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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

WESTERN DIGITAL TECHNOLOGIES, INC.,
Petitioner,

v.

GODO KAISHA IP BRIDGE 1,
Patent Owner.

Case No. IPR2024-01494
Patent No. 11,968,909

PATENT OWNER'S PRELIMINARY RESPONSE

TABLE OF CONTENTS

I.	INTRODUCTION	1
A.	Petitioner’s Sole Alleged Motivation for Modifying the Primary References—to Allegedly Lower Their Barrier Heights—Is Unsupported.....	4
B.	Soukup Does Not Teach a Tunnel Barrier Height	5
II.	MAGNETIC TUNNEL JUNCTION DEVICES.....	6
A.	Overview	6
B.	Use in Non-Volatile Storage Devices	8
C.	“Magnetoresistance Ratio” and “Tunneling Magnetoresistance Ratio” (TMR) Describe the Same Parameter	10
III.	THE ’909 PATENT.....	12
A.	Disclosed Embodiments	12
B.	Challenged Claims.....	16
IV.	PERSON OF ORDINARY SKILL IN THE ART (“POSA”).....	17
V.	GROUND 1 (BOWEN-SOUKUP) FAILS	17
A.	Petitioner’s Sole Alleged Reason Why a POSA Would Have Modified Bowen’s Tunnel Barrier Height Based on Soukup Is Unsupported.....	18
1.	Petitioner Needed to Establish Some Supportable Reason Why Soukup Would Have Motivated a POSA to Modify Bowen in the Manner Alleged to Meet the Claims	18
2.	Petitioner’s Sole Alleged Reason to Reduce Bowen’s Barrier Height Based on Soukup Was to Increase Its TMR, But Petitioner Fails to Support that Allegation.....	19
3.	Petitioner Admits that TMR Depends on R_p <u>and</u> R_{ap} But Never Explains or Even Considers How a Lower Barrier Height Would Affect R_{ap} or How Changes to R_{ap} Would Affect TMR.....	22
4.	Petitioner Fails to Show that Lowering Bowen’s Barrier Height Would Have Increased Its TMR.....	23
a.	The Petition Cites No Teaching in the Art that Lowering the Barrier Height Increases the TMR	26

b. Petitioner’s Expert Declaration Cannot and Does Not Cure the Petition’s Failure	26
5. Conclusion Regarding Petitioner’s Failure to Establish Any Supportable Reason Why a POSA Would Have Modified Bowen Based on Soukup.....	29
B. Petitioner Fails to Establish that Soukup Would Have Motivated a POSA to Pursue a Tunnel Barrier Height of 0.33 eV in Bowen Because Petitioner Fails to Establish that Soukup Discloses a Tunnel Barrier Height.....	30
1. Soukup Did Not Determine a Tunnel Barrier Height	30
a. Soukup’s Devices Are Neither Magnetic, Nor Tunneling Devices	30
i. Soukup’s Devices Are Not Magnetic	30
ii. Soukup Is Not Directed to Tunneling Devices	31
(1) Current Flow Mechanisms for Metal-Insulator-Metal Devices	31
(i) Schottky Emission Current.....	32
(ii) Tunneling Current	32
(iii)Magnetic-Dependent Tunneling Current.....	33
(2) Soukup’s Diode Current Measurements Were Consistent with Schottky Emission.....	33
b. Conclusion.....	35
C. Ground 1 Fails for <i>All</i> Challenged Claims for the Same Reasons It Fails for Claims 5-6	35
VI. GROUND 2 (NAGAHAMA AND SOUKUP) FAILS FOR ALL THE SAME REASONS GROUND 1 FAILS.....	36
VII. STATUTORY DISCLAIMER UNDER 37 C.F.R. § 1.321(A).....	38
VIII.CONCLUSION.....	40
IX. APPENDIX A: U.S. PATENT NO. 11,968,909 CLAIM LIST.....	41

TABLE OF AUTHORITIES

Cases

<i>Cook Group Inc. v. Boston Scientific Scimed, Inc.</i> , IPR2017-00131, Paper 13 (May 15, 2017).....	27
<i>Delta Electronics, Inc. v. Vicor Corporation</i> , IPR2024-00134, Paper No. 8 (PTAB May 17, 2024)	39
<i>Inguran, LLC d/b/a Sexing Technologies v. Premium Genetics (UK) Ltd.</i> , IPR2016-00756, Paper No. 9 (PTAB, August 31, 2016)	39
<i>Instrumentation Lab. Co. v. Hemosonics LLC</i> , IPR2017-00855, Paper 55 (Feb. 13, 2019).....	27
<i>KSR Int’l Co. v. Teleflex Inc.</i> , 550 U.S. 398 (2007).....	18
<i>SFC Co., Ltd. v. LG Chem, Ltd.</i> , IPR2020-00178, Paper No. 16 (PTAB May 29, 2020)	39
<i>Tandus Flooring, Inc. v. Interface, Inc.</i> , IPR2013-00526, Paper No. 7 (PTAB, February 14, 2014)	39
<i>TQ Delta, LLC v. Cisco Sys., Inc.</i> , 942 F.3d 1352 (Fed. Cir. 2019)	18
<i>Unified Patents Inc. v. Sound View Innovations, LLC.</i> , IPR2019-01113, Paper No. 8 (PTAB November 22, 2019).....	39
<i>Unigene Labs., Inc. v. Apotex, Inc.</i> , 655 F.3d 1352 (Fed. Cir. 2011)	18
<i>Xerox Corp. v. Bytemark, Inc.</i> , IPR2022-00624, Paper 9 (Aug. 24, 2022)	28

Statutes

35 U.S.C. § 253(a)	3, 38, 39
35 U.S.C. § 312(a)(3).....	25

Regulations

37 C.F.R. § 1.321(a).....	3, 38, 39
37 C.F.R. § 42.104(b)(5).....	27
37 C.F.R. § 42.107(e).....	38
37 C.F.R. § 42.22(a)(2).....	26
37 C.F.R. § 42.6(a)(3).....	27
37 C.F.R. § 42.65(a).....	28

EXHIBIT LIST

Exhibit	Description
2001	Kittel, C., <i>Introduction to Solid State Physics</i> , 6th Edition, 1986, pgs. 13-15, 18, 23 (“Kittel”)
2002	Duke, C.B., <i>Tunneling in Solids</i> , Solid State Physics: Advances in Research and Applications, 1969, pgs. 1, 6-7, 34-35, 78-79 (“Duke”)
2003	Definition of “ferromagnetism,” Oxford English Reference Dictionary, Second Edition, pg. 513 (“Oxford English Reference Dictionary”)
2004	“Ferromagnetism,” The New Encyclopaedia Britannica: Volume 4, 15th Edition, 2003, pgs. 748-749 (“Britannica”)
2005	Zhu, J.G., et al., <i>Magnetic tunnel junctions</i> , Materials today, Volume 9, Number 11, November 2006, pgs. 36-45 (“Zhu”)
2006	Wulfhekel, W., et al., <i>Single-crystal magnetotunnel junctions</i> , Applied Physics Letters, Volume 78, Number 4, January 2001, pgs. 509-511 (“Wulfhekel”)
2007	RESERVED
2008	RESERVED
2009	RESERVED
2010	RESERVED
2011	RESERVED
2012	RESERVED
2013	RESERVED
2014	RESERVED
2015	RESERVED
2016	RESERVED
2017	RESERVED
2018	Statutory Disclaimer Under 37 C.F.R. § 1.321(a)

I. INTRODUCTION

The challenged patent, U.S. Patent No. 11,968,909 (“the ’909 Patent”), is directed to a ground-breaking advance to a special kind of solid-state electronics device known as a “magnetic tunnel junction” (“MTJ”) device.

In simple terms, MTJ devices have two magnetic electrodes separated by an insulating layer. Under certain conditions, current can flow between the electrodes, through the insulator layer, via a quantum mechanical phenomenon known as “tunneling.” One important parameter of an MTJ device is its “tunnel barrier height,” which in simple terms relates to an energy potential, measured in electron volts (“eV”), that affects tunneling current flow through the insulating layer. The ’909 Patent inventor developed an MTJ device with a lower barrier height than had been achieved previously.

