

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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**RESONAC HARD DISK CORPORATION and  
RESONAC CORPORATION,**  
Petitioners,

v.

**MR TECHNOLOGIES GMBH,**  
Patent Owner.

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Case No. IPR2026-00014  
U.S. Patent No. 9,928,864

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**PETITION FOR *INTER PARTES* REVIEW OF  
U.S. PATENT NO. 9,928,864  
CHALLENGING CLAIMS 1-6, 9-15, and 22-23**

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## PETITIONERS' EXHIBIT LIST

| Exhibit | Description                                                                                                                                                                                         |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ex-1001 | U.S. Patent No. 9,928,864 (“’864 Patent”)                                                                                                                                                           |
| Ex-1002 | File History of the ’864 Patent                                                                                                                                                                     |
| Ex-1003 | Declaration of Dr. Jian-Gang Zhu                                                                                                                                                                    |
| Ex-1004 | CV of Dr. Jian-Gang Zhu                                                                                                                                                                             |
| Ex-1005 | U.S. Patent No. 8,329,321 (“Takenoiri”)                                                                                                                                                             |
| Ex-1006 | U.S. Patent No. 6,834,026 (“Fullerton”)                                                                                                                                                             |
| Ex-1007 | W. K. Shen et al., <i>Composite perpendicular magnetic recording media using [Co/PdSi]<sub>n</sub> as a hard layer and FeSiO as a soft layer</i> . Journal of applied physics 97.10 (2005) (“Shen”) |
| Ex-1008 | D. Suess et al., <i>Exchange Spring Recording Media for Areal Densities Up to 10 Tbit/in<sup>2</sup></i> , Journal of Magnetism and Magnetic Materials 290 (2005): 551-554. (“Suess 2004”)          |
| Ex-1009 | A. Yu Dobin et al., <i>Domain wall assisted magnetic recording</i> . Applied Physics Letters 89.6 (2006). (“Dobin”)                                                                                 |
| Ex-1010 | U.S. Patent No. 6,777,066 (“Chang”)                                                                                                                                                                 |
| Ex-1011 | D. Suess et al., <i>Exchange spring media for perpendicular recording</i> . Applied Physics Letters 87.1 (2005). (“Suess 2005”)                                                                     |
| Ex-1012 | Reserved                                                                                                                                                                                            |
| Ex-1013 | Reserved                                                                                                                                                                                            |
| Ex-1014 | Reserved                                                                                                                                                                                            |
| Ex-1015 | Reserved                                                                                                                                                                                            |
| Ex-1016 | U.S. Patent No. 5,536,570 (“Osato”)                                                                                                                                                                 |

|         |                                                                                                                                                                                                            |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ex-1017 | C. M. Christensen, <i>The rigid disk drive industry: A history of commercial and technological turbulence</i> . Business history review 67.4 (1993): 531-588.                                              |
| Ex-1018 | P. Gourevitch, R. Bohn, and D. McKendrick. <i>Globalization of production: insights from the hard disk drive industry</i> . World development 28.2 (2000): 301-317.                                        |
| Ex-1019 | <i>MR Technologies GmbH v. Western Digital Technologies, Inc.</i> , 8:24-cv-01848 (C.D. Cal.), Dkt. No. 195, Claim Construction Order                                                                      |
| Ex-1020 | S. Okamoto et al., <i>The anisotropy field of FePt L10 nanoparticles controlled by very thin Pt layer</i> . Journal of Physics: Condensed Matter 16.12 (2004): 2109.                                       |
| Ex-1021 | WIPO Patent Publication No. WO 2001/022407 A1                                                                                                                                                              |
| Ex-1022 | U.S. Patent No. 7,846,564 (“Li”)                                                                                                                                                                           |
| Ex-1023 | K. Z. Gao, et al., <i>Magnetic recording configuration for densities beyond 1 Tb/in<sup>2</sup> and data rates beyond 1 Gb/s</i> . IEEE transactions on magnetics 38.6 (2002): 3675-3683.                  |
| Ex-1024 | JP Patent Application JP2004-197775 (Takenori Certified Priority Document)                                                                                                                                 |
| Ex-1025 | JP4540557B2 (Takenori JP counterpart)                                                                                                                                                                      |
| Ex-1026 | CN100570715C (Takenori CN counterpart)                                                                                                                                                                     |
| Ex-1027 | U.S. Patent Application Publication No. 2003/0096127 A1                                                                                                                                                    |
| Ex-1028 | T. Shimatsu et al., <i>High perpendicular magnetic anisotropy of CoPtCr/Ru films for granular-type perpendicular media</i> . IEEE transactions on magnetics 40.4 (2004): 2483-2485.                        |
| Ex-1029 | I. Kaitsu, R. Inamura, J. Toda, and T. Morita, <i>Ultra High Density Perpendicular Magnetic Recording Technologies</i> , Fujitsu Science and Technology Journal, vol. 42, No. 1, p.122-130 (January 2006). |

|         |                                                                                                                                                                                                         |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ex-1030 | G. Asti et al., <i>Magnetic phase diagram and demagnetization processes in perpendicular exchange-spring multilayers</i> , 73 Phys. Rev. B 094406 (2006).                                               |
| Ex-1031 | S.S.P. Parkin, <i>Systematic Variation of the Strength and Oscillation Period of Indirect Magnetic Exchange Coupling through the 3d, 4d, and 5d Transition Metals</i> , 67 Phys. Rev. Lett. 398 (1991). |
| Ex-1032 | M. Zheng et al., <i>Role of Oxygen Incorporation in Co-Cr-Pt-Si-O Perpendicular Magnetic Recording Media</i> . IEEE Transactions on Magnetics, 40.4 (2004): 2498-2500.                                  |
| Ex-1033 | V.S. Gornakov et al., <i>Direct experimental study of the exchanger spring formation process</i> . Journal of Magnetism and Magnetic Material, vol. 246, pp. 80-85 (2002).                              |
| Ex-1034 | CV of Sylvia Hall-Ellis, Ph.D.                                                                                                                                                                          |
| Ex-1035 | Reserved                                                                                                                                                                                                |
| Ex-1036 | Declaration of Sylvia Hall-Ellis, Ph.D.                                                                                                                                                                 |

## **I. INTRODUCTION**

Petitioners request *Inter Partes* Review (“IPR”) of claims 1-6, 9-15, and 22-23 (“Challenged Claims”) of U.S. Patent No. 9,928,864 (“’864 Patent,” Ex-1001), purportedly owned by MR Technologies GmbH (“Patent Owner” or “PO”).

This petition asks the USPTO to right its wrong in allowing a family of patent applications on what the field already knew and practiced: multilayer perpendicular magnetic recording (“PMR”) media with a thermally stable hard layer (that can only be switched by a high external magnetic field) to preserve data and one or more softer layers (exchange coupled to the hard layer) that switches under a lower external magnetic field and thereby assists in switching of the hard layer. The Examiner did not consider the most relevant prior art, including Takenoiri, which expressly teaches this structure and renders the challenged claims unpatentable.

By the time Austrian professor, Dr. Seuss, filed his first application in the challenged family in June 2006, U.S. research labs and U.S. and Japanese hard-drive manufacturers had already published, built, and shipped this architecture. His supposed “contribution” was merely to add another soft layer and recite hard-to-search numerical parameters that were either disclosed or inherent in known structures. But tri- (or more) layer PMR stacks with graded anisotropy were not new.

This is not invention; it is appropriation. The Office erred, and the PTAB, with its technical expertise, is the proper forum to correct it.

## II. MANDATORY NOTICES

### A. Real Party-in-Interest (37 C.F.R. §42.8(b)(1)):

The real parties-in-interest for Petitioners are Resonac Hard Disk Corporation, Resonac Corporation, and Resonac America, Inc.

### B. Related Matters (37 C.F.R. §42.8(b)(2)):

The following judicial or administrative matters may affect, or be affected by, a decision in this proceeding:

- *MR Technologies GmbH v. Toshiba America Electronic Components, Inc. et al*, No. 8:25-cv-00786-JVS (C.D. Cal.)
- *MR Technologies GmbH v. Seagate Technology LLC et al*, 0-25-cv-01460 (D. Minn.)
- *MR Technologies GmbH v. Western Digital Technologies, Inc.*, 2-22-cv-06088 (C.D. Cal.) (terminated)
- *MR Technologies GmbH v. Western Digital Technologies, Inc.*, 8-22-cv-01599 (C.D. Cal.) (terminated)
- *MR Technologies GmbH v. Western Digital Technologies, Inc.*, 6-22-cv-0-0612 (W.D. Tex.) (terminated)

Petitioners are not named defendants in the above matters. To the best of

Petitioners' knowledge, the '864 Patent has not been asserted in any other matters.<sup>1</sup>

**C. Lead Counsel (37 C.F.R. §§42.8(b)(3) & 42.10):**

Petitioners designate Dion M. Bregman (Reg. No. 45,645) as lead counsel, and designate Sarah J. Guske (*pro hac vice* forthcoming) and Amanda S. Williamson (Reg. No. 73,683) as back-up counsel.

**D. Service (37 C.F.R. §42.8(b)(3)-(4)):**

Service Address: Morgan, Lewis & Bockius LLP, 1400 Page Mill Road, Palo Alto, CA (Telephone: 650.843.4000; Fax: 650.843.4001).

Pursuant to 37 C.F.R. §42.8(b)(4), Petitioners consent to email service at: MLB-Resonac-IPRs@morganlewis.com.

Pursuant to 37 C.F.R. §42.10(b), a Power of Attorney accompanies this Petition.

**III. SUMMARY OF THE '864 PATENT**

The application resulting in the '864 Patent was filed November 17, 2009, and claims the benefit of Patent Appl. No. 11/424,859, now U.S. Patent No. 9,978,413, filed June 17, 2006 (hereinafter, the "Critical Date"). For purposes of this Petition, Petitioners assume that the Challenged Claims are entitled to the Critical Date as the

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<sup>1</sup> Petitioners are concurrently challenging two related patents of the '864 Patent, i.e., U.S. Patent Nos. 12,020,734 ("the '734 Patent") and 11,138,997 ("the '997 Patent"), in IPR2026-00016 and IPR2026-00015, respectively.

priority date, which is consistent with the inventor's district court testimony, but Petitioners reserve the right to challenge such date in other proceedings. The '864 Patent is governed under the pre-AIA Patent Act.

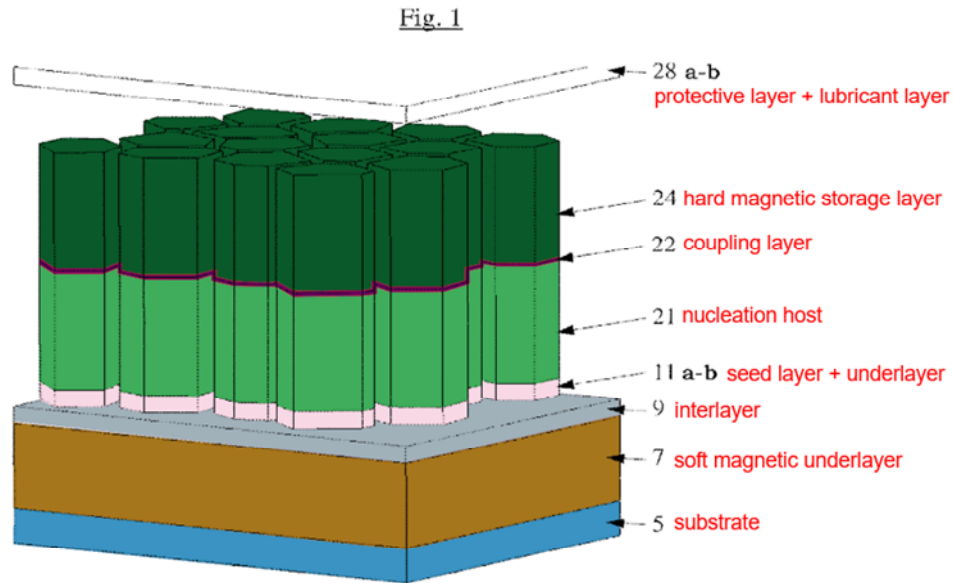
**A. Brief Description of the '864 Patent**

As recording density for magnetic recording media increases, a continued decrease in the magnetic grain size is no longer feasible because when the grain size is small enough, thermal fluctuations at room temperature can switch the grain's magnetization, resulting in information loss. Ex-1001, 1:11-20. While increasing a material's anisotropy constant  $K$  helps improve thermal stability, according to the '864 Patent, "such an increase also results in an unfavorable increase of the coercivity  $H_c$ ," making writing harder. *Id.*, 1:21-28. Ex-1003, ¶58.

