of the formation of a thin crystalline layer where the bulk of the layer remains amorphous. *See id.*

1024 ¶ 135; Ex. 1086, 258–259). Dr. Bokor testifies that the ’138 patent provides less detail than Parkin (Ex. 1024 ¶ 135), but the patent nonetheless discloses that the “magnetic alloy in the electrode layers” is “entirely crystallized” (Ex. 1011, 9:23–24). Accordingly, we are not persuaded by Petitioner’s argument on this issue—the ’138 patent explicitly 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” (Ex. 1011, 9:20–27), which provides support for the recited limitation.

The Petition also refers to another patent application’s prosecution history, which cites a different prior art reference than the one at issue here and which also names Parkin as an inventor, where the Examiner states that the prior art disclosed ferromagnetic materials that are “partially or entirely crystallized.” *See* Pet. 19, Ex. 1086, 258–259. Petitioner does not explain how the other prior art reference naming Parkin referred to in that prosecution history is related to the Parkin reference relied upon by the Petitioner here, nor does Dr. Bokor explain how the other reference further informs him on the cited teachings in Parkin, so we are not persuaded on this issue. Ex. 1024 ¶ 135. Petitioner also argues that the prior art contains at least as much detail as that asserted by Patent Owner in the related litigation. Pet. 19–20. We do find this argument persuasive; the issue before us is not the related litigation, but rather it is whether Petitioner has provided evidence and argument at this juncture that demonstrates a reasonable likelihood of success on the merits.

Accordingly, Petitioner has not sufficiently demonstrated that the same element of Parkin teaches the first ferromagnetic material layer of limitation 1[a] and limitation 1[d], which requires the first layer is entirely crystallized, and has not sufficiently demonstrated that the same element of Parkin teaches the second ferromagnetic layer of limitation 1[c] and limitation 1[d], which requires that the second layer be entirely crystallized.

Thus, Petitioner has not established a reasonable likelihood of demonstrating that the combination of Parkin, Wang, and Soukup renders obvious independent claims 1, 7, and 12. The other claims challenged under this ground, claims 2–4, 8–10, and 13, depend, directly or indirectly, from claim 18. The evidence and arguments presented for the dependent claims fail to cure the deficiencies in the showing as to claims 1, 7, and 12. Pet. 22–33. Thus, the challenges to claims 2–4, 8–10, and 13 fail because of their dependencies on claims 1, 7, and 12.

Accordingly, Petitioner has not demonstrated a reasonable likelihood that it would prevail in showing that claims 1–4, 7–10, 12, and 13 would have been rendered obvious by the combination of Parkin, Wang, and Soukup.

E. Asserted Obviousness of Claims 1–14 over Bowen, Wang, and Soukup and of Claims 5, 6, 11, and 14 over Parkin, Wang, Soukup, and Bowen

Petitioner contends that claims 1–14 are unpatentable under 35 U.S.C. § 103(a) as obvious over the combination of Bowen, Wang, and Soukup. Pet. 46–65. Patent Owner argues that neither Bowen or Wang disclose a

layer that includes Co, Fe, and B and is entirely crystallized. Prelim. Resp. 50–66.

Petitioner also asserts that the combination of Parkin, Wang, Soukup, and Bowen renders obvious dependent claims 5, 6, 11, and 14. Pet. 33–46.

We begin our discussion with a brief summary of Bowen, and then address some of the evidence and arguments presented.

1. Bowen (Ex. 1026)

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.* (Abstract).

Bowen discloses that “numerical calculations of spin-dependent tunneling and TMR have been developed for single crystal MTJs [magnetic tunnel junctions] such as Co/Al₂O₃/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.*

In Bowen, 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. Discussion

In view of our determination below, we need only address issues similar to those addressed for the Parkin, Wang, and Soukup ground discussed above.