An MTJ device has two different states (referred to as its parallel and antiparallel states) that correspond to different relative magnetizations between its magnetic electrodes as illustrated below. MTJ’s are referred to as “magnetoresistive” devices because the MTJ device resistance R_{ap} in its antiparallel state is higher than the resistance R_p in its parallel state. MTJs are storage devices, with parallel and antiparallel magnetic states being used to encode/decode binary data with one state corresponding to a “0” and the other corresponding to a “1.”

Fig. 8(A) (Low Resistance)

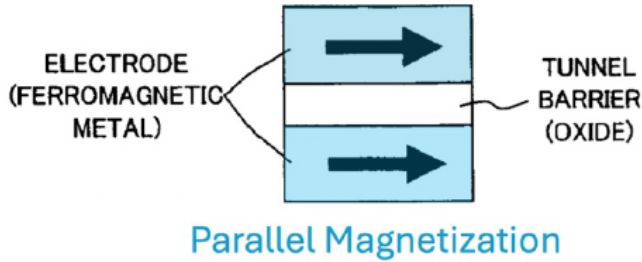
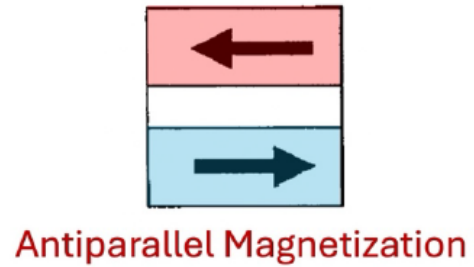


Fig. 8(B) (High Resistance)



A parameter of an MTJ device that Petitioner refers to as the “tunnel magnetoresistance ratio” (“TMR”) represents the difference between the device’s antiparallel resistance (R_{ap}) and its parallel resistance (R_p), normalized by the parallel resistance (R_p), as shown by the formula below reproduced from the Petition. A higher TMR desirably makes it easier to accurately determine whether the MTJ device is in its antiparallel or parallel state because a higher TMR reflects a larger difference between the antiparallel and parallel resistances than for a device with lower TMR.

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

The Petition presents two grounds (Grounds 1 and 2). Both share the same fatal flaws for every Challenged Claim.¹ The Challenged Claims all recite a magnetoresistive device that has, *inter alia*, a tunnel barrier height of 0.1-0.85 eV (claims 5, 9-11, 13-14) or 0.2-0.5 eV (claims 6, 12, 15-20). Petitioner identified no such device in the prior art.

Grounds 1 and 2 rely on different primary references. Both primary references disclose an MTJ device but neither has a tunnel barrier height that meets the claimed range. Grounds 1 and 2 rely on the same secondary reference “Soukup” to purportedly teach a tunnel barrier height of 0.33 eV within the claimed range, and each ground alleges that Soukup would have motivated a POSA to modify the primary reference to use this alleged barrier height. Petitioner’s showing fails for a number of independent reasons.

¹ The ’909 Patent issued with 20 claims. Patent Owner has disclaimed claims 1-4 and 7-8 pursuant to 35 U.S.C. § 253(a) and 37 C.F.R. § 1.321(a). *See* EX2018 (filed February 10, 2025); *see also infra* §VII. Thus, the Petition challenges claims 5-6 and 9-20 (“the Challenged Claims”), which have not been disclaimed. Petition, 16.

A. Petitioner’s Sole Alleged Motivation for Modifying the Primary References—to Allegedly Lower Their Barrier Heights—Is Unsupported

Grounds 1 and 2 offer the same single reason why a POSA allegedly would have been motivated by Soukup to lower the barrier height of the primary reference’s MTJ device. Petitioner alleges that a POSA would have been motivated to do so because lowering the barrier height would have yielded a lower parallel resistance (R_p) and thereby would have increased the device’s tunnel magnetoresistance ratio (“TMR”).

The fatal flaw in Petitioner’s assertion is clear from simple mathematics. Petitioner ignores the impact that lowering the barrier height would have had on the device’s *other* resistance—its antiparallel resistance R_{ap} . As seen from Petitioner’s own TMR equation below, whether a change to an MTJ device that results in a lower parallel resistance R_p would increase the TMR depends entirely on the impact the change would have had on the antiparallel resistance R_{ap} . The TMR would only increase if lowering the barrier height of the MTJ caused the parallel resistance R_p to be reduced by a proportionally greater amount than that by which the antiparallel resistance R_{ap} is reduced. Petitioner does not even allege that this is true, let alone submit evidence to establish it. Thus, Petitioner fails to establish that lowering the barrier height of an MTJ device would increase its TMR.

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

As a result, Petitioner fails to support the *only* reason it alleged for why a POSA would have sought to lower the barrier height in either primary reference. Both grounds fail for this reason alone.

B. Soukup Does Not Teach a Tunnel Barrier Height

Soukup's devices are not tunneling devices. Soukup's research was focused on identifying the current flow mechanism in the metal-insulator-metal emission diodes with non-magnetic (gold) electrodes which are not "*tunnelling* devices" as Petitioner erroneously alleges. EX1028, 3229. Indeed, Soukup's emission diodes are neither magnetic devices nor tunneling devices, let alone *magnetic tunnel* junction devices. Thus, the operation of Soukup's diodes is not impacted by a **magnetic** polarization state of its (non-magnetic) electrodes, which is a fundamental operating principle of an MTJ device.

* * *

For these and other reasons detailed below, Petitioner fails to establish a reasonable likelihood of prevailing on either ground. Institution should be denied.

II. MAGNETIC TUNNEL JUNCTION DEVICES

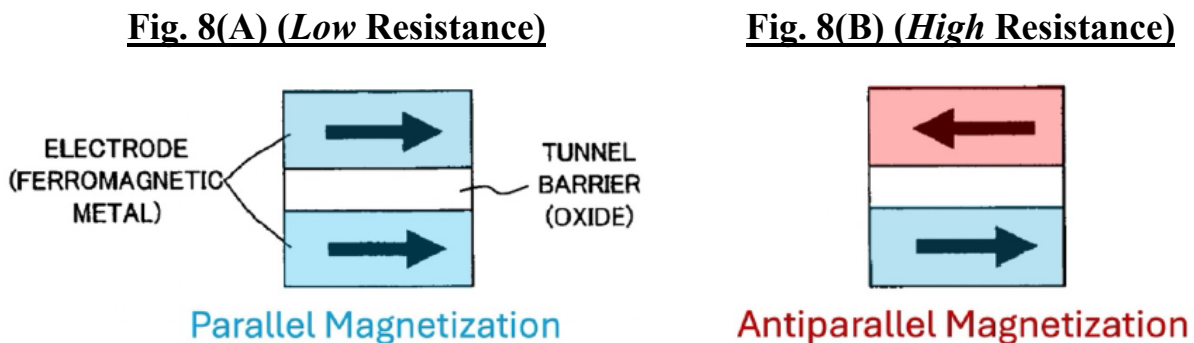
A. Overview

A magnetic tunnel junction device is a special kind of solid-state electronics device. It has an insulator—called a tunnel barrier layer—sandwiched between two ferromagnetic electrodes. EX1017, 1:54-58. In '909 Patent Fig. 1(B) below, the ferromagnetic electrodes 1 and 5 are iron (“Fe”) and the barrier layer 3 is magnesium oxide (“MgO”). The “(001)” in Fig. 1(B) is conventional notation indicating the orientation of crystalline Fe and MgO layers.² EX2001 (“Kittel”), 14. Current flows through an MTJ device—*e.g.*, between electrodes—using a quantum mechanical phenomenon called “tunnelling” that is discussed further below. EX2002 (“Duke”), 1.



² “(001)” identifies a type of crystal plane orientation discussed *infra* §III.A.

The ferromagnetic electrodes are highly susceptible to magnetization. EX2003, 513 (definition of “ferromagnetism”). When an MTJ electrode is subjected to an applied magnetic field, the electrode magnetization may be aligned with the applied magnetic field. EX2004, (“Britannica”), 748. Arrows in ’909 Patent Figures 8(A)-8(B), annotated below, show the magnetization direction in each electrode. An MTJ device is in a “parallel” state when its electrodes have the same magnetization (Fig. 8(A)) and in an “antiparallel” state when its electrode magnetizations point in different directions (Fig. 8(B)). EX1017, 1:60-2:4.