To address this, prior designs used a soft magnetic layer on top of the hard layer. Ex-1001, 1:48-56. These layers are exchange-coupled, allowing the write head to flip the soft layer, in turn switching the hard layer, thereby reducing the required write field while preserving thermal stability. Ex-1003, ¶59.

The '864 Patent purportedly adds a second soft layer on top of the existing soft layer, forming what it calls a "nucleation host." This nucleation host consists of "ferromagnetic layers with increasing anisotropy constant  $K$  from layer to layer," exchange-coupled to the hard layer beneath. Ex-1001, 10:50–52. The patent asserts that with its structure, "the coercive field is reduced..., while the thermal stability

is...not influenced.” Ex-1001, 3:48–54. It claims to “overcom[e] the writeability problem of extremely hard magnetic storage layers.” Ex-1001, 3:58–61. Figure 1 depicts the nucleation host below the hard layer, contrary to claim 1.<sup>2</sup>

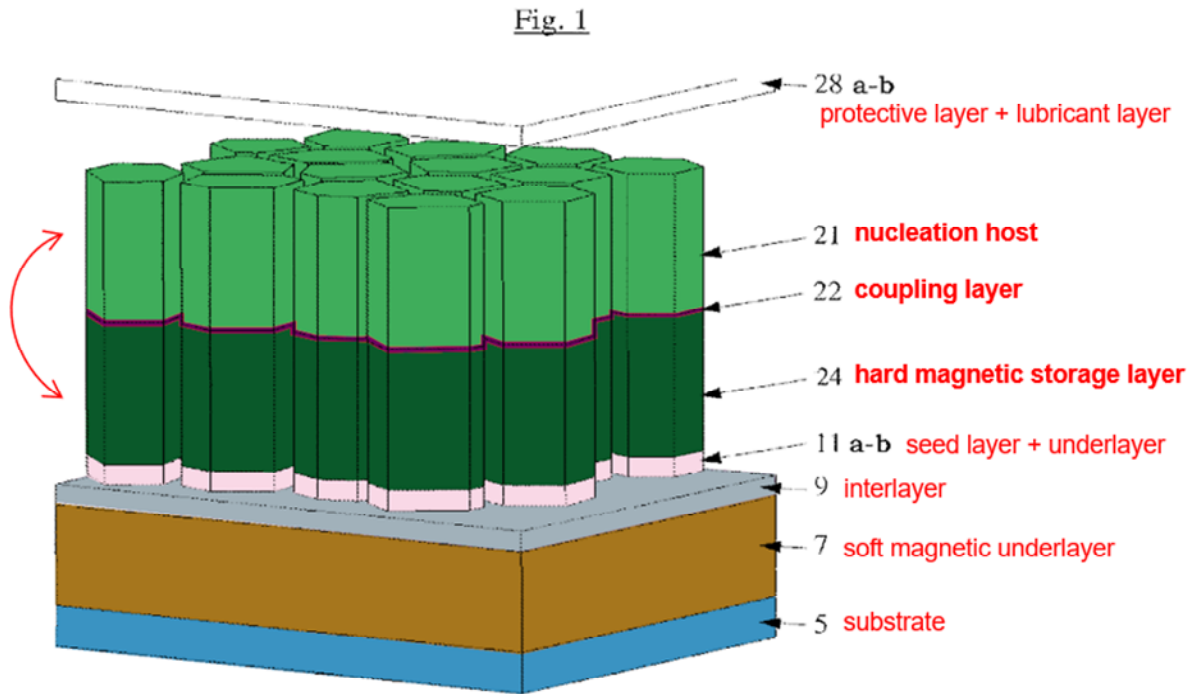


Ex-1001, Fig. 1, 4:17-23.<sup>3</sup> Ex-1003, ¶60.

Figure 1 of the '864 Patent has been revised to show the structure of the claimed magnetic recording medium:

<sup>2</sup> Petitioners reserve the right to challenge the '864 Patent claims under 35 U.S.C. § 112 in other proceedings. *See* 37 C.F.R. 1.83(a).

<sup>3</sup> Unless indicated otherwise, all annotations and emphasis are added.



Ex-1001, Fig. 1 (revised, to show nucleation host on top). Ex-1003, ¶¶60-62.

As the '864 Patent acknowledges, combining soft and hard layers was nothing new. *Id.*, 1:52-56. As shown in Ground 1 below, the '864 Patent's purported "special **multilayer** host layer (nucleation host)" structure (*id.*, 2:48-52) was also well known at the time of the alleged invention. Ex-1003, ¶63.

## **B. Summary of the Prosecution History of the '864 Patent**

U.S. Patent No. 9,928,864 (the "'864 Patent") issued on March 27, 2018, from U.S. Pat. Appl. No. 12/619,849, filed November 17, 2009. Ex-1001. Prosecution of the '864 Patent spanned eight years, including eight Office Actions rejecting the claims under §§102 and 103 based on various combinations of four references. *See, e.g.*, Ex-1002, 323. The Applicant repeatedly amended the claims, and in the final

two Office Actions added the following limitations (underlined) to secure allowance:

A magnetic recording medium, comprising:  
an essentially non-magnetic substrate;  
an underlayer formed on the non-magnetic substrate; and  
an exchange coupled magnetic multilayer structure, including  
a hard magnetic storage layer, having a first coercive field  $H_s > 0.5$  T, formed  
on the underlayer; and  
a nucleation host, having a second coercive field  $H_n$  without the hard magnetic  
storage layer, lower than the first coercive field,  $H_n < H_s$ , wherein  
said nucleation host  
is formed on the hard magnetic storage layer such that the hard magnetic  
storage layer is between the nucleation host and the non-magnetic substrate,  
is exchange coupled to the hard magnetic storage layer, and  
comprises ferromagnetic layers with increasing anisotropy constant K from  
layer to layer.

Ex-1002, 110, 193.

In the Notice of Allowance, the Examiner noted that “the prior art of record does not teach or suggest [(i)] the coercive field relationship between the nucleation host and hard magnetic storage layer *and* [(ii)] a nucleation host comprising multiple ferromagnetic layers with increasing anisotropy constant K from layer to layer.” Ex-1002, 16 (emphasis original).

#### IV. THE PRIOR ART

##### A. Takenoiri

U.S. Patent No. 8,329,321 (“Takenoiri,” Ex-1005) was filed on **July 1, 2005** and issued **December 11, 2012**, and is prior art under at least §§102(a) and (e). The Examiner was not aware of Takenoiri during prosecution.

Like the '864 Patent, Takenoiri recognizes the same trade-off between thermal stability and writeability, explaining that increasing the anisotropy within each magnetic recording layer, and reducing bit size, improves stability but makes writing more difficult, reducing what it calls “recordability.” Ex-1005, 1:62-67. Like the '864 Patent, Takenoiri introduces a softer magnetic recording layer 7 (green) on top of a hard magnetic recording layer 5 (dark green), coupled by a coupling layer 6 (purple), as illustrated below. Ex-1003, ¶68.

|                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Fig. 1 bi-layer</p> <p>9<br/>8<br/>7 second magnetic recording layer<br/>6 coupling layer<br/>5 first magnetic recording layer<br/>4 nonmagnetic intermediate layer<br/>3 underlayer<br/>2 soft magnetic backing layer<br/>1 nonmagnetic substrate</p> | <p>Fig. 1</p> <p>28 a-b protective layer + lubricant layer<br/>21 nucleation host<br/>22 coupling layer<br/>24 hard magnetic storage layer<br/>11 a-b seed layer + underlayer<br/>9 interlayer<br/>7 soft magnetic underlayer<br/>5 substrate</p> |
| Ex-1005, Fig. 1                                                                                                                                                                                                                                           | Ex-1001, Fig. 1<br>(revised, to show nucleation host on top)                                                                                                                                                                                      |

Takenoiri’s structure achieves “simultaneous improvements in thermal stability and recordability” because “each magnetic layer reverses magnetization individually.” Ex-1005, 5:8-15.

Takenoiri expressly discloses that its structure can have “three or more magnetic recording layers” (Ex-1005, 10:7-18; *see* Section VIII.A, *infra*), which, as

explained in Ground 1 below, teaches the exact same “nucleation host” (with varying anisotropy) that the ’864 Patent claims. Ex-1003, ¶¶69-72.

**B. Shen**

Composite perpendicular magnetic recording media using  $[\text{Co/PdSi}]_n$  as a hard layer and FeSiO as a soft layer (“Shen,” Ex-1007), publicly available at least as early as May 17, 2005, is prior art under at least §§102(a) and (b). Ex-1036, ¶50. The Examiner was not aware of Shen during prosecution.

**C. Li**

U.S. Patent No. 7,846,564 (“Li,” Ex-1022), filed on **September 27, 2005**, and issued **December 7, 2010**, is prior art under at least § 102(e). The Examiner was not aware of Li during prosecution.

**D. Asti**

Magnetic phase diagram and demagnetization processes in perpendicular exchange-spring multilayers (“Asti,” Ex-1030), publicly available at least as early as **March 8, 2006**, is prior art under at least § 102(a). Ex-1036, ¶62. The Examiner was not aware of Asti during prosecution.

**E. Chang**

U.S. Patent No. 6,777,066 (“Chang,” Ex-1010), filed on **November 7, 2001**, and issued **August 17, 2004**, is prior art under at least §§102(a), (b), and (e). The Examiner was not aware of Chang during prosecution.

**V. REQUIREMENTS FOR *INTER PARTES* REVIEW UNDER 37 C.F.R. §42.104**

**A. Grounds for Standing 37 C.F.R. §42.104(a) and Fees**

Petitioners certify that the '864 patent is available for IPR and that Petitioners are not barred or estopped from requesting this IPR.

Any additional fees for this IPR may be charged to Deposit Account No. 50-0310 (Order No. 034913-0832).

**B. Identification of Challenge Under 37 C.F.R. §42.104(b) and Relief Requested**

Claims 1-6, 9-15, and 22-23 of the '864 patent are unpatentable and should be cancelled.

| Ground | Statute | Reference(s)      | '864 Patent Claims   |
|--------|---------|-------------------|----------------------|
| 1      | §103    | Takenoiri         | 1, 3-5, 9, 13-14, 23 |
| 2      | §103    | Takenoiri + Shen  | 2, 6                 |
| 3      | §103    | Takenoiri + Li    | 10-12                |
| 4      | §103    | Takenoiri + Asti  | 15                   |
| 5      | §103    | Takenoiri + Chang | 22                   |

**VI. LEVEL OF ORDINARY SKILL**

A person having ordinary skill in the art ("POSITA") at the time of the alleged invention of the '864 patent was a person holding at least a master's degree in Physics, Material Science, or Electrical Engineering with at least two years training or experience with magnetic recording, such as hard disk drives. Ex-1003, ¶16.