Petitioner relies on Bowen’s disclosure of its “Fe(200 Å)” of its “Fe(200 Å)/MgO(20 Å)/FeCo(250 Å) trilayer” as the “first ferromagnetic material layer.” Pet. 47 (citing Ex. 1026, 1655–1656). Figures 1 (a), (b), and (c) of Bowen are reproduced below:

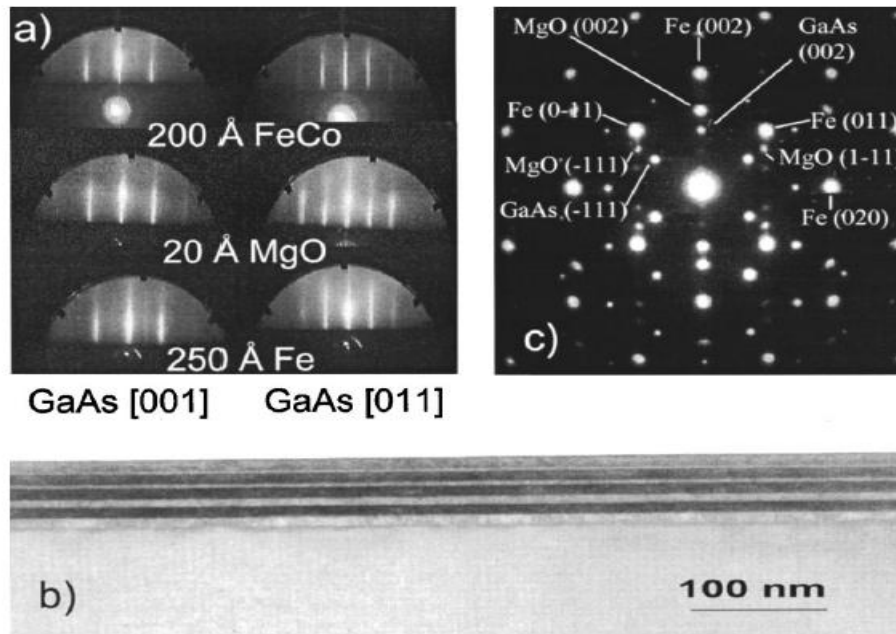


FIG. 1. (a) RHEED patterns along the GaAs [100] and [110] substrate azimuths of a typical FeCo/MgO/Fe epitaxial structure; (b) cross section TEM image of a Fe/MgO(001) multilayer with gradually decreasing MgO layer thickness; (c) TEM electron diffraction pattern.

Figures 1 (a), (b), and (c) of Bowen, above, depict structures of substrates. Ex. 1026, 1656.

Petitioner asserts that a person of ordinary skill in the art would have been motivated to replace Bowen's first ferromagnetic material layer with CoFeB to increase TMR as taught by Wang. Pet. 47–48 (citing Ex. 1055, 2268–2270; Ex. 1024 ¶¶ 253, 256).

Petitioner contends that Bowen teaches a second “upper” ferromagnetic layer. Petitioner asserts that Bowen teaches how to grow a “FeCo/MgO/Fe epitaxial structures” with the “FeCo top electrode,” where “Bowen's upper FeCo electrode was grown on top of, or disposed over, the MgO barrier layer.” Pet. 52 (citing Ex. 1026, 1655, Abstract, Fig. 1 (annotated), 1656; Ex. 1024 ¶¶ 270). Petitioner asserts that this top

electrode is the second ferromagnetic material layer. *Id.* Similar to the contention for the “first ferromagnetic material layer,” Petitioner asserts that one of skill would have substituted Wang’s use of CoFeB in the “second” layer. *Id.* at 52–53 (citing Ex. 1024 ¶¶ 273, 256, 274).

For limitation 1[d]. Petitioner asserts that both Bowen and Wang recognized that annealing would produce better results, so a person of ordinary skill in the art would have annealed CoFeB layers with the expectation of higher TMRs. Pet. 53–54 (Ex. 1026, 1655; Ex. 1055, Abstract; Ex. 1024 ¶ 278). Petitioner also asserts that annealing MTJs with CoFeB layers was routine with a known expectation of success. *Id.* at 54.

Petitioner contends that “[i]t was known that CoFeB layers crystallize at least partially upon annealing.” Pet. 55 (citing Ex. 1061, 2273).

Petitioner refers to Parkin and its disclosure that electron microscopy revealed “that a portion of the [CoFeB] storage layer 175 adjacent to the MgO tunnel barrier 120’ has crystallized.” *Id.* (citing Ex. 1062, 18:51–55) (emphasis omitted). Petitioner argues that “[a]s explained in Ground 1 [based on Parkin, Wang, and Soukup], the crystallized portion of the CoFeB layers adjacent to the MgO tunnel barrier would be an ‘entirely crystallized’ layer, satisfying Claim 1[d].” *Id.* (citing Pet. §VI.A.5; Ex. 1062, 19:17–27 (describing formation of “a thin crystalline layer of CoFeB” that “‘is much lower in B content’”)); Ex. 1061, 2273; Ex. 1024 ¶ 280).