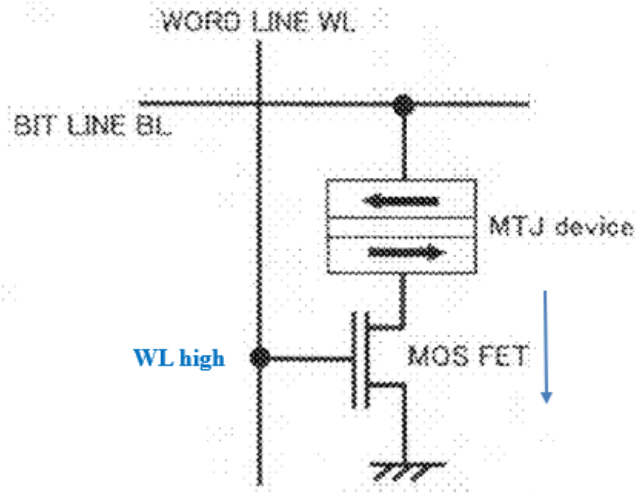
The MTJ device’s resistance to current flow through the device depends on the electrode magnetization, making the MTJ device a magnetoresistive device. *Id.*, 1:60-2:9. The resistance R_{ap} in the antiparallel state is ***higher*** than the resistance R_p in the parallel state. *Id.* By applying appropriate magnetic fields, an MTJ device can be configured in its parallel or antiparallel state. EX1062 (“Parkin”), 1:40-56. An MTJ device is thus a form of programmable resistor because its resistance can be changed by changing the relative magnetization of its electrodes.

B. Use in Non-Volatile Storage Devices

While an MTJ device has many applications, one use is in persistent non-volatile storage devices (*i.e.*, storage that retains data when power is turned off) like a solid-state memory or hard drive.

A solid-state memory can be formed with an array of memory cells that each includes an MTJ device that can store a bit of data. EX1017, 1:37-2:39. The two resistive states of an MTJ device (the parallel low resistance state and the antiparallel high resistance state) can encode a stored bit value as a binary “0” or “1,” respectively. *Id.*, 2:4-7 (“information ‘1’ or ‘0’ can be stored depending on whether the [MTJ] resistance value is high or not”), 2:21-25 (“[s]tored information can be read by reading the resistance value of the MTJ device . . .”). The MTJ device in a memory cell can be a resistive load for a type of transistor referred to as a metal-oxide-semiconductor field effect transistor (“MOSFET”). *Id.*, Figs. 9(B) (annotated below), 9(C), 2:21-25.

antiparallel



A magnetoresistive random access memory (“MRAM”) is a large-scale non-volatile memory device consisting of an array of WORD LINES (“WLs”) and BIT LINES (“BLs”) disposed in an intersecting manner, with an MRAM cell disposed at each intersection. *Id.*, 1:44-50, 2:14-17, Fig. 9(A). When the WL in a MRAM cell is driven high (“WL high”) the MOSFET turns on and current (blue arrow) flows through the MOSFET and the MTJ device on the BL, as illustrated above. This allows determining the resistance of the MTJ device from the BL. *Id.*, 2:18-24. Because the MTJ device has a relatively high resistance R_{ap} in its *antiparallel* state compared to when the MTJ device is in its *parallel* state with relatively low resistance R_p , whether a “0” or “1” is stored in the MTJ memory cell can be determined by assessing whether the resistance on the BIT LINE is relatively high or low. *Id.*, 1:60-2:9; 2:18-24.

An MTJ device can alternatively be used as a read-out sensor for a magnetic disk drive that stores data using different magnetization states on a disk to encode binary “0s” and “1s.” EX1027 (“Nagahama”), [0082]; EX2005 (“Zhu”), 41, Fig. 12. In the read-out sensor, one of the MTJ’s electrodes has fixed magnetization while the other electrode’s magnetization is not fixed and therefore is sometimes called a “free layer.” EX2005, 41, Fig. 12. When the read-out sensor is brought into proximity with a location on the disk that stores a data bit using magnetization, the read-out sensor’s non-fixed MTJ electrode is impacted by the magnetic field of the stored data bit. *Id.* The read-out sensor’s MTJ thus adopts its parallel magnetization state (*e.g.*, when the stored data is a “1”) or its non-parallel magnetization state (*e.g.*, when the stored data is a “0”) depending on the stored data bit’s value. *Id.* When the read-out sensor pulls current through the MTJ to read the stored data bit value, the magnitude of the voltage across the MTJ’s electrodes indicates whether the MTJ is in its low resistive parallel state or its high resistive non-parallel state, and thereby indicates whether the stored data being read is a “1” or a “0.” *Id.*

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

For both above-described exemplary use cases, it is desirable to increase the difference between the MTJ’s parallel (R_p) and antiparallel (R_{ap}) resistances. EX1017, 2:45-3:4. For the same current passing through the MTJ device when a

stored data value is read, a greater difference between R_p and R_{ap} provides a larger difference between the read-out voltages representing a “1” and “0,” respectively. *Id.*, 5:10-16; 8:41-46. This reduces read-out errors by making it easier to distinguish between the voltages reflecting stored “1s” and stored “0s.” *Id.*, 2:61-67.

A parameter the '909 Patent calls the “magnetoresistance ratio” (“MR ratio”) quantifies the difference between the MTJ device’s magnetoresistance in its antiparallel and parallel states. *Id.*, 5:10-16. The '909 Patent represents this ratio as follows:

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

Id.

The MR ratio is thus the difference between the MTJ device’s magnetoresistance in its antiparallel and parallel states, normalized by the magnetoresistance in the parallel state. A relatively larger MR ratio corresponds to a larger proportional difference between the antiparallel resistance R_{ap} and parallel resistance R_p .

The MTJ device parameter the '909 Patent calls the MR ratio is called the “tunnel magnetoresistance ratio” (“TMR”) in the Petition and is represented using the same formula reproduced below. Petition, 5-6 (“Mathematically, TMR for an MTJ is equal to the difference in the resistance between the antiparallel (R_{ap}) and

parallel states (R_p), divided by the parallel state resistance . . . Thus, high antiparallel resistance R_{ap} compared to lower parallel resistance R_p results in high TMR”).

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

Id., 6.

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

III. THE ’909 PATENT

A. Disclosed Embodiments

Dr. Shinji Yuasa, the ’909 Patent inventor, discovered how to make an MTJ device with an increased TMR. EX1017, 8:15-30 (an MTJ device produced using the inventive method achieved “the highest MR ratios that have so far been obtained at room temperature”).

Prior art MTJ devices used an amorphous material (aluminum oxide) as the tunnel barrier layer, meaning that the atoms in the tunnel barrier layer lacked an ordered arrangement. *Id.*, 5:39-47. Dr. Yuasa determined that a barrier layer with a particular ordered arrangement would experience less scattering and that the “coherent states of electrons” would be conserved “during the tunneling process” through the barrier. *Id.*, 5:42-47. Dr. Yuasa determined that this could be achieved

by using a barrier layer comprising single-crystal magnesium oxide (MgO) (001) or poly-crystalline (*i.e.*, made up of multiple crystals) MgO with the (001) crystal plane preferentially oriented. *Id.*, 5:42-6:18.

In a cubic crystal the sides of the cubic structure are in—or parallel to—planes, like the top face of the cube which is in the (001) plane as shown in the annotated figure below. EX2001, 15, Fig. 16. The (001) notation means that a crystalline structure, *e.g.*, crystalline MgO(001), is oriented on the (001) plane.