## VII. CLAIM CONSTRUCTION

The court in *MR Technologies GmbH v. Western Digital Technologies, Inc.*, 8-22-cv-01599 (C.D. Cal.) (the “Western Digital case”) issued a claim construction order, which construes certain terms in the ’864 Patent, none of which are binding on the Board in this proceeding.

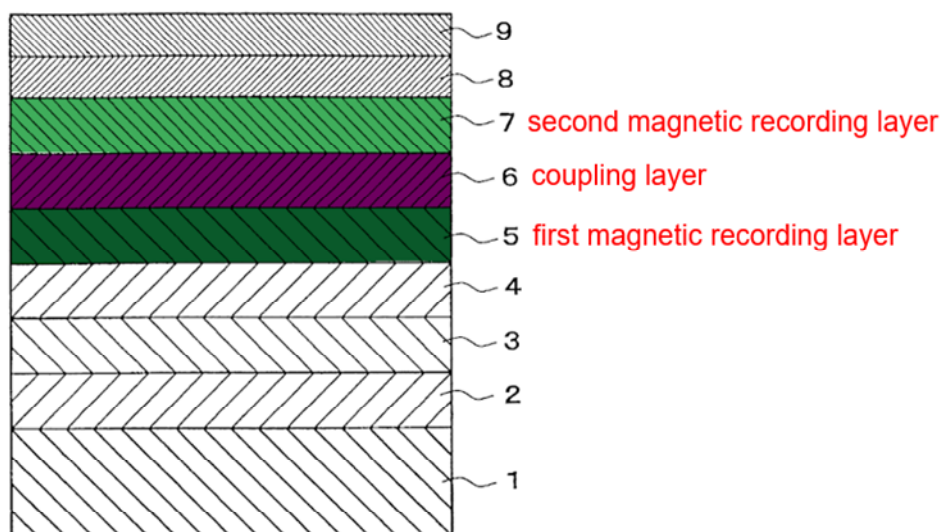
Petitioners believe that all claims should be given their plain and ordinary meanings, and no express constructions are required. Ex-1003, ¶75.

## VIII. GROUND 1: CLAIMS 1, 3-5, 9, 13-14, AND 23 ARE OBVIOUS OVER TAKENOIRI ALONE

### A. Takenoiri’s Tri-Layer Structure

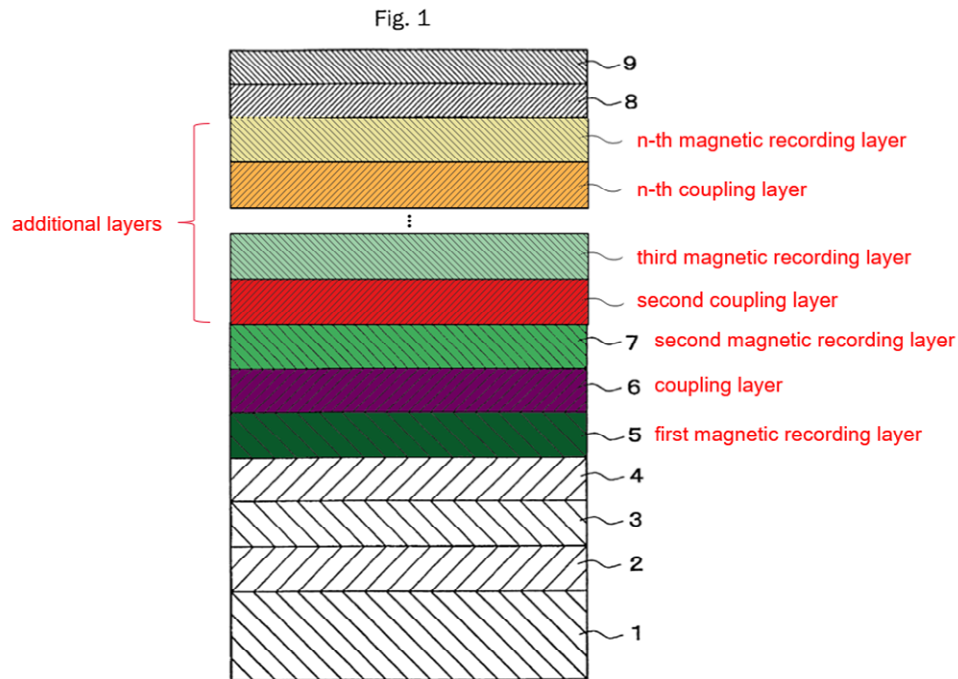
As discussed in Section IV.A, Takenoiri discloses a bi-layer embodiment with two magnetic recording layers: first magnetic recording layer 5 and second magnetic recording layer 7, coupled by coupling layer 6. Ex-1005, 5:66-6:6.

Fig. 1 bi-layer



Ex-1005, Fig. 1. Ex-1003, ¶89.

Takenoiri expands on the disclosure, teaching that the structure can have “three or more layers.” *Id.*, 10:7-10.<sup>4</sup> Below is a revised Figure 1 that illustrates a three (or more) magnetic recording layered structure. Ex-1003, ¶90.



Ex-1005, Fig. 1 (tri-layer structure in modified Fig. 1).<sup>5</sup> Ex-1003, ¶92.

As shown above, a second coupling layer (red) is disposed between the second

<sup>4</sup> While Takenoiri does not explicitly state where a third magnetic recording layer would be positioned, a POSITA would have found it obvious to add additional layer(s) above the second magnetic recording layer 7. Ex-1003, ¶91.

<sup>5</sup> To distinguish from Takenoiri’s bi-layer structure, this Petition refers to Takenoiri’s structure with three or more magnetic recording layers as “tri-layer structure.”

magnetic recording layer 7 (**green**) and the third magnetic recording layer (**light green**) as taught by Takenoiri: “[t]he ferromagnetic coupling is provided between every two magnetic recording layers through a coupling layer.” *Id.*, 10:8-10. Ex-1003, ¶93.

Therefore, Takenoiri discloses, or at least renders obvious, a tri-layer structure. Ex-1003, ¶94.

## **B. Claim 1**

### **1. 1[P]: “A magnetic recording medium, comprising:”**

To the extent that the preamble 1[P] is limiting, Takenoiri discloses it. Ex-1003, ¶96.

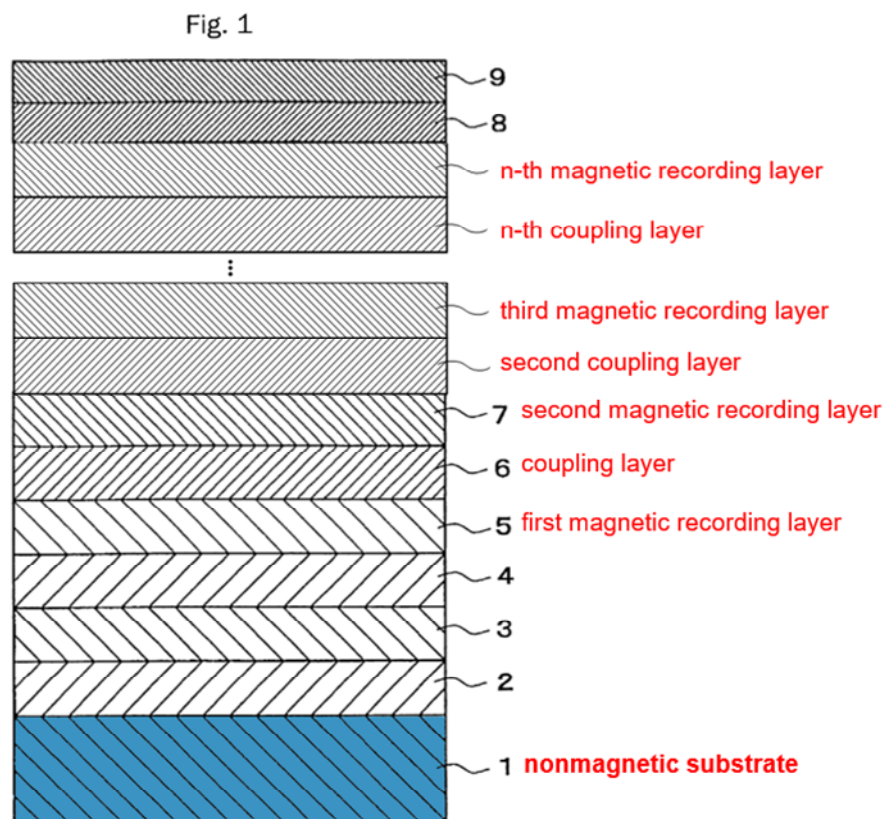
Takenoiri discloses “a perpendicular **magnetic recording medium** mounted on a hard disk drive,” which applies to the embodiment described in Figure 1 and the tri-layer structure. Ex-1005, 1:14-19. As discussed below, Takenoiri discloses all remaining claim elements, and as such discloses “[a] **magnetic recording medium** [e.g., Takenoiri’s perpendicular magnetic recording medium].” Ex-1003, ¶97.

### **2. 1[A]: “an essentially non-magnetic substrate;”**

The ’864 Patent specification uses “essentially non-magnetic substrate” once, without explanation. *See, e.g.*, Ex-1001, 10:18-21, 10:14, 11:61, 12:2. Claim 1 later references “the non-magnetic substrate” without antecedent basis, which a POSITA would understand refers to the earlier recited “essentially non-magnetic substrate.”

Ex-1001, claim 1. A POSITA would thus interpret “essentially non-magnetic substrate” to include a “non-magnetic substrate.” Ex-1003, ¶99.

Takenoiri discloses a “[n]onmagnetic substrate 1 [blue]...composed of an aluminum alloy with NiP plating, strengthened glass, crystalline glass, or the like.” Ex-1005, 6:7-10. These are the same or similar substrate materials in the '864 Patent. *See* Ex-1001, 4:26-28 (“Substrate 5 may be made of any suitable material such as ceramic glass, amorphous glass, or NiP plated AlMg or an AlMg alloy base with a NiP surface coating.”).



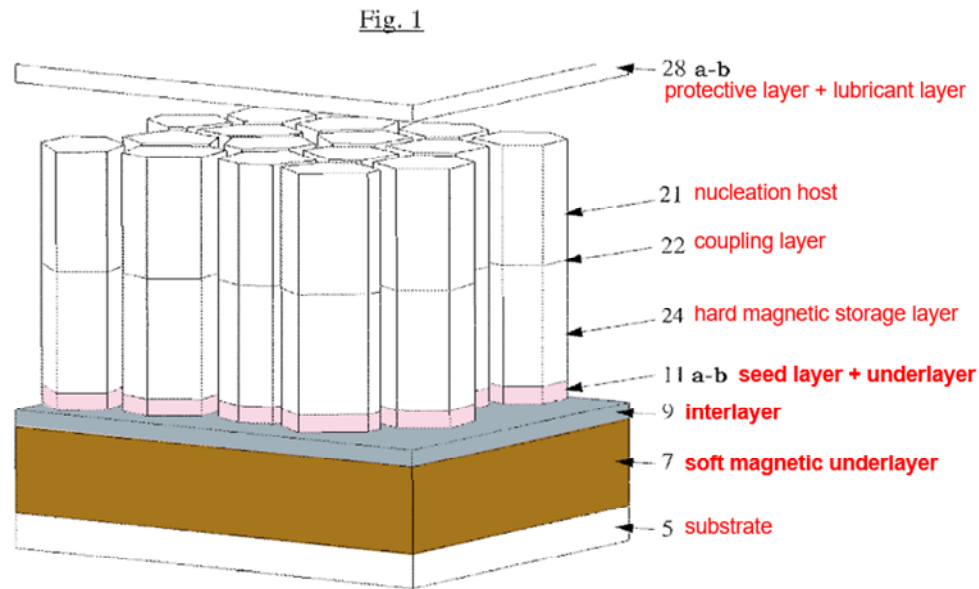
Ex-1005, Fig. 1 (tri-layer structure in modified Fig. 1). Ex-1003, ¶100.