In support, Dr. Bokor testifies that a person of skill in the art “would have understood and known that annealing resulted in crystallized CoFeB layers.” Ex. 1024 ¶ 279 (citing Ex. 1061; Ex. 1060, 31; Ex. 1062). Dr. Bokor testifies that “it was known that if an MgO MTJ with CoFeB layers is

annealed, at least a portion of those CoFeB layers adjacent to the MgO barrier layer would crystallize.” *Id.* ¶ 280 (citing Ex. 1062 (Parkin), 19:17–27). Dr. Bokor testifies that “[i]t is evident” from the cited references “that crystallization was inherent in annealing CoFeB layers.” *Id.* Dr. Bokor further testifies that “[i]n my opinion, after annealing, the portion of the CoFeB layers adjacent to the MgO barrier would be ‘entirely crystallized’ as required by Claim 1[d].” *Id.*

As identified above, Petitioner and Dr. Bokor rely only on a portion or “thin layer” of Bowen’s layers for teaching limitation 1[d]. *See* Pet. 55; Ex. 1024 ¶¶ 279–280. Similar to the discussion above for the ground relying on Parkin, Wang, and Soukup, Petitioner fails to reconcile how its assertions that the first (“Fe(200 Å)”) and second (“FeCo top electrode”) ferromagnetic layers, as mapped, also meet the limitation that the first and second ferromagnetic layers are each “entirely crystallized” when Petitioner relies on the theory that only a portion of the layers is entirely crystallized. Again, Petitioner’s mapping is inconsistent: Petitioner relies upon the entirety of “layers” of Bowen for the teaching of the claimed ferromagnetic layers, but then only relies upon thin portion of their depth for the assertion that the “layers” are entirely crystallized.

Accordingly, Petitioner has not sufficiently demonstrated that the same element identified in Bowen teaches the first ferromagnetic material layer of limitation 1[a] as well as limitation 1[d], which requires the first layer is entirely crystallized, and has not sufficiently demonstrated that the same element identified in Bowen teaches the second ferromagnetic layer of

limitation 1[c] as well as limitation 1[d], which requires that the second layer is entirely crystallized.

Thus, Petitioner has not established a reasonable likelihood of demonstrating that the combination of Bowen, Wang, and Soukup renders obvious independent claims 1, 7, and 12. The other claims challenged under this ground, claims 2–6, 8–11, 13, and 14 depend, directly or indirectly, from claims 1, 7, and 12. The evidence and arguments presented for the dependent claims fail to cure the deficiencies in the showing as to claims 1, 7, and 12. Pet. 57–65. Thus, the challenges to claims 2–6, 8–11, 13, and 14 fail because of their dependencies on claim 1, 7 and 12 for this ground.

Additionally, Petitioner asserts that the combination of Parkin, Wang, Soukup, and Bowen renders obvious dependent claims 5, 6, 11, and 14. Pet. 33–46. The evidence and arguments presented for the dependent claims fail to cure the deficiencies in the showing as to claims 1, 7, and 12. *See id.* Thus, the challenges to claims 5, 6, 11, and 14 fail because of their dependencies on claim 1, 7 and 12 for the Parkin-Wang-Soukup-Bowen ground.

Accordingly, Petitioner has not demonstrated a reasonable likelihood that it would prevail in showing that claims 1–14 would have been rendered obvious by the combination of Bowen, Wang, and Soukup and has not demonstrated a reasonable likelihood that it would prevail in showing that claims 5, 6, 11, and 14 would have been rendered obvious by the combination of Parkin, Bowen, Wang, and Soukup.

IV. CONCLUSION

For the foregoing reasons, we conclude that the information presented in the Petition fails to establish a reasonable likelihood that Petitioner would prevail in showing that at least one claim of the '138 patent is unpatentable. Accordingly, we do not institute *inter partes* review.

V. ORDER

Accordingly, it is:

ORDERED that, pursuant to 35 U.S.C. § 314(a), *inter partes* review is *denied*.

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