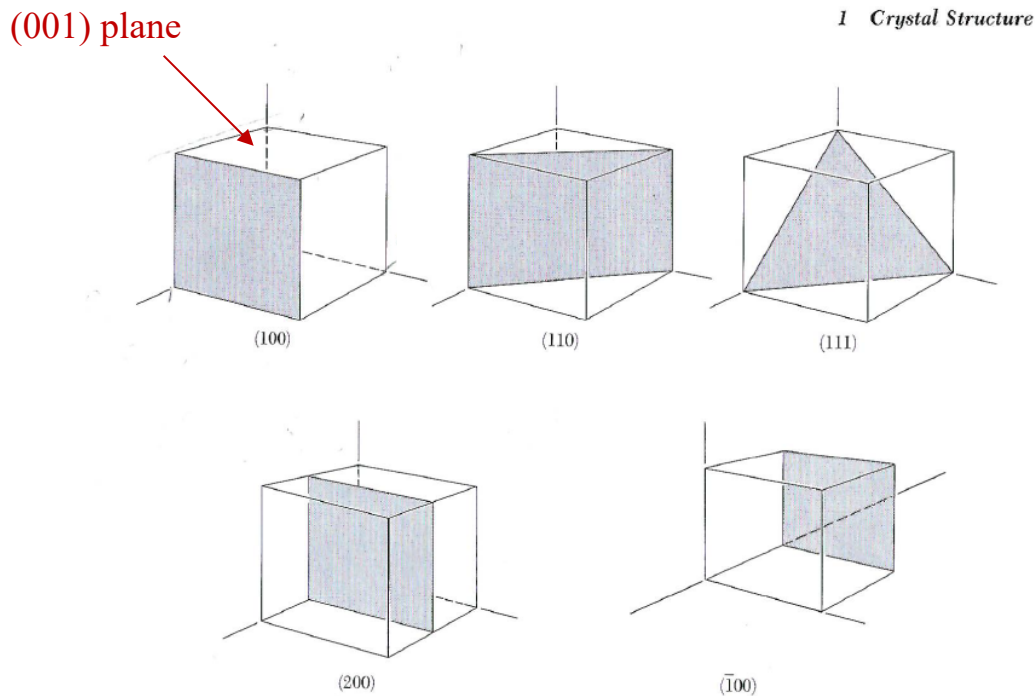


Figure 16 Indices of important planes in a cubic crystal. The plane (200) is parallel to (100) and to $(\bar{1}00)$.

In one embodiment, Dr. Yuasa created an MTJ device with electrodes formed from Fe(001)—a crystalline iron layer with a (001) crystal plane orientation—sandwiching a single-crystalline MgO(001) layer. EX1017, 5:51-

6:46. Oxygen vacancies were formed in the MgO barrier layer during the fabrication process. *Id.*, 7:12-38. An oxygen vacancy refers to the absence of an oxygen atom where one is expected in a crystalline MgO structure. EX1037 (“Castanier”), 1, 3, Fig. 1. Because of the oxygen vacancies, the MgO crystal did not have a 1:1 ratio by atom of magnesium to oxygen. Instead, it was an MgO_x structure where “x” represents the number of oxygen atoms per magnesium atom, and where “x” was a value less than 1. EX1017, 7:19-23, 7:34-36 (“The value of x in MgO_x *due to oxygen vacancy defects* is such that $0.98 < x < 1$, and more preferably $0.99 < x < 1$.”).

Dr. Yuasa noted that an MTJ device having an MgO_x crystalline or polycrystalline structure in which “x” was less than 1 had a lower barrier height than if a perfect single-crystal MgO barrier layer had been used.³ *Id.*, 3:24-28 (“the *height of the tunnel barrier . . . is smaller* than an ideal value of a perfect single-crystal without defect”). The specification refers to work that had been done by Wulfhekel (EX2006). *Id.*, 4:66-5:3. Wulfhekel used ultraviolet photoemission spectroscopy to identify an MgO crystal that was as perfect as could be made “with hardly any oxygen vacancy defect or lattice defect.” *Id.*, 5:6-7. Wulfhekel

³ In conventional notation, “MgO” (*i.e.*, where no x appears) indicates a 1:1 ratio of magnesium and oxygen by atom. EX1017, 6:39-41.

determined that this perfect MgO layer had a barrier height of 3.6 eV. EX2006 (“Wulffhekel”), 509; *see also* EX1017, 7:26-28. The ’909 Patent refers to this as the “ideal value” for the barrier height of an MgO barrier layer because Dr. Yuasa noted that any defects in an MgO barrier layer would reduce its barrier height, *e.g.*, Wulffhekel’s ideal value of 3.6 eV represented an upper limit on the potential barrier height for an MgO barrier layer. EX1017, 4:66-5:7, 7:26-28.

Dr. Yuasa determined that making an MTJ device so that its electrodes had a crystalline structure, and its MgO barrier layer had oxygen defects so it was not a defect-free crystal, resulted in a tunnel barrier height of 0.10 to 0.85 eV—smaller than the 3.6 eV barrier height for an ideal MgO barrier layer. *Id.*, 7:19-23.

Dr. Yuasa estimated the tunnel barrier height in his MTJ device by fitting electrical conductance characteristics (*i.e.*, current-voltage (“I-V”) curves) of the MTJ device to the known Simmons’ formula. *Id.*, 7:39-8:14. Simmons’ formula was the accepted technique for determining the tunnel barrier height for a tunneling device, *e.g.*, where current flowed due to the quantum mechanical phenomenon known as tunneling, which is described *infra* §V.B.1.

Dr. Yuasa discovered that his MTJ devices with crystalline electrodes, and a crystalline MgO barrier layer with oxygen vacancies, had ***increased*** TMR as compared to conventional MTJ devices. EX1017, 3:29-30 (“[t]hese features ***increase the magnetoresistance***”). As discussed *supra* §§II.B-II.C, when the MTJ

is used in a memory cell, increased TMR improves the read-out accuracy for a stored data bit by increasing the differentiation between the voltages that represent stored “0s” and “1s.” EX1017, 3:29-32, Figs. 9(B), 9(C), 10 (“characteristics required for G bit-MRAM”).

B. Challenged Claims

Claims 5-6 and 9-20 are at issue in this proceeding (“Challenged Claims”). Patent Owner disclaimed claims 1-4 and 7-8. *See* EX2018 (filed February 10, 2025); *see also infra* §VII. Claims 5 and 6 depend from disclaimed independent claim 1. Claims 9 and 15 are independent. Every Challenged Claim requires a magnetoresistive device having, *inter alia*, first and second ferromagnetic layers (Limitations 1[a], 9[a], 15[a], 15[c]), a tunnel barrier formed of MgO (Limitations 1[b]-1[c], 9[b]-9[c], 15[b]), and a tunnel barrier height in a range of 0.2-0.5 or 0.1-0.85 eV (Limitations 5, 6, 9[c], 15[b]).⁴ EX1017, col. 9-11.

⁴ Patent Owner adopts Petitioner’s claim limitation labelling. Petition, xvii-xix (“List of Challenged Claims”). In adopting this convention, Patent Owner does not acquiesce to any characterization of the claims.

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

For purposes of this Preliminary Patent Owner Response only, Patent Owner does not challenge Petitioner’s POSA definition (Petition, 18-19) because the Petition fails even if Petitioner’s POSA definition is adopted.

V. GROUND 1 (BOWEN-SOUKUP) FAILS⁵

Bowen discloses a magnetoresistive MTJ device with a crystalline MgO barrier layer, but Petitioner admits that Bowen’s device has a tunnel barrier height that falls outside the range required by every Challenged Claim. Petition, 23-24. Petitioner could not identify a *single* reference that discloses a magnetoresistive device having an MgO barrier layer and a tunnel barrier height within the claimed range.

Petitioner alleges that Soukup teaches a tunnel barrier height within the claimed range and that Soukup would have motivated a POSA to modify Bowen’s device to use such a lower tunnel barrier height to increase its TMR. Petitioner’s assertion that a POSA would have expected that lowering Bowen’s barrier height would have increased the TMR is *entirely unsupported* because, as Petitioner

⁵ Ground 1 does not rely on Sunai or Parkin for the energy barrier height limitation. Ground 1 only includes Sunai and Parkin when challenging disclaimed claim 7. Pet., 59-62; EX2018 [Statutory Disclaimer]; *see also infra* §VII.

admits, TMR depends on **both** parallel (R_p) **and** antiparallel (R_{ap}) resistances, but Petitioner never explains or even considers how a lower barrier height would affect R_{ap} or how changes to R_{ap} would affect TMR. Petition, 34. Petitioner thus fails to substantiate either assertion for at least the two independent reasons discussed in §§V.A-V.B below.