Therefore, Takenoiri discloses “an essentially non-magnetic substrate [e.g.,

Takenoiri's non-magnetic substrate 1].” Ex-1003, ¶101.

**3. 1[B]: “an underlayer formed on the non-magnetic substrate; and”**

The '864 Patent discloses “a soft magnetic underlayer 7” and an “underlayer 11b,” as well as an interlayer 9 and a seed layer 11a in between, which are all formed on substrate 5. Ex-1001, 4:17-25 (describing Figure 1).<sup>6</sup>

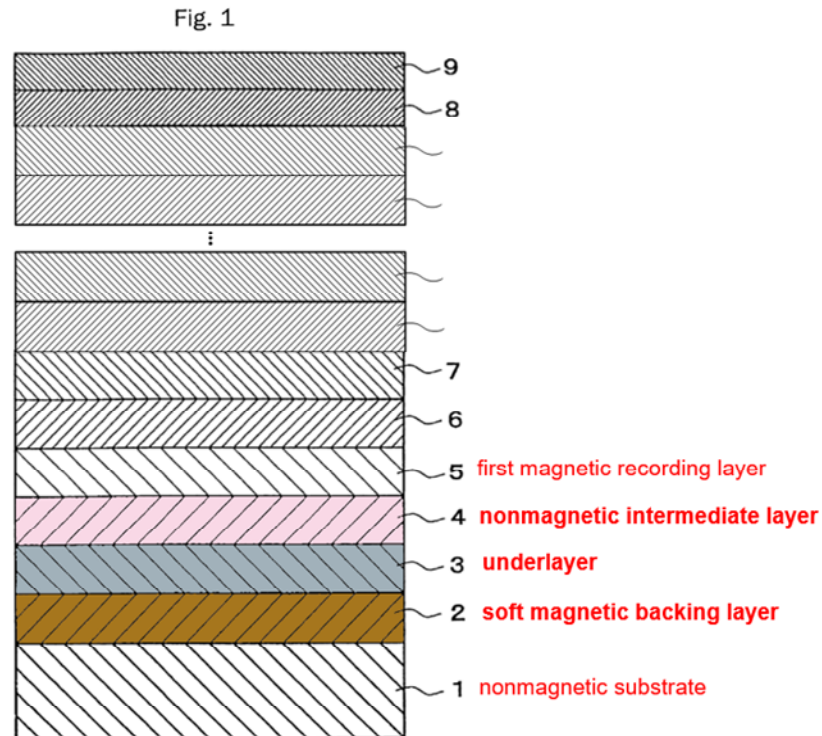


Ex-1001, Fig. 1 (revised, to show nucleation host on top). Ex-1003, ¶103.

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<sup>6</sup> The claims do not specify that the “underlayer” be a single layer formed from a single material between the non-magnetic substrate and the hard magnetic storage layer, and the Western Digital (“WD”) court’s construction for the term “underlayer” was: “**one or more layers** on which the hard magnetic storage layer is formed.” Ex-1019, pp.21-22. Ex-1003, ¶104.

Takenoiri discloses that “[o]n **nonmagnetic substrate 1** sequentially formed are **soft magnetic backing layer 2, underlayer 3, nonmagnetic intermediate layer 4, first magnetic recording layer 5...**” Ex-1005, 6:1-4.



Ex-1005, Fig. 1 (tri-layer structure in modified Fig. 1). Ex-1003, ¶¶105-107.

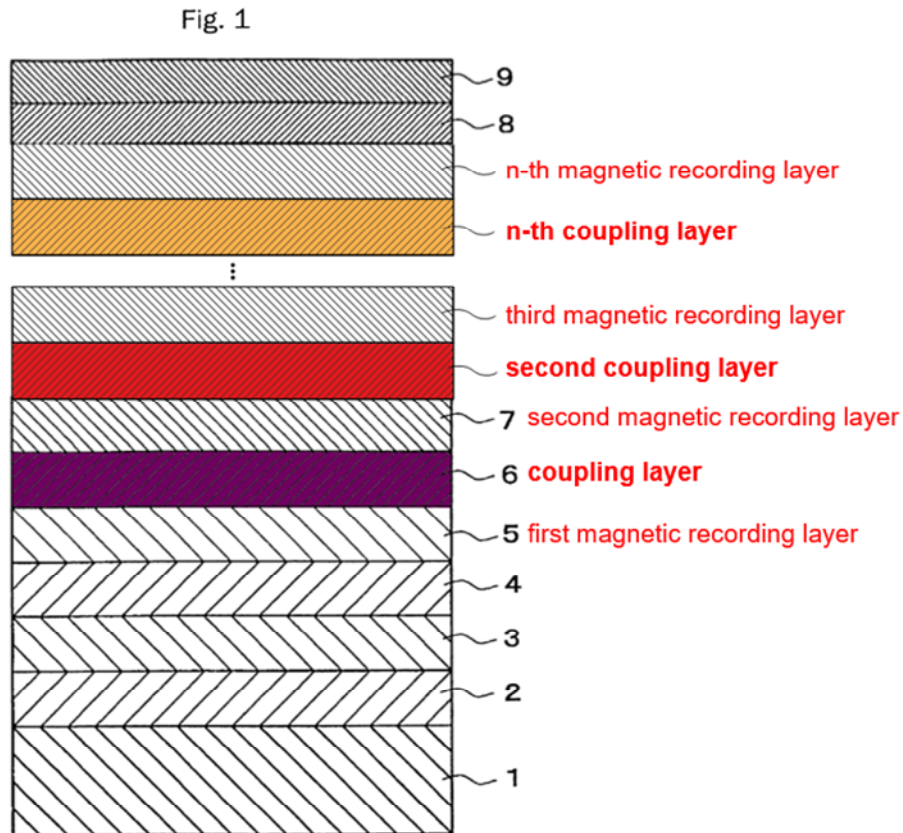
If the claimed “underlayer” requires a single layer, each of Takenoiri’s soft magnetic backing layer 2, underlayer 3, and nonmagnetic intermediate layer 4 constitutes a single underlayer and Takenoiri notes that each of these layers “may be omitted.” Ex-1005, 6:16, 6:33-34, 6:55. Ex-1003, ¶108.

Therefore, Takenoiri discloses “**an underlayer** [e.g., one or more of Takenoiri’s soft magnetic backing layer 2, underlayer 3, and/or nonmagnetic intermediate layer 4] **formed on the non-magnetic substrate** [e.g., Takenoiri’s

nonmagnetic substrate 1].” Ex-1003, ¶109.

**4. 1[C]: “an exchange coupled magnetic multilayer structure, including”**

As explained in Section VIII.A, *supra*, Takenoiri discloses a three-or-more layered structure, where every two magnetic recording layers are ferromagnetically coupled via a coupling layer “for controlling the **exchange coupling** energy between the magnetic recording layers.” Ex-1005, 5:63-65, 10:8-10. Ferromagnetic coupling is a type of exchange coupling. Ex-1003, ¶111. Accordingly, Takenoiri’s coupling layer 6 and additional coupling layers added between adjacent additional magnetic layers (including the second coupling layer and n-th coupling layer) are coupling layers that exchange couple the first, second, third,...and n-th magnetic recording layers. Ex-1003, ¶112.



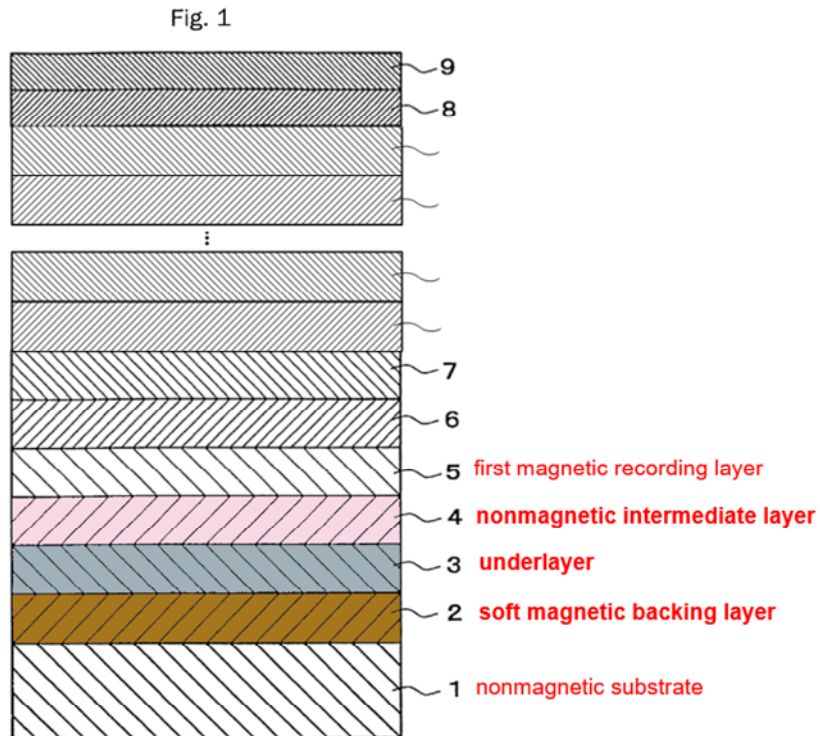
Ex-1005, Fig. 1 (tri-layer structure in modified Fig. 1).

Moreover, as discussed below, Takenoiri discloses all of the elements required in the recited “exchange coupled magnetic multilayer structure,” including the recited “hard magnetic storage layer” and “nucleation host.” Ex-1003, ¶113.

Therefore, Takenoiri discloses “**an exchange coupled magnetic multilayer structure** [e.g., Takenoiri’s multilayered structure with three or more magnetic recording layers exchange coupled to one another, having the recited structures described below].” Ex-1003, ¶114.

5. **1[D]: “a hard magnetic storage layer, having a first coercive field  $H_s > 0.5$  T, formed on the underlayer; and”**

*First*, Takenoiri’s tri-layer structure includes a “magnetic storage layer..., formed on the underlayer.” As shown below, Takenoiri discloses that “[o]n nonmagnetic substrate 1 sequentially formed are **soft magnetic backing layer 2, underlayer 3, nonmagnetic intermediate layer 4, first magnetic recording layer 5...**” Ex-1005, 6:1-4.



Ex-1005, Fig. 1 (tri-layer structure in modified Fig. 1). Therefore, Takenoiri’s first magnetic recording layer is formed on the “underlayer” (e.g., one or more of Takenoiri’s soft magnetic backing layer 2, underlayer 3, and nonmagnetic intermediate layer 4). Ex-1003, ¶116.

*Second*, Takenoiri's first magnetic recording layer 5 is "a hard magnetic storage layer...having a first coercive field  $H_s > 0.5$  T." Ex-1003, ¶117.