Petitioner thus fails to prove that Ground 1 meets all the requirements of any Challenged Claim for the reasons discussed in §§V.A-V.B below.

A. Petitioner’s Sole Alleged Reason Why a POSA Would Have Modified Bowen’s Tunnel Barrier Height Based on Soukup Is Unsupported

1. Petitioner Needed to Establish Some Supportable Reason Why Soukup Would Have Motivated a POSA to Modify Bowen in the Manner Alleged to Meet the Claims

To demonstrate any Challenged Claim was obvious, Petitioner needed to establish some supportable non-hindsight **reason why** a POSA “would have selected and combined [the] prior art elements” in a manner that “yield[s] the claimed invention.” *Unigene Labs. v. Apotex*, 655 F.3d 1352, 1360 (Fed. Cir. 2011); *see also KSR Int’l v. Teleflex*, 550 U.S. 398, 418 (2007) (establishing obviousness requires establishing some **reason** to combine the prior art in the manner claimed); *TQ Delta v. Cisco Sys.*, 942 F.3d 1352, 1359 (Fed. Cir. 2019) (reversing the Board’s obviousness determination because the Board “fails to

identify any actual *reason why* a skilled artisan would have combined the elements in the manner claimed.”) (internal citations omitted)).

2. Petitioner’s Sole Alleged Reason to Reduce Bowen’s Barrier Height Based on Soukup Was to Increase Its TMR, But Petitioner Fails to Support that Allegation

Petitioner offers a single reason why a POSA allegedly would have been motivated by Soukup to lower the barrier height of Bowen’s MTJ device—because lowering the barrier height would have allegedly yielded a lower parallel resistance (R_p) and thereby would have allegedly increased the device’s TMR. No credible evidence supports this assertion because, as Petitioner admits, TMR depends on *both* R_p *and* R_{ap} , but Petitioner never explains or even considers how a lower barrier height would affect R_{ap} or how changes to R_{ap} would affect TMR. Petition, 34.

Petitioner admits that Bowen’s tunnel barrier height is outside of the claimed ranges of 0.1-0.85 eV and 0.2-0.5 eV. Petition, 33 (alleging Bowen “place[d] the barrier height at $\phi = 0.9$ eV”). Instead, Petitioner alleges that Soukup teaches a “barrier height” within these claimed ranges and that a POSA had reason to use Soukup’s “barrier height” in Bowen. Petition, 33-36.

Even if Soukup taught a tunnel barrier height within the claimed ranges (it does not as explained below in §V.B), in order to prove obviousness Petitioner needed to establish some *reason why* a POSA would have modified Bowen to

provide Soukup's alleged barrier height (*supra* §V.A.1). Petitioner's **only** reason is its allegation that lowering the barrier height would have yielded a lower parallel resistance (R_p) and thereby **increased its TMR**. Petition, 33-36.

More specifically, Petitioner asserts that a POSA "would have been motivated to apply Soukup's . . . 'barrier height' of 'about 0.33 eV' to Bowen's MgO barrier" because "lowering the resistance (barrier height)⁶ for parallel electrons (R_p) would improve TMR" by "**increasing TMR** to enable better performing MRAM [magnetoresistive random access memory]." *Id.*, 34; *see also id.*, 35 (alleging that a POSA "looking to **increase TMR** of an MgO barrier would have been motivated to explore lower barrier heights to facilitate tunneling of

⁶ As the Petition acknowledges, barrier height is not the same thing as parallel resistance R_p . *See e.g.*, Petition, 8-9 ("tunnel barrier height represents the difference between the bottom of the conduction band of the tunnel barrier layer and the Fermi level of electrons in the conductor"), 11 (tunnel barrier height is measured in electron volts (eV), not Ohms that measure resistance), 34 (alleging that Soukup teaches a barrier height despite Soukup's device having **non-magnetic** electrodes and not being MTJ devices that even have parallel (R_p) and antiparallel (R_{ap}) resistances as discussed *supra* §II.A).

parallel electrons”) and 36 (alleging that a POSA “would have been motivated to . . . **improve TMR by lowering the barrier height** as taught by Soukup.”).

Petitioner says that the **way** a POSA would have lowered Bowen’s barrier height was by increasing oxygen vacancy defects in the MgO barrier layer.

Petition, 34-35 (alleging that in Soukup “a higher level of oxygen vacancy defects lowered the barrier height”). This offers no different reason why a POSA would have sought to lower the barrier height in the first place; the **only** reason Petitioner alleged to lower the barrier height was to allegedly increase the TMR. Petition, 36 (“one of skill would have been motivated to adjust oxygen vacancy defects **to improve TMR by lowering the barrier height** as taught by Soukup”).

Petitioner’s assertion that a POSA would have expected that lowering Bowen’s barrier height would have increased the TMR is **entirely unsupported** because, as Petitioner admits, TMR depends on **both** parallel (R_p) **and** antiparallel (R_{ap}) resistances, but Petitioner never explains or even considers how a lower barrier height would affect R_{ap} or how changes to R_{ap} would affect TMR. Petition, 34. Thus, even if a POSA had motivation to increase Bowen’s TMR, Petitioner’s sole alleged motivation for making the Bowen-Soukup combination fails because nothing supports Petitioner’s assertion that a POSA would have expected that lowering Bowen’s barrier height would have increased the TMR.

3. Petitioner Admits that TMR Depends on R_p and R_{ap} But Never Explains or Even Considers How a Lower Barrier Height Would Affect R_{ap} or How Changes to R_{ap} Would Affect TMR

Petitioner admits that the TMR is impacted by both the MTJ device's parallel (R_p) and antiparallel (R_{ap}) resistances. Petition, 5-6 (“high antiparallel resistance R_{ap} compared to lower parallel resistance R_p results in high TMR”). Petitioner illustrates this using the below formula:

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

Id., 6.

Petitioner asserts that lowering the barrier height would “lower[] the resistance . . . for parallel electrons (R_p) [and thereby] would improve [*i.e.*, increase] TMR.” *Id.*, 34. Petitioner’s argument is premised on the implicit and entirely unsupported assumption that lowering Bowen’s barrier height would not have also lowered its antiparallel resistance R_{ap} by proportionally the same (or greater) amount than it would have lowered the parallel resistance R_p .

As Petitioner’s expert concedes, to increase the TMR by lowering the parallel resistance R_p , R_p must be lowered “***compared to*** [the] antiparallel” resistance R_{ap} . EX1024 (“Bokor Decl.”), ¶169. Indeed, as a matter of simple math, the parallel resistance R_p must be lowered by a ***proportionally greater amount*** than

the antiparallel resistance R_{ap} to increase the TMR.⁷ For example, an MTJ device with an R_{ap} of 8 and an R_p of 4 would have a TMR of $(8-4)/4=1$. If R_{ap} and R_p were both reduced proportionally by half, that would not change the TMR: $(4-2)/2=1$. And if R_{ap} is reduced by a proportionally greater amount than R_p , that would have had the *opposite* effect and would have undesirably *decreased* Bowen's TMR.

4. Petitioner Fails to Show that Lowering Bowen's Barrier Height Would Have Increased Its TMR

Petitioner alleges a POSA "would have been motivated to adjust oxygen vacancy defects to improve [*i.e.*, increase⁸] TMR by lowering the barrier height as taught by Soukup." Petition, 36. Petitioner alleges that "[a]ccording to the equation for TMR, *lowering the resistance* (barrier height) for *parallel electrons* (R_p) would improve [*i.e.*, increase] TMR." *Id.*, 34.

⁷ For completeness, lowering the parallel resistance R_p would increase TMR if: (1) R_{ap} remained unchanged; (2) R_{ap} increased; or (3) R_{ap} decreased, but by proportionally less than the amount by which R_p decreased. All three scenarios fall under the umbrella of the parallel resistance R_p needing to be lowered by a proportionally greater amount than the anti-parallel resistance R_{ap} , and thus that is the language used herein.

⁸ TMR is improved by "increasing TMR." Petition, 34; *see also supra* §II.C.

But as the “equation for TMR” shows, Petitioner fatally ignores the impact that lowering the barrier height would have had on the *antiparallel resistance* R_{ap} . As a result, Petitioner fails to substantiate its assertion that lowering Bowen’s barrier height would have increased its TMR.

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

Id., 6.

As explained above, the formula for TMR is quite simple. As a matter of straightforward math, to support its assertion that a POSA would have been motivated to lower Bowen’s barrier height because it would have lowered the parallel resistance R_p and thereby “increas[ed] TMR” (Petition, 34; *supra* §V.A.2), Petitioner needed to establish that lowering the barrier height would have either (1) had no impact on the antiparallel resistance R_{ap} despite lowering the parallel resistance R_p , (2) increased R_{ap} despite lowering R_p , or (3) reduced R_{ap} by a *proportionally smaller* amount than R_p is reduced (*supra* §II.C). Yet, Petitioner did not even allege that any of these was true, let alone submit *evidence* to establish that any of these was true.

Petitioner’s discussion of the TMR makes a single reference to “compar[ing]” the parallel and antiparallel states. Petition, 34. Petitioner alleges that “Butler and Mathon 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.” Petition, 34 (*citing* EX1044 (“Butler”) at 1, EX1046 (“Mathon”) at 1, and EX1024 ¶170). But neither Butler nor Mathon teaches that lowering the barrier height increases the TMR.⁹ Indeed, as the Petition concedes, “Butler and Mathon taught that MgO barriers would achieve higher TMRs *due to improved symmetry matching between the MgO barrier and ferromagnetic electrodes*”—not due to lowering barrier height. Petition, 34. Thus, Petitioner’s only reference to teachings in the art about *how* to increase the TMR (*id.*, 34) is obfuscation because those teachings never say that lowering the barrier height increases the TMR and thus do not support Petitioner’s alleged motivation to modify Bowen based on Soukup.

Petitioner never even alleges that lowering Bowen’s barrier height would have lowered its parallel resistance R_p by a *proportionally greater amount relative to the antiparallel resistance R_{ap}* as would have been required to increase the TMR. That should end the matter because the Petition was required to state its grounds “with particularity” (35 U.S.C. § 312(a)(3)) and to have “Content” that

⁹ Butler never mentions barrier height and Mathon reports a barrier height of about 3.6 eV (EX1046, 1), well above the claimed range.

includes “a detailed explanation of the significance of the evidence” (37 C.F.R. § 42.22(a)(2)). The Petition does not even allege facts sufficient to substantiate its assertion that lowering Bowen’s barrier height would have increased its TMR.

Even if the Petition is somehow read as having alleged that lowering Bowen’s barrier height would have lowered its parallel resistance R_p by a *proportionally greater amount* relative to the antiparallel resistance R_{ap} as would be required to increase the TMR (it did not), the Petition cites no *evidence* that would support such an assertion.

a. The Petition Cites No Teaching in the Art that Lowering the Barrier Height Increases the TMR

Petitioner does not cite a single reference that teaches that lowering the barrier height in an MTJ device like Bowen’s would have lowered the parallel resistance R_p proportionally more than the antiparallel resistance R_{ap} and thereby increase the TMR. Petition, 33-36. There is good reason for this because there is no reason to believe that lowering Bowen’s barrier height would have increased the TMR.

b. Petitioner’s Expert Declaration Cannot and Does Not Cure the Petition’s Failure

The Petition’s section addressing claims 5-6 (reciting barrier heights of 0.1-0.85 and 0.2-0.5 eV) cites seventeen paragraphs of testimony from Dr. Bokor spanning about nine pages of his declaration. Petition, 33-37. Dr. Bokor, in turn,

cites *eight references* that are *never even cited*—let alone explained—in the *Petition*’s showing for claims 5-6. EX1024, ¶¶165-181. None of that argument and evidence can save Petitioner because it cannot be incorporated by reference into the *Petition*. *Instrumentation Lab. v. Hemosonics*, IPR2017-00855, Paper 55, 20 (PTAB Feb. 13, 2019) (citing 37 C.F.R. § 42.6(a)(3)); *Cook Group v. Boston Scientific Scimed*, IPR2017-00131, Paper 13, 15 (PTAB May 15, 2017); 37 C.F.R. § 42.104(b)(5).

But even if the Board were to wade into the Bokor Declaration, the Board would not find any evidence supporting Petitioner’s assertion that lowering Bowen’s tunnel barrier height would have increased Bowen’s TMR. EX1024, ¶¶46-48, 165-181. Dr. Bokor makes the same conclusory argument the *Petition* does—often in language that parrots the *Petition verbatim*. Like the *Petition* does, Dr. Bokor fatally ignores the impact that lowering Bowen’s barrier height would have had on its antiparallel resistance R_{ap} .

Dr. Bokor admits that increasing the TMR requires lowering the parallel resistance R_p “compared” to the antiparallel resistance R_{ap} . EX1024, ¶¶169 (“lowering the resistance (barrier height) for parallel spin electrons *compared to antiparallel* [spin electrons] improved TMRs”), 170 (referring to a higher TMRs as “facilitating tunneling of parallel electrons across the barrier *compared to*

antiparallel tunneling.”). Despite that, Dr. Bokor never addresses the impact that lowering Bowen’s barrier height would have had on its antiparallel resistance R_{ap} .

Thus, Dr. Bokor *never even alleges* that a POSA would have believed that lowering Bowen’s barrier layer would have lowered its parallel resistance R_p by proportionally more than it would have lowered its antiparallel resistance R_{ap} as would be required to increase the TMR. Dr. Bokor’s declaration shares the same fatal deficiency as the Petition.

Dr. Bokor simply states the naked conclusion 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.” EX1024, ¶171. This conclusory testimony offers no reasoning or explanation addressing the impact that lowering the barrier height would have on Bowen’s *antiparallel* resistance R_{ap} , and cites no corroborating evidence to support its conclusory assertion that lowering the barrier height would have increased the TMR. This testimony warrants no weight under the Board’s precedential *Xerox* case. *Xerox Corp. v. Bytemark, Inc.*, IPR2022-00624, Paper 9, 15 (PTAB Aug. 24, 2022) (precedential) (“*Xerox*”) (“the cited declaration *testimony is conclusory and unsupported*, adds little to the conclusory assertion for which it is offered to support, and is *entitled to little weight*”) (citing 37 C.F.R. § 42.65(a) (“Expert testimony that does not disclose the

underlying facts or data on which the opinion is based is entitled to little or no weight’’)).

The failure to address the impact that lowering Bowen’s barrier height would have had on Bowen’s antiparallel resistance R_{ap} is a glaring omission in Dr. Bokor’s testimony. Likely Dr. Bokor offered no testimony that lowering Bowen’s barrier layer would have lowered its R_p *by proportionally more than its R_{ap}* as would be required to increase the TMR because there is no factual basis for such a position.

5. Conclusion Regarding Petitioner’s Failure to Establish Any Supportable Reason Why a POSA Would Have Modified Bowen Based on Soukup

The sole reason Petitioner advances for why a POSA allegedly would have modified Bowen to adopt Soukup’s alleged barrier height of 0.33 eV was to increase TMR “by lowering the barrier height.” Petition, 36; *see also id.*, 35 (POSA “would have been motivated to achieve Soukup’s barrier height . . . to improve . . . TMR”), 6 (TMR is improved by increasing it) and 41 (same). Yet, as detailed above, Petitioner fails to establish that a POSA would have believed that adopting Soukup’s alleged lower barrier height in Bowen would have increased Bowen’s TMR. *See supra* §V.A.4.

Thus, Ground 1’s obviousness showing fails because Petitioner fails to establish any reason, *supported by the evidence*, why a POSA would have

modified Bowen to adopt Soukup’s alleged barrier height. *See supra* §V.A.1 (citing authority establishing that a reason is required).

Ground 1 also fails for an additional independent reason detailed in §V.B below.