The '864 Patent does not clearly define what constitutes a "hard" magnetic storage layer. Nonetheless, Takenoiri discloses "a hard magnetic storage layer" having a "first coercive field  $H_s > 0.5$  T" (addressed below) that is higher than the nucleation host (*see* Section VIII.B.6 (limitation 1[E])).<sup>7</sup> Ex-1003, ¶118.

Takenoiri's first magnetic storage layer 5 having a coercive field greater than 0.5 T is **separately shown** in three embodiments. Ex-1003, ¶120.

*Takenoiri's Example 1 and Comparative Example 1.* The coercivity ( $H_c$ ), i.e., coercive field, of the first magnetic recording layer 5 in Takenoiri's Example 1 is determined by looking at both Example 1 and Comparative Example 1. Because the structure in Takenoiri's Example 1 includes, among other things, a first magnetic recording layer 5, a coupling layer 6, and a second magnetic recording layer 7 (Ex-1005, 10:56-66), while Comparative Example 1 is the same as Example 1 except

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<sup>7</sup> Because Takenoiri's first magnetic recording layer 5, as its name suggests, is used for magnetic recording, a POSITA would have understood that it meets the WD court's claim construction for the "hard magnetic storage layer" term: "a magnetic layer that stores information in magnetically oriented bits." Ex-1019, p.20. Ex-1003, ¶119.

that it includes only the first magnetic recording layer 5, with no coupling layer 6 or second magnetic recording layer 7, the coercivity of the first magnetic recording layer in this example is 6770 Oe (red).<sup>8</sup> *Id.*, 11:17-21.

| TABLE 1                                          |           |           |
|--------------------------------------------------|-----------|-----------|
| Item                                             | Example 1 | Comp Ex 1 |
| H <sub>c</sub><br>(Oe)                           | 4,710     | 6,770     |
| TAA [336 kfc] (mVp-p)                            | 1.82      | 1.29      |
| normalized noises [336 kfc] (μVrms/mVp-p)        | 19.5      | 22.4      |
| S/N [336 kfc] (dB)                               | 25.5      | 23.5      |
| D <sub>50</sub> (kfc)                            | 371       | 344       |
| decay rate of output signals [28 kfc] (%/decade) | 0.67      | 0.25      |

*Id.*, Table 1. Ex-1003, ¶122.

The unit conversion for coercive field is 1 Tesla (T) = 10k Oersted (Oe). Ex. 1021, p.9 (“1Tesla (10,000 Oe)”). Therefore, the coercive field of the first magnetic recording layer 5 in this example is 0.677 T, which is greater than 0.5 T. Ex-1003, ¶123.

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<sup>8</sup> Coercivity and coercive field are synonymous. While the ’864 Patent claim 1 uses H<sub>s</sub> and H<sub>n</sub> to refer to coercive field, it is most often denoted by H<sub>c</sub>. Ex-1003, ¶121.

Similarly for Example 2 and Comparative Example 3, the  $H_c$  of the first magnetic recording layer 5 is 6990 Oe (red), which is 0.699 T and greater than 0.5 T.

| TABLE 3                                                |           |           |
|--------------------------------------------------------|-----------|-----------|
| Item                                                   | Example 2 | Comp Ex 3 |
| $H_c$<br>(Oe)                                          | 5,214     | 6,990     |
| O/W<br>(dB)                                            | 46.5      | 16.0      |
| normalized noises [336 kfc] ( $\mu V_{rms}/mV_{p-p}$ ) | 22.8      | 23.1      |
| S/N [336 kfc]<br>(dB)                                  | 24.3      | 22.9      |
| $D_{50}$<br>(kfc)                                      | 396       | 349       |
| decay rate of output signals [28 kfc]<br>(%/decade)    | 0.01      | 4.66      |

Ex-1005, 14:54-67 (Table 3). Ex-1003, ¶124.

Similarly for Examples 3-6 and Comparative Example 4, the  $H_c$  of the first magnetic recording layer 5 in Examples 3-6 is 6449 Oe (red), which is 0.6449 T and greater than 0.5 T.

| TABLE 4                         |                            |                                                                          |                                                                                                              |                                                                         |                                                         |              |
|---------------------------------|----------------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|---------------------------------------------------------|--------------|
|                                 |                            | Example 3                                                                | Example 4                                                                                                    | Example 5                                                               | Example 6                                               | Comp Ex 4    |
| first magnetic recording layer  | composition thickness (nm) | 9.5                                                                      | (Co <sub>72</sub> Cr <sub>10</sub> Pt <sub>18</sub> ) <sub>90</sub> (SiO <sub>2</sub> ) <sub>10</sub><br>9.5 | 9.5                                                                     | 9.5                                                     | 9.5          |
| coupling layer                  | composition thickness (nm) | Ru<br>1.6                                                                | Ru<br>0.25                                                                                                   | Ru<br>0.25                                                              | Ru<br>0.25                                              | none<br>none |
| second magnetic recording layer | composition thickness (nm) | Co <sub>61</sub> Cr <sub>22</sub> Pt <sub>13</sub> B <sub>4</sub><br>6.5 | Co <sub>61</sub> Cr <sub>22</sub> Pt <sub>13</sub> B <sub>4</sub><br>6.5                                     | Co <sub>69</sub> Cr <sub>22</sub> Pt <sub>8</sub> B <sub>4</sub><br>6.5 | Co <sub>76</sub> Cr <sub>20</sub> B <sub>4</sub><br>6.5 | none<br>none |
|                                 | $H_c$<br>(Oe)              | 5,016                                                                    | 5,119                                                                                                        | 4,490                                                                   | 4,176                                                   | 6,449        |
|                                 | O/W<br>(dB)                | 38.1                                                                     | 37.4                                                                                                         | 45.6                                                                    | 46.2                                                    | 24.7         |

*Id.*, 16:50-67 (Table 4). Ex-1003, ¶125.

Therefore, Takenoiri discloses “**a hard magnetic storage layer** [e.g., Takenoiri’s first magnetic recording layer 5], **having a first coercive field  $H_s > 0.5$  T** [e.g., in each of Takenoiri’s Examples 1-6, the coercive field of the first magnetic recording layer 5 is 0.677 T, 0.699 T, or 0.6449 T, respectively, which are all greater than 0.5 T], **formed on the underlayer** [e.g., one or more of Takenoiri’s soft magnetic backing layer 2, underlayer 3, and/or nonmagnetic intermediate layer 4].” Ex-1003, ¶¶126-127.

If the recited “first coercive field” refers to the coercive field of the hard magnetic storage layer with the nucleation host attached, Takenoiri also discloses or at least renders obvious this limitation. For example, Takenoiri discloses in Examples 2-4 that the coercive field of the entire structure is 0.5214 T, 0.5016 T, and 0.5119 T, respectively. Because the completion of magnetic reversal of an entire composite magnetic recording medium structure depends on the completion of magnetic reversal of the hardest layer within the stack (e.g., Takenoiri’s first magnetic recording layer 5) (*see* Section VIII.B.9, *infra*, for limitation 1[H])), a POSITA would have understood that for Takenoiri’s multilayer structure, the coercive field of the first magnetic recording layer 5 in the stack of layers in Examples 2-4 is at least 0.5214 T, 0.5016 T, and 0.5119 T, respectively, which are all greater than 0.5 T. Ex-1003, ¶¶128-129.

TABLE 3

| Item                                                   | Example 2 | Comp Ex 3 |
|--------------------------------------------------------|-----------|-----------|
| Hc<br>(Oe)                                             | 5,214     | 6,990     |
| O/W<br>(dB)                                            | 46.5      | 16.0      |
| normalized noises [336 kfc] ( $\mu\text{Vrms/mVp-p}$ ) | 22.8      | 23.1      |
| S/N [336 kfc]<br>(dB)                                  | 24.3      | 22.9      |
| D <sub>50</sub><br>(kfc)                               | 396       | 349       |
| decay rate of output signals [28 kfc]<br>(%/decade)    | 0.01      | 4.66      |

Ex-1005, Table 3.

TABLE 4

|                                 |                | Example 3                                                                                             | Example 4                                                         | Example 5                                                        | Example 6                                        | Comp Ex 4 |
|---------------------------------|----------------|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|------------------------------------------------------------------|--------------------------------------------------|-----------|
| first magnetic recording layer  | composition    | (Co <sub>72</sub> Cr <sub>10</sub> Pt <sub>18</sub> ) <sub>90</sub> (SiO <sub>2</sub> ) <sub>10</sub> |                                                                   |                                                                  |                                                  |           |
|                                 | thickness (nm) | 9.5                                                                                                   | 9.5                                                               | 9.5                                                              | 9.5                                              | 9.5       |
| coupling layer                  | composition    | Ru                                                                                                    | Ru                                                                | Ru                                                               | Ru                                               | none      |
|                                 | thickness (nm) | 1.6                                                                                                   | 0.25                                                              | 0.25                                                             | 0.25                                             | none      |
| second magnetic recording layer | composition    | Co <sub>61</sub> Cr <sub>22</sub> Pt <sub>13</sub> B <sub>4</sub>                                     | Co <sub>61</sub> Cr <sub>22</sub> Pt <sub>13</sub> B <sub>4</sub> | Co <sub>69</sub> Cr <sub>22</sub> Pt <sub>5</sub> B <sub>4</sub> | Co <sub>76</sub> Cr <sub>20</sub> B <sub>4</sub> | none      |
|                                 | thickness (nm) | 6.5                                                                                                   | 6.5                                                               | 6.5                                                              | 6.5                                              | none      |
|                                 | Hc (Oe)        | 5,016                                                                                                 | 5,119                                                             | 4,490                                                            | 4,176                                            | 6,449     |
|                                 | O/W (dB)       | 38.1                                                                                                  | 37.4                                                              | 45.6                                                             | 46.2                                             | 24.7      |

*Id.*, Table 4.

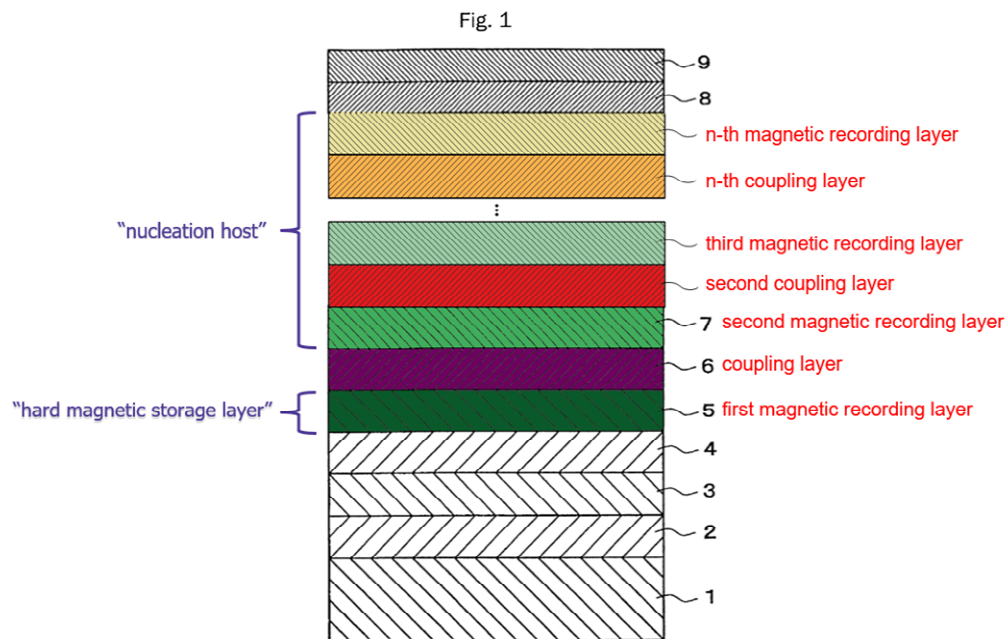
As detailed in Section VIII.B.6 (limitation 1[E]), *infra*, Takenoiri teaches introducing softer layer(s) to make switching easier, e.g., by initiating reversal through the layer stack. *See, e.g.*, Ex-1005, 10:7-18. This allows Takenoiri to

maintain thermal stability by keeping the first magnetic recording layer with high coercivity/anisotropy. *Id.*; Ex-1003, ¶130. Takenoiri's tri-layer structure introduces a third magnetic recording layer softer than the second magnetic recording layer 7, making switching even easier than the bi-layer structure. Therefore, in view of the additional third magnetic recording layer (e.g., introduced into Takenoiri's bi-layer structure in Examples 2-4), a POSITA looking to further improve the thermal stability of Takenoiri's tri-layer structure while maintaining its writeability would have been motivated to further increase the coercivity/anisotropy of the first magnetic recording layer 5, such that the overall coercivity of the tri-layer structure (which is also the coercivity of the first magnetic recording layer with Takenoiri's "nucleation host" (Section VIII.B.6 (limitation 1[E])) attached) maintains at the same level as the bi-layer structure, i.e., 0.5214 T, 0.5016 T, and 0.5119 T, respectively, which are all greater than 0.5 T, and would have had reasonable expectation of success, as Takenoiri expressly teaches tuning  $H_c$  via layer thickness and composition. Ex-1005, 9:23-29; *see also id.*, 9:63-67. Ex-1003, ¶131.