B. Petitioner Fails to Establish that Soukup Would Have Motivated a POSA to Pursue a Tunnel Barrier Height of 0.33 eV in Bowen Because Petitioner Fails to Establish that Soukup Discloses a Tunnel Barrier Height

1. Soukup Did Not Determine a Tunnel Barrier Height

Soukup’s tested emission diodes are not tunneling devices at all. Thus, as discussed in more detail below, Petitioner fails to establish that the “barrier height” values that Soukup reported are “*tunnel* barrier heights” as claimed. Petitioner fails to support its assertion that Soukup would have motivated a POSA to lower Bowen’s tunnel barrier height (Petition, 33-36) when Soukup does not disclose any value for a *tunnel* barrier height.

a. Soukup’s Devices Are Neither Magnetic, Nor Tunneling Devices

Soukup’s devices are neither magnetic nor tunneling devices, let alone magnetic tunnel junction devices.

i. Soukup’s Devices Are Not Magnetic

Soukup describes research into the carrier transport mechanism of emission diodes having gold (“Au”) electrodes. EX1028 (“Soukup”) , 3229 (“voltage-current characteristics of Au-MgO-Au thin-film emission diodes . . . are consistent

with . . . Schottky field emission”). It was well-known that gold is not magnetic. EX1027, [0011]-[0012] (“nonmagnetic” gold “interlayer”), [0043] (“nonmagnetic . . . layer is formed of Au”).

Soukup characterized the behavior of sixty “thin-film *emission diodes*” comprising MgO depositions between non-magnetic gold electrodes by measuring their currents at different voltages and temperatures. EX1028, 3229, 3230 (“Measurements of the *I-V* characteristics were made”), Fig. 3. Soukup’s devices are thus not magnetic.

ii. Soukup Is Not Directed to Tunneling Devices

Soukup’s research was focused on identifying the current flow mechanism in the tested metal-insulator-metal emission diodes. And the tested devices were not “*tunnelling* devices” as Petitioner erroneously alleges.

(1) Current Flow Mechanisms for Metal-Insulator-Metal Devices

Soukup recognized that several “possible current flow mechanisms from metal to metal have been proposed for metal-insulator-metal sandwich devices” like his emission diodes. EX1028, 3229. The insulator layer in these devices meant none of these mechanisms were typical current flow through a conductive wire, because the insulator was a barrier that blocked such conventional current. EX1031 (“Simmons”), 1794 (“[T]he insulating film . . . introduce[s] a potential barrier . . . which impedes the flow of electrons between the electrodes.”).

(i) *Schottky Emission Current*

One way current flows between two electrodes separated by an insulator is when electrons in one electrode are sufficiently energized that they overcome the insulator's resistance to current flow—*i.e.*, the electrons have more energy than required to overcome the insulator's potential barrier (*e.g.*, the barrier height). EX1031, 1794 (describing current flow “if . . . electrons in the electrodes have enough thermal energy to surmount the potential barrier”); EX1028, 3229 (“*If the barrier is low enough* some electrons will have *enough thermal energy to surmount the barrier* and give rise to a Schottky current when a field is applied.”); EX2002, 34-35 (comparing “tunneling current” with “thermionic emission current *over* the potential barrier”). Soukup found that the current in his emission diodes was consistent with this mechanism, known as Schottky field emission. EX1028, 3229.

(ii) *Tunneling Current*

Tunneling is a *different* type of current flow mechanism through an insulator than Schottky field emission (*e.g.*, Richardson-Schottky current) over a barrier. EX1031, 1793 (current flow by “tunnel effect”), 1794 (describing current flow through insulator “if . . . [t]he barrier is *thin enough* to permit its penetration by the electric tunnel effect”). In simple terms, tunneling—a purely quantum mechanical effect—occurs when certain conditions of the insulator, electrodes, and

electrons are met that result in current flow through the insulator even though the electron's energy is *not sufficient to overcome* the insulator's potential barrier that opposes conventional current flow.

(iii) *Magnetic-Dependent Tunneling Current*

Magnetic tunnel junctions use a special type of tunneling that depends on a combination of factors including at least the materials that form the barrier layer, the structure of the barrier layer, the thickness of the barrier layer, the materials forming ferromagnetic electrodes, and the symmetry between the materials that form the electrodes and the barrier layer. EX1026, 1655 (“[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.”).

(2) **Soukup's Diode Current Measurements Were Consistent with Schottky Emission**

Soukup studied emission diodes, not MTJ devices. The diodes had non-magnetic (gold) electrodes and an MgO insulator between them. EX1028, 3230, 3233, Fig. 1. In simple terms, emission diodes allow current flow in only one direction, when the diode's anode is positively biased relative to the opposing electrode. *Id.*, 3230, Fig. 2 (illustrating “anode”), 3233 (“[t]he only way in which an emission current was observed was with both the overlayer and anode biased

positively with respect to the underlayer.”). It was known before Soukup’s research *that* current flows through emission diodes. *Id.*, 3229. The purpose of Soukup’s research was to determine *how* and *why* current flowed in those devices, *i.e.*, what is the “current flow mechanism[.]” *Id.*, 3235 (“SUMMARY”).

Soukup characterized the diodes by measuring their current (I)-voltage (V) characteristics (also called the I - V characteristics), and determined that his measured results were consistent with Schottky field emission as explained *supra* §V.B.1.a.i. EX1028, 3229 (“The voltage-current characteristics of Au-MgO-Au thin-film emission diodes . . . are consistent with an expression derived for Schottky field emission into the conduction band of the oxide.”), 3230 (I - V “functional dependence . . . is the same as for Schottky emission.”), 3232 (“the functional dependence of I upon V indicates a Schottky mechanism”), 3235-36 (discussing evidence of Schottky emission).

Soukup found that tunneling was *not* the current flow mechanism in the diodes he tested because tunnelling was inconsistent with the observed I - V (*i.e.*, current-voltage) measurements in several sample diodes. *Id.*, 3230 (“the Fowler-Nordheim [tunneling] equation *does not hold* for these devices”), 3235 (“[a] number of current flow mechanisms were ruled out”); *cf.* EX2002, 7 (“calculation [] made by Fowler and Nordheim” is one “application of the idea of tunneling.”).

b. Conclusion

Soukup's emission diodes are neither magnetic devices nor tunneling devices, let alone *magnetic tunnel* junction devices. Thus, the operation of Soukup's diodes is not impacted by a **magnetic** polarization state of its (non-magnetic) electrodes, which is a fundamental operating principle of an MTJ device. *See supra* §II.A. Soukup's emission diodes have non-magnetic (gold) electrodes. EX1028, 3229. Soukup's devices do not have parallel (R_p) and antiparallel (R_{ap}) resistances, let alone a TMR that quantifies a difference between those magnetic-state-dependent resistances. *See supra* §II.C.

C. Ground 1 Fails for *All* Challenged Claims for the Same Reasons It Fails for Claims 5-6

Like claims 5 and 6, independent claims 9 and 15 all require a “magnetoresistive device” with a “tunnel barrier height” of 0.1-0.85 or 0.2-0.5 eV. *See* Limitations 1[preamble], 5, 6, 9[preamble], 9[c], 15[preamble], and 15[b].

Ground 1 alleges that independent claims 9 and 15 are rendered obvious by the same Bowen-Soukup combination alleged to meet claims 5-6. Petition, 19 and 42-46. Petitioner fails to establish any supportable reason why a POSA would have made the Bowen-Soukup combination as discussed *supra* §§V.A-V.B. Ground 1's showing for claims 9 and 15 fail for those same reasons.

Additionally, in mapping independent claims 9 and 15 to Ground 1's Bowen-Soukup combination, the Petition's showing for how and why the Bowen-

Soukup combination allegedly meets the limitations that require a tunnel barrier height of 0.1-0.85 eV or 0.2-0.5 eV only cross-references its earlier analysis for Limitation 1[c] and claims 5 and 6. *See* Petition, 43 (Limitation 9[c] analysis merely says “*Supra* Claim 1[c] and 5, §§VI.A.4, VI.E”), 44 (Limitation 15[b] analysis merely says “*Supra* Claims 1[c] and 6, §§VI.A.4, VI.F”). Thus, Petitioner’s showing for each of independent claims 9 and 15 inherits all the above-discussed failures for claims 5 and 6.

Ground 1 fails for *all* Challenged Claims for all of the same reasons it fails for claims 5 and 6.

VI. GROUND 2 (NAGAHAMA AND SOUKUP) FAILS FOR ALL THE SAME REASONS GROUND 1 FAILS

Ground 2 uses a different primary reference—Nagahama instead of Bowen—than Ground 1 to purportedly disclose a magnetoresistive device (an MTJ) that has an MgO barrier layer and meets all the limitations of the independent claims other than the tunnel barrier height. Petition, 47-67 (citing EX1027, [0074]-[0075]).

Nagahama does not disclose the device’s tunnel barrier height. Petitioner relies on the same Soukup reference used in Ground 1 to meet the tunnel barrier height limitation required by every Challenged Claim.

For claims 5-6's tunnel barrier heights of 0.1-0.85 eV and 0.2-0.5 eV, Ground 2's arguments closely track Ground 1's arguments, often word-for-word. *Compare* Petition, 57-59 *with* Petition, 33-37.

Petitioner again relies on Soukup's alleged disclosure of a "'barrier height' of 'about 0.33 eV.'" Petition, 57. As shown below, Ground 2 alleges that a POSA "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" in the same way Ground 1 alleges that Soukup would have motivated a POSA to adopt this alleged barrier height in Bowen. Petition, 57 and 33-34.

Ground 2 states that "[a]s explained for Claim 5 in Ground 1, TMR was an 'important parameter'" and that a POSA was motivated to "improve [*i.e.*, increase] TMR." *Compare* Petition, 57-58 *with* 34. Like Ground 1, Ground 2 cites to Butler and Mathon to purportedly teach a desire to improve TMR. *Compare* Petition, 58 *with* 34.

Ground 2 alleges that "[a]s explained for Claim 5 in Ground 1 . . . lowering the resistance (barrier height) for parallel electrons would improve TMR." Petition, 57-58; *compare with* 34 (Ground 1: "lowering the resistance (barrier height) for parallel electrons (R_p) would improve TMR"). This assertion fails for the same reasons discussed *supra* §V.A in connection with Ground 1, because Petitioner again fatally ignores the impact that lowering the barrier height would have had on

the antiparallel resistance R_{ap} which is critical to determining whether a change to barrier height would increase, decrease, or have no effect on the TMR.

Thus, Ground 2 (like Ground 1) fails for all the same reasons discussed *supra* §§V.A-V.B in connection with Ground 1, because:

- Petitioner’s assertion that a POSA would have expected that lowering Nagahama’s barrier height would have increased the TMR is entirely unsupported because Petitioner fails to address the impact of lowering the tunnel barrier height on R_{ap} and thus on TMR (*supra* §V.A.1-5);
- Petitioner fails to prove that Soukup teaches a ***tunnel*** barrier height at all because Soukup is not a tunneling device and Soukup did not determine a ***tunnel*** barrier height in a tunneling device (*supra* §V.B);

As demonstrated above, Ground 2 shares every flaw identified above for Ground 1 and thus fails for the same reasons that Ground 1 fails.

VII. STATUTORY DISCLAIMER UNDER 37 C.F.R. § 1.321(A)

On February 10, 2025, Patent Owner filed a statutory disclaimer, disclaiming claims 1-4 and 7-8 of the ’909 patent under 35 U.S.C. § 253(a) and in compliance with 37 C.F.R. § 1.321(a), using the form approved for such submissions by the Office and accompanied by the appropriate fee. EX2018. Because “no *inter partes* review will be instituted based on disclaimed claims” (37 C.F.R. § 42.107(e)), Patent Owner respectfully submits that institution of a trial

here would be improper with respect to disclaimed claims 1-4 and 7-8. *See Unified Patents Inc. v. Sound View Innovations, LLC.*, IPR2019-01113, Paper No. 8, 7-8 (PTAB November 22, 2019) (denying institution and holding that “[b]ecause [some of the challenged] claims . . . have been disclaimed under 35 U.S.C. § 253(a) in compliance with 37 C.F.R. § 1.321(a), we cannot institute a trial on these claims”); *SFC Co., Ltd. v. LG Chem, Ltd.*, IPR2020-00178, Paper No. 16, 7-8 (PTAB May 29, 2020) (similar); *Delta Electronics, Inc. v. Vicor Corporation*, IPR2024-00134, Paper No. 8, 11-12 (PTAB May 17, 2024) (similar); *see also Tandus Flooring, Inc. v. Interface, Inc.*, IPR2013-00526, Paper No. 7 (PTAB, February 14, 2014) (denying institution of trial because patent owner had disclaimed all of the challenged claims); *Inguran, LLC d/b/a Sexing Technologies v. Premium Genetics (UK) Ltd.*, IPR2016-00756, Paper No. 9 (PTAB, August 31, 2016) (same).

VIII. CONCLUSION

Petitioner fails to meet its burden to demonstrate a likelihood of showing that any Challenged Claim is unpatentable. The Board should deny institution.

Respectfully submitted,
GODO KAISHA IP BRIDGE I

Date: February 11, 2025

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IX. APPENDIX A: U.S. PATENT NO. 11,968,909 CLAIM LIST¹⁰

Ref	Limitation
1[preamble]	A magnetoresistive device comprising a magnetic tunnel junction structure comprising a multi-layer material stack including:
1[a]	first and second ferromagnetic material layer; and
1[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,
1[c]	wherein said tunnel barrier layer comprises crystalline $\text{MgO}_x(001)$ with oxygen vacancy defects and $(0 < x < 1)$.
2	The magnetoresistive device of claim 1, wherein $0.9 < x < 1$.
3	The magnetoresistive device of claim 2, wherein $0.98 < x < 1$.
4	The magnetoresistive device of claim 3, wherein $0.99 < x < 1$.
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.
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.
7	The magnetoresistive device of claim 1, wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer comprises Boron.
8	The magnetoresistive device of claim 1, wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer is partially or entirely crystallized.

¹⁰ Claims 1-4 and 7-8 have been disclaimed. See EX2018.

Ref	Limitation
9[preamble]	A magnetoresistive device comprising a magnetic tunnel junction structure comprising:
9[a]	first and second ferromagnetic material layer; and
9[b]	a tunnel barrier layer between the first and second ferromagnetic material layers,
9[c]	wherein said tunnel barrier layer comprises magnesium oxide and has a barrier height in a range of 0.1 eV to 0.85 eV.
10	The magnetoresistive device of claim 9, wherein the tunnel barrier layer comprises partially or fully crystalline magnesium oxide.
11	The magnetoresistive device of claim 10, wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer is partially or entirely crystallized.
12	The magnetoresistive device of claim 11, wherein the barrier height is in a range of 0.2 eV to 0.5 eV.
13	The magnetoresistive device of claim 11, wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer exhibits a body-centered cubic (BCC) structure.
14	The magnetoresistive device of claim 11, wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer comprises Cobalt and Iron.
15[preamble]	A magnetoresistive device comprising:
15[a]	a first ferromagnetic material layer;
15[b]	a tunnel barrier comprising magnesium oxide and having a barrier height in a range of 0.2 eV to 0.5 eV; and

Ref	Limitation
15[c]	a second ferromagnetic material layer disposed on the tunnel barrier layer and separated from the first ferromagnetic material layer by the tunnel barrier layer.
16	The magnetoresistive device of claim 15, wherein the tunnel barrier layer comprises partially or fully crystalline magnesium oxide.
17	The magnetoresistive device of claim 16, wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer is partially or entirely crystallized.
18	The magnetoresistive device of claim 17, wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer exhibits a body-centered cubic (BCC) structure.
19	The magnetoresistive device of claim 17, wherein the first ferromagnetic material layer and/or the second ferromagnetic material layer comprises Cobalt and Iron.
20	The magnetoresistive device of claim 15, wherein the tunnel barrier layer has a thickness less than 10 nm.

CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24, the undersigned certifies that the foregoing **PATENT OWNER'S PRELIMINARY RESPONSE** contains 7,770 words excluding; a table of contents, a table of authorities, a certificate of service or word count, or appendix of exhibits or claim listing. Patent Owner has relied on the word count feature of the word processing system used to create this paper in making this certification.

Date: February 11, 2025

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CERTIFICATE OF SERVICE UNDER 37 C.F.R. § 42.6 (e)(4)

I certify that on February 11, 2025, I will cause a copy of the foregoing document, including any exhibits filed therewith, to be served via electronic mail, as previously consented to by Petitioner, upon the following:

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