**6. 1[E] "a nucleation host, having a second coercive field  $H_n$  without the hard magnetic storage layer, lower than the first coercive field,  $H_n < H_s$ , wherein"**

As shown below, in addition to the first magnetic recording layer, Takenoiri's tri-layer structure includes multiple additional magnetic recording layers (second, third, fourth,...n-th magnetic recording layers). And as shown below, these

additional magnetic recording layers have a coercivity lower than that of the first magnetic recording layer (i.e., the claimed hard magnetic storage layer), allowing them to facilitate switching of the first magnetic recording layer 5 to which they are coupled. These layers therefore constitute the recited “nucleation host,” consistent with WD court’s construction of this term. *See, infra*, Section VIII.B.9 (limitation 1[H]).



Ex-1005, Fig. 1 (tri-layer structure in modified Fig. 1). Ex-1003, ¶133.

Takenoiri’s “nucleation host” (at least second and third magnetic recording layers) has a coercive field lower than that of the first magnetic recording layer 5 for at least the following reasons. Ex-1003, ¶134.

Takenoiri’s Examples 1–6 demonstrate that adding a second magnetic recording layer with lower coercivity ( $H_{c2}$ ) to the first layer ( $H_{c1}$ ) reduces the overall

coercivity ( $H_{c1+2}$ ). Ex-1003, ¶135. For example, in Example 1, adding the second magnetic recording layer and a coupling layer drops  $H_c$  from 6770 Oe (Comparative Example 1) to 4710 Oe—a 30% reduction. Ex-1005, 11:16-20, 11:64-66, Table 1; Ex-1003, ¶¶136-137. The same effect appears in Examples 2–6, with  $H_c$  consistently reduced compared to their respective controls. Ex-1005, 12:46-16:49, Tables 3-4; Ex-1003, ¶138-142. This demonstrates that  $H_{c2}$  is lower than both  $H_{c1}$  and  $H_{c1+2}$ . Ex-1003, ¶143.

Given that  $H_{c2} < H_{c1}$ , a POSITA would have been motivated to continue this trend in a tri-layer (or more) structure by setting  $H_{c3} < H_{c2}$  to accomplish Takenoiri's stated goal of reducing switching fields while maintaining thermal stability. While Takenoiri's Figures 1 and 4, as well as Examples 1-6, concern bi-layer structures, Takenoiri explicitly states that the same individual magnetization reversal principle applies to a structure having three or more magnetic recording layers. *See* Ex-1005, 10:14-18 (“**By individually reversing the magnetization of each magnetic recording layer as in this measure, the structure having three or more magnetic recording layers still produces the effect of improving thermal stability and the effect of reducing switching field at the same time.**”). Thus, a POSITA would have been motivated to set  $H_{c3}$  lower than  $H_{c2}$ , to continue to **reduce the switching field**

for the tri-layer structure as taught by Takenoiri.<sup>9</sup> Ex-1003, ¶¶144-147. Doing so would further reduce overall coercivity ( $H_{c1+2+3}$ ), enhancing writability as Takenoiri intended. Alternatively, overall coercivity ( $H_{c1+2+3}$ ) can be maintained while increasing the coercivity of the first layer ( $H_{c1}$ ) to improve the thermal stability of the recording layer. *Id.*, ¶148. Therefore, it is axiomatic that when  $H_{c3} < H_{c2} < H_{c1}$ , the coercivity of the combined second and third magnetic recording layers (hereinafter “ $H_{c2+3}$ ”) is lower than  $H_{c1}$ . *Id.*

At minimum, a POSITA would have been motivated to set  $H_{c3}$  lower than  $H_{c1+2}$  to maintain or reduce the overall coercivity ( $H_{c1+2+3}$ ) compared to a bi-layer structure because, as Takenoiri teaches with its bi-layer structures, introducing a “softer” layer with coercivity lower ( $H_{c2}$ ) than the existing structure reduces the overall coercivity ( $H_{c1+2}$ ). Ex-1003, ¶¶149-152. Moreover, as there are only three configurations for  $H_{c3}$  relative to  $H_{c1+2}$  (greater than, equal to, or less than), a POSITA would have been motivated to try (i.e., it would have been **obvious to try**) the third option, as it aligns with Takenoiri’s goal of reducing switching fields.

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<sup>9</sup> Takenoiri appears to use coercive field  $H_c$  and switching field synonymously. *See* Ex-1005, Abstract (“achieves improved recordability... by **reducing the switching field**”), 12:1-3 (“This condition contributes to the **reduction of  $H_c$** , which in turn is believed to improve the recordability.”). Ex-1003, ¶151.

When  $H_{c3} < H_{c1+2} < H_{c1}$ , since  $H_{c2} < H_{c1}$  (as explained above), it follows that  $H_{c2+3} < H_{c1}$ .

*Id.*, ¶153.

A POSITA would have had reasonable expectation of success in setting  $H_{c3}$  lower than  $H_{c1+2}$  and/or  $H_{c2}$ , both of which results in  $H_{c2+3}$  and  $H_{c1+2+3}$  lower than  $H_{c1}$ , as Takenoiri teaches how to tune  $H_c$  via layer thickness, composition, and grain isolation. Ex-1003, ¶¶154-155.<sup>10</sup>

Therefore, Takenoiri renders obvious “**a nucleation host** [e.g., at least Takenoiri’s second magnetic recording layer 7, the third magnetic recording layer, and the coupling layer in between, as part of Takenoiri’s tri-layer structure], **having a second coercive field  $H_n$  without the hard magnetic storage layer** [e.g., the coercive field  $H_c$  of Takenoiri’s “nucleation host,” i.e.,  $H_{c2+3}$ ], **lower than the first**

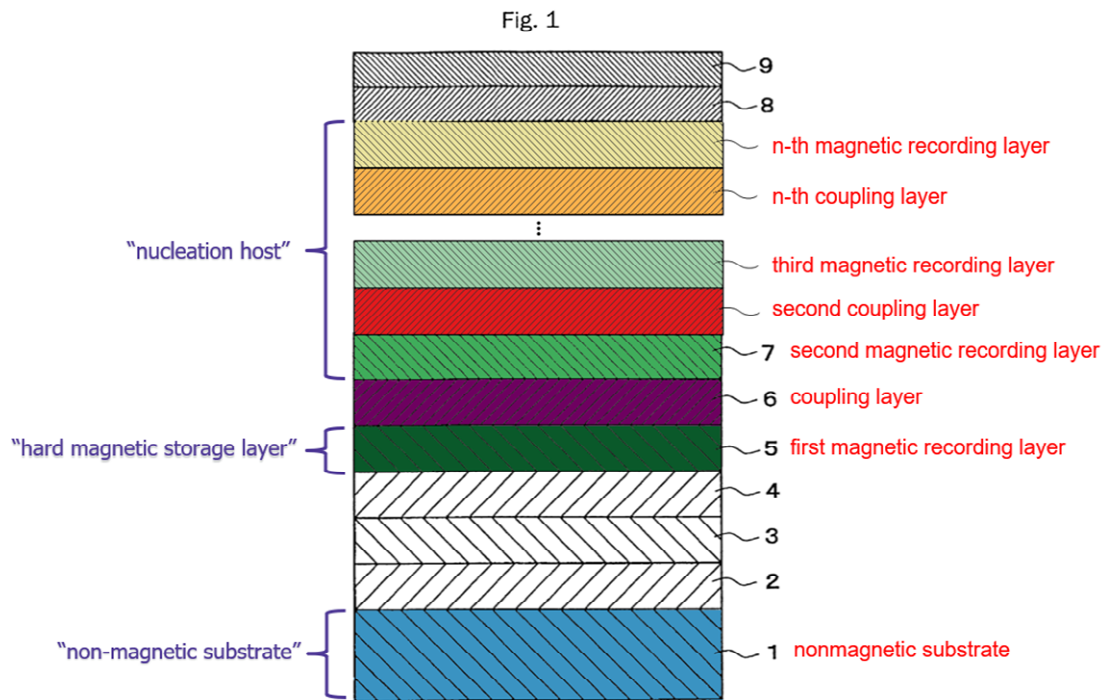
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<sup>10</sup> Moreover, this configuration of  $H_{c3} < H_{c2} < H_{c1}$  is not novel. A POSITA would have been motivated by Osato and Li to implement a coercivity gradient ( $H_{c3} < H_{c2} < H_{c1}$ ) in Takenoiri’s tri-layer structure, with a reasonable expectation of success. Osato shows such a gradient at room temperature; Li shows a reverse gradient in PMR. These references confirm that coercivity grading was known and technically feasible, making its application to Takenoiri’s structure both logical and predictable. *See* Ex-1016, 2:24-39, Figs 1A-1B; *see also* Ex-1022, 5:20-25, 5:9-16. Ex-1003, ¶¶156-157.

**coercive field,  $H_n < H_s$**  [e.g., both  $H_{c2+3}$  and  $H_{c1+2+3}$  being lower than  $H_c$  of Takenoiri's first magnetic recording layer 5, i.e.,  $H_{c1}$ ].” Ex-1003, ¶158.

7. **1[F]: “said nucleation host is formed on the hard magnetic storage layer such that the hard magnetic storage layer is between the nucleation host and the non-magnetic substrate,”**

As shown below, Takenoiri's “hard magnetic storage layer” is between its “nucleation host” (*see* Section VIII.B.6 (limitation 1[E])) and the non-magnetic substrate.

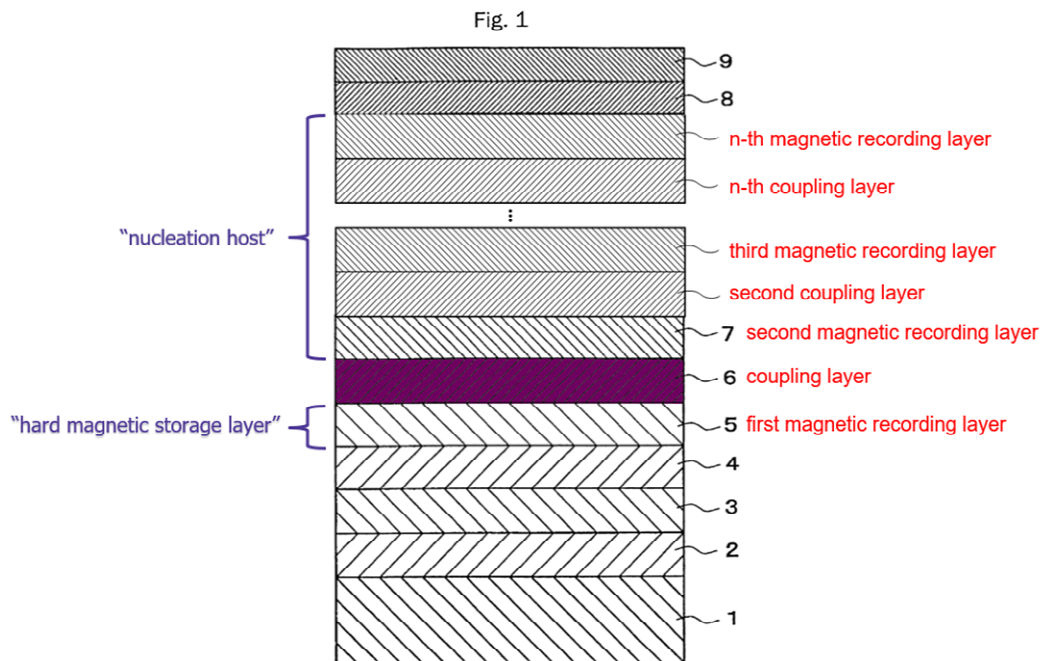


Ex-1005, Fig. 1 (tri-layer structure in modified Fig. 1). Ex-1003, ¶160.

Therefore, Takenoiri discloses that “**said nucleation host** [e.g., at least Takenoiri's second magnetic recording layer 7, the third magnetic recording layer, and the coupling layer in between, as part of Takenoiri's tri-layer structure] **is**

formed on the hard magnetic storage layer [e.g., Takenoiri's first magnetic recording layer 5] such that the hard magnetic storage layer is between the nucleation host and the non-magnetic substrate [e.g., Takenoiri's nonmagnetic substrate 1].” Ex-1003, ¶161.

8. 1[G]: “[said nucleation host] is exchange coupled to the hard magnetic storage layer, and”



Ex-1005, Fig. 1 (tri-layer structure in modified Fig. 1). Ex-1003, ¶163.

As confirmed in Fig. 1 (tri-layer structure) above, “[t]he first magnetic recording layer [5] and the second magnetic recording layer [7] are ferromagnetically coupled through the coupling layer [6 (purple)].” *Id.*, 3:5-7; *see also id.*, 3:21-23 (“Advantageously, an **exchange coupling energy** per unit area between the first magnetic recording layer and the second magnetic recording layer

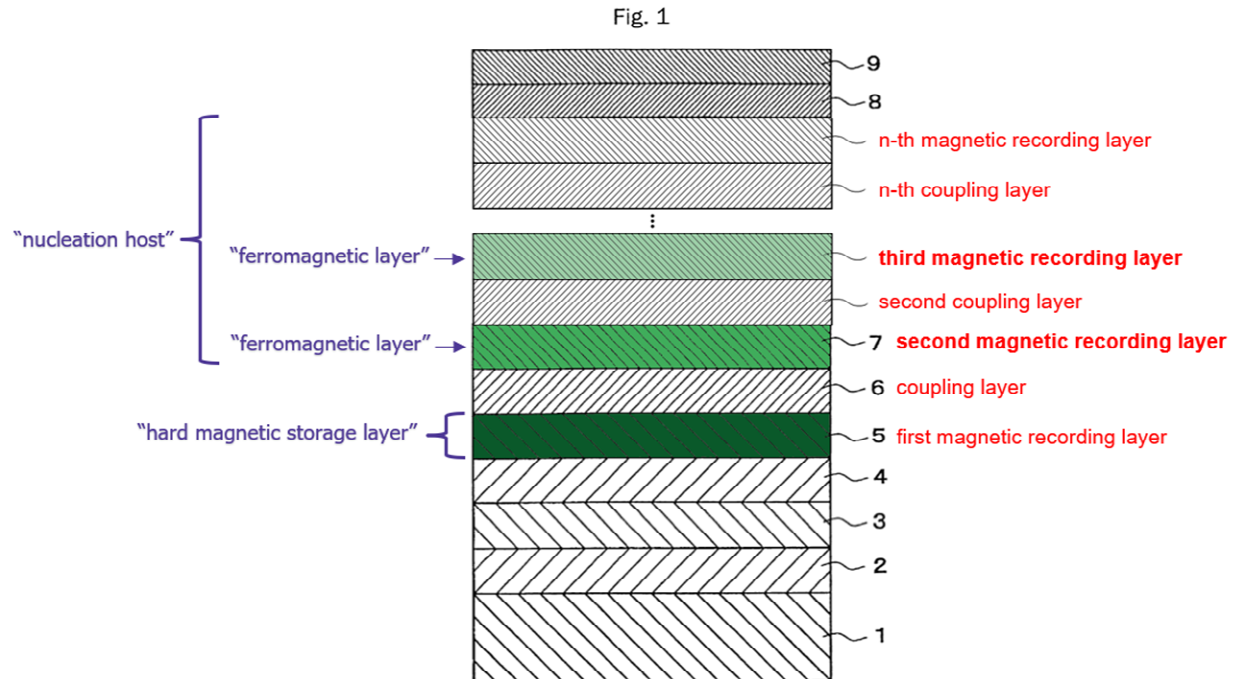
is at least  $5 \times 10^{-3}$  erg/cm<sup>2</sup>.”). Ex-1003, ¶164.

Therefore, Takenoiri discloses “[said nucleation host] **is exchange coupled to the hard magnetic storage layer** [e.g., Takenoiri’s “nucleation host” is exchange coupled to the first magnetic recording layer 5 because the second magnetic recording layer 7 as part of Takenoiri’s “nucleation host” is exchange coupled to the first magnetic recording layer 5].” Ex-1003, ¶165.

**9. 1[H]: “[said nucleation host] comprises ferromagnetic layers with increasing anisotropy constant K from layer to layer.”**

Takenoiri’s tri-layer magnetic recording architecture’s “nucleation host” (*see* Section VIII.B.6 (limitation 1[E])) includes ferromagnetic layers with the claimed anisotropy gradient. Takenoiri expressly extends the described bi-layer switching and anisotropy principles to three or more magnetic recording layers. Ex-1005, 10:7-18. Ex-1003, ¶167.

**Ferromagnetic layers.** Takenoiri’s “nucleation host” includes at least two ferromagnetic layers. As shown below, Takenoiri’s “nucleation host,” as part of its tri-layer (or more) structure includes at least two magnetic recording layers: the second magnetic recording layer 7 (green) and the third magnetic recording layer (light green).



Ex-1005, Fig. 1 (tri-layer structure in modified Fig. 1). Ex-1003, ¶168.

Takenoiri discloses that the second magnetic recording layer 7 can employ “the same material and structure as in first magnetic recording layer 5” (Ex-1005, 9:13-15), which “is preferably composed of a **ferromagnetic alloy** containing at least cobalt and platinum.” *Id.*, 6:66-67. Therefore, Takenoiri’s second magnetic recording layer 7 is a ferromagnetic layer. Ex-1003, ¶169.

A POSITA would have found it obvious to use the same or a similar material as in the first and second magnetic recording layers for the third magnetic recording layer for the following reasons. First, the third layer participates in the same sequential magnetization reversal process as the first and second layers, as described in Ex-1005 at 10:14–18. Second, the third layer is exchange-coupled to the second layer beneath it, just as the second layer is exchange-coupled to the first. Third, all

three layers must satisfy the same functional requirement involving the  $K_u \cdot T$  relationship. *Id.*, 10:10-14; *see also* Takenoiri's Examples 1-6 (showing that similar materials are used for the first and second magnetic recording layers though different compositions for achieving different anisotropy field  $H_k$ ). Takenoiri uses similar material with different compositions to meet this requirement in the first and second magnetic recording layers, and a POSITA would have applied the same approach to the third magnetic recording layer. Moreover, because Takenoiri's magnetic layers are exchange coupled (*id.*, 10:7-10), a POSITA would have understood that the main ferromagnetic element(s) in the magnetic alloy materials used for these magnetic layers need to be of similar though different compositions to ensure appropriate coupling. Thus, the third magnetic recording layer is also composed of "ferromagnetic alloy" and therefore is also a ferromagnetic layer. Ex-1003, ¶¶170-171.

Therefore, Takenoiri discloses, or at least suggests, "[said nucleation host] **comprises ferromagnetic layers** [e.g., at least Takenoiri's second magnetic recording layer 7 and third magnetic recording layer as part of its tri-layer structure]." Ex-1003, ¶172.

**Anisotropy Constants.** A POSITA would have found it obvious to configure Takenoiri's "nucleation host" such that the anisotropy constant of Takenoiri's second magnetic recording layer 7 (hereinafter " $K_u2$ ") is greater than the anisotropy

constant of Takenoiri's third magnetic recording layer (hereinafter "Ku<sub>3</sub>"), for at least the following reasons. Ex-1003, ¶173.

*First*, Takenoiri discloses that for a bi-layer structure, if  $H_{k1} > H_{k2}$ , then  $K_{u1}T_1 > K_{u2}T_2$ , where  $H_{k1}/H_{k2}$ ,  $K_{u1}/K_{u2}$ , and  $T_1/T_2$  are anisotropy magnetic field, uniaxial anisotropy constant, and thickness of the first/second magnetic recording layer, respectively. Ex-1005, claim 1. As shown in the table below summarizing Takenoiri's Examples 1-6, in each of Examples 1-6,  $K_{u1} > K_{u2}$ . Ex-1003, ¶174.

|                                   |                          | Ex. 1                                                                                                  | Ex. 2                                                                                                  | Ex. 3                                                             | Ex. 4 | Ex. 5                                                            | Ex. 6                                            |
|-----------------------------------|--------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|-------|------------------------------------------------------------------|--------------------------------------------------|
| second magnetic recording layer 7 | Composition              | (Co <sub>72</sub> Cr <sub>16</sub> Pt <sub>12</sub> ) <sub>90</sub> -(SiO <sub>2</sub> ) <sub>10</sub> | Co <sub>70</sub> Cr <sub>20</sub> Pt <sub>10</sub>                                                     | Co <sub>61</sub> Cr <sub>22</sub> Pt <sub>13</sub> B <sub>4</sub> |       | Co <sub>69</sub> Cr <sub>22</sub> Pt <sub>5</sub> B <sub>4</sub> | Co <sub>76</sub> Cr <sub>20</sub> B <sub>4</sub> |
|                                   | thickness T <sub>2</sub> | 6                                                                                                      | 6                                                                                                      | 6.5                                                               | 6.5   | 6.5                                                              | 6.5                                              |
|                                   | Ku <sub>2</sub>          | 2.5                                                                                                    | 2                                                                                                      | 1.85                                                              | 1.85  | 1.51                                                             | 1.31                                             |
|                                   | Hk <sub>2</sub>          | 13.2                                                                                                   | 11.1                                                                                                   | 13.2                                                              | 13.2  | 10.1                                                             | 8.17                                             |
| coupling layer 6                  | Composition              | Ru                                                                                                     | Cobalt                                                                                                 | Ru                                                                |       |                                                                  |                                                  |
|                                   | Thickness                | 0.2                                                                                                    | 0.3                                                                                                    | 1.6                                                               | 0.25  | 0.25                                                             | 0.25                                             |
| first magnetic recording layer 5  | Composition              | (Co <sub>74</sub> Cr <sub>12</sub> Pt <sub>14</sub> ) <sub>90</sub> -(SiO <sub>2</sub> ) <sub>10</sub> | (Co <sub>72</sub> Cr <sub>10</sub> Pt <sub>18</sub> ) <sub>90</sub> -(SiO <sub>2</sub> ) <sub>10</sub> |                                                                   |       |                                                                  |                                                  |
|                                   | thickness T <sub>1</sub> | 10                                                                                                     | 10                                                                                                     | 9.5                                                               | 9.5   | 9.5                                                              | 9.5                                              |
|                                   | Ku <sub>1</sub>          | 4.2                                                                                                    | 5                                                                                                      | 5.05                                                              | 5.05  | 5.05                                                             | 5.05                                             |
|                                   | Hk <sub>1</sub>          | 18.7                                                                                                   | 20                                                                                                     | 20                                                                | 20    | 20                                                               | 20                                               |

Takenoiri discloses that the unit for thickness T<sub>1</sub> and T<sub>2</sub> is nm and the unit for Hk<sub>1</sub> and Hk<sub>2</sub> is kOe. *See, e.g.*, Ex-1005, 10:56-66, 11:31-36. While the unit for Ku<sub>1</sub> and Ku<sub>2</sub> in Takenoiri is 10<sup>-6</sup> erg/cm<sup>3</sup> (*id.*, 11:31-33), a POSITA would have understood that this is a typographical error, because it was well known that the Ku values of CoCrPt-based materials, as used for Takenoiri's Examples 1-6, are in the 10<sup>6</sup> erg/cm<sup>3</sup> range. *See* Ex-1028, Figures 3, 4, 7; Ex-1036, ¶90. Regardless, this typographical error does not change the analysis in this Petition because Takenoiri discloses the correct relative values of Ku and KuT. Ex-1003, ¶175.

Thus, if a third magnetic layer is added (per Takenoiri's tri-layer (or more) structure described above), it would have been obvious to a POSITA that  $Ku_2 > Ku_3$ , following the same  $Ku$  trend described in each of Examples 1-6 to preserve the switching behavior, e.g., sequential magnetization switching from top to bottom. *See, e.g.*, Ex-1005, 9:25-29. In other words, a POSITA would have understood that extending the  $Ku$  scheme between two magnetic layers to a third magnetic layer naturally suggests the same directional  $Ku$  gradient, so that sequential magnetization switching from top to bottom (as illustrated in Examples 1-6) can be more easily achieved in Takenoiri's tri-layer structure (as explained below), thereby "still produc[ing] the effect of improving thermal stability and the effect of reducing switching field at the same time." *Id.*, 10:14-18; Ex-1003, ¶176.

*Second*, of the only three configurations that could exist: (i)  $Ku_3 > Ku_2$ ; (ii)  $Ku_3 = Ku_2$ ; or (iii)  $Ku_3 < Ku_2$ , a POSITA would have been motivated to try (i.e., **obvious to try**) all three configurations, but in particular a POSITA would have been motivated to try configuration (iii) because, as explained above, it aligns with Takenoiri's established gradient of decreasing anisotropy and supports sequential switching from top-to-bottom. Ex-1003, ¶¶177-178.

*Third*, a POSITA would have been motivated to set  $Ku_2 > Ku_3$  because a lower  $Ku_3$  makes Takenoiri's top-to-bottom sequential switching easier to achieve. For Takenoiri's second magnetic layer 7 to reverse before the first magnetic recording

layer 5,  $H_{k1} > H_{k2}$  and  $K_{u1}T_1 > K_{u2}T_2$  must be satisfied. Extending this to a tri-layer structure, a POSITA would have recognized that  $H_{k2} > H_{k3}$  and  $K_{u2}T_2 > K_{u3}T_3$  must also hold. *See* Ex-1005, 10:10-14 (“The order of magnitude of the product  $K_uT$  of a uniaxial anisotropy constant and a thickness of each magnetic recording layer are determined in accordance with the order of magnitude of the anisotropy magnetic field  $H_k$  of the magnetic recording layer.”). Lowering  $K_{u3}$  helps meet both conditions. Lower  $K_{u3}$  contributes to lower  $K_{u3}T_3$ . Moreover, under Takenoiri’s equation “ $H_k = 2 K_u/M_s$ ,” lower  $K_{u3}$  also reduces  $H_{k3}$ , which in turn contributes to lower  $H_c$ , making sequential switching more attainable. Ex-1003, ¶179.

*Fourth*, a POSITA would have been motivated to set  $K_{u2} > K_{u3}$  because a lower  $K_{u3}$  helps reduce the overall coercivity ( $H_c$ ) of the structure. Although Takenoiri discloses specific relationships between  $H_{k1}$ ,  $H_{k2}$ ,  $K_{u1}$ ,  $K_{u2}$ ,  $T_1$ , and  $T_2$ , these relationships aim to “contribute to the reduction of the  $H_c$ .” Ex-1005, 14:30-34; *see also id.*, 10:14-18 (“By individually reversing the magnetization of each magnetic recording layer as in this measure, the structure having three or more magnetic recording layers still produces the effect of improving thermal stability and the **effect of reducing switching field** at the same time.”).<sup>11</sup> As explained in Section

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<sup>11</sup> As explained, Takenoiri uses coercive field  $H_c$  and switching field synonymously.

*See* fn. 9.

VIII.B.6 (limitation 1[E]), a POSITA would have been motivated to configure  $H_{c3} < H_{c2}$  to further reduce the overall coercivity. It was also well known that lower  $K_u$  leads to lower  $H_c$  or switching field. The '864 Patent itself acknowledges this: “[I]ncreasing the anisotropy  $K$ ...results in an unfavorable increase of the coercivity  $H_c$ .” Ex-1001, 1:19-23. Therefore, to achieve  $H_{c3} < H_{c2}$ , a POSITA would have been motivated to configure  $K_{u3} < K_{u2}$ . Ex-1003, ¶180.

Finally, a POSITA would have had **reasonable expectation of success** in configuring  $K_{u3}$  lower than  $K_{u2}$ , as Takenoiri has provided detailed examples of magnetic recording layers with varying  $K_u$  values, material compositions, and deposition conditions in Examples 1-6. See Ex-1005, 10:56-66, 13:49-58, 15:21-30. Using these teachings, a POSITA would have selected a lower- $K_u$  layer—such as the second magnetic layer 7 in Example 5 (red)—to serve as the third magnetic recording layer in the Example 1. Ex-1003, ¶181.

|                                   |                          | Ex. 1                                                                                                  | Ex. 2                                                                                                  | Ex. 3                                                             | Ex. 4 | Ex. 5                                                            | Ex. 6                                            |
|-----------------------------------|--------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|-------|------------------------------------------------------------------|--------------------------------------------------|
| second magnetic recording layer 7 | Composition              | (Co <sub>72</sub> Cr <sub>16</sub> Pt <sub>12</sub> ) <sub>90</sub> -(SiO <sub>2</sub> ) <sub>10</sub> | Co <sub>70</sub> Cr <sub>20</sub> Pt <sub>10</sub>                                                     | Co <sub>61</sub> Cr <sub>22</sub> Pt <sub>13</sub> B <sub>4</sub> |       | Co <sub>69</sub> Cr <sub>22</sub> Pt <sub>5</sub> B <sub>4</sub> | Co <sub>76</sub> Cr <sub>20</sub> B <sub>4</sub> |
|                                   | thickness T <sub>2</sub> | 6                                                                                                      | 6                                                                                                      | 6.5                                                               | 6.5   | 6.5                                                              | 6.5                                              |
|                                   | K <sub>u2</sub>          | 2.5                                                                                                    | 2                                                                                                      | 1.85                                                              | 1.85  | 1.51                                                             | 1.31                                             |
|                                   | H <sub>k2</sub>          | 13.2                                                                                                   | 11.1                                                                                                   | 13.2                                                              | 13.2  | 10.1                                                             | 8.17                                             |
| coupling layer 6                  | Composition              | Ru                                                                                                     | Cobalt                                                                                                 | Ru                                                                |       |                                                                  |                                                  |
|                                   | Thickness                | 0.2                                                                                                    | 0.3                                                                                                    | 1.6                                                               | 0.25  | 0.25                                                             | 0.25                                             |
| first magnetic recording layer 5  | Composition              | (Co <sub>74</sub> Cr <sub>12</sub> Pt <sub>14</sub> ) <sub>90</sub> -(SiO <sub>2</sub> ) <sub>10</sub> | (Co <sub>72</sub> Cr <sub>10</sub> Pt <sub>18</sub> ) <sub>90</sub> -(SiO <sub>2</sub> ) <sub>10</sub> |                                                                   |       |                                                                  |                                                  |
|                                   | thickness T <sub>1</sub> | 10                                                                                                     | 10                                                                                                     | 9.5                                                               | 9.5   | 9.5                                                              | 9.5                                              |
|                                   | K <sub>u1</sub>          | 4.2                                                                                                    | 5                                                                                                      | 5.05                                                              | 5.05  | 5.05                                                             | 5.05                                             |
|                                   | H <sub>k1</sub>          | 18.7                                                                                                   | 20                                                                                                     | 20                                                                | 20    | 20                                                               | 20                                               |

Moreover, Takenoiri teaches that lower  $H_k$ , and therefore lower  $K_u$ , can be achieved by reducing platinum content in the magnetic recording layer. Ex-1005,

10:1-6, 9:49-54. Ku adjustment was well known and widely implemented. A POSITA would also have readily lowered Ku by increasing Cr content and incorporating elements like Ta, B, Nb, and N, as Takenoiri suggests. *See, e.g.*, Ex-1005, 9:57-67. Therefore, a POSITA would have had **reasonable expectation of success** in configuring  $Ku_3$  lower than  $Ku_2$  in Takenoiri's tri-layer structure. Ex-1003, ¶182.

Because Takenoiri's  $Ku_2$  is greater than  $Ku_3$ , the anisotropy constant increases from the third magnetic recording layer to the second magnetic recording layer.<sup>12</sup> Ex-1003, ¶183.

Therefore, Takenoiri renders obvious that “[said nucleation host] **comprises ferromagnetic layers** [e.g., at least Takenoiri's second magnetic recording layer 7 and third magnetic recording layer as part of its tri-layer structure] **with increasing anisotropy constant K from layer to layer** [e.g., Takenoiri's anisotropy constant

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<sup>12</sup> This is consistent with the WD court's construction of the term: “nucleation host includes two or more ferromagnetic layers which have anisotropy constants K, and the value of the anisotropy constant K for the layers increase as the layers get closer to the hard magnetic storage layer, such that the nucleation host has an overall increase in anisotropy toward the hard magnetic storage layer.” Ex-1019, p.14. Ex-1003, ¶183.

of the second magnetic recording layer 7 ( $Ku_2$ ) being greater than the anisotropy constant  $K$  of the third magnetic recording layer ( $Ku_3$ )].”<sup>13</sup> Ex-1003, ¶184.

### C. Claim 3

Claim 3 depends from claim 1 (obvious over Takenoiri; Section VIII.B) and further recites “**wherein: the nucleation host and the hard magnetic storage layer are in direct contact,**” which Takenoiri discloses, or at least renders obvious. Ex-1003, ¶187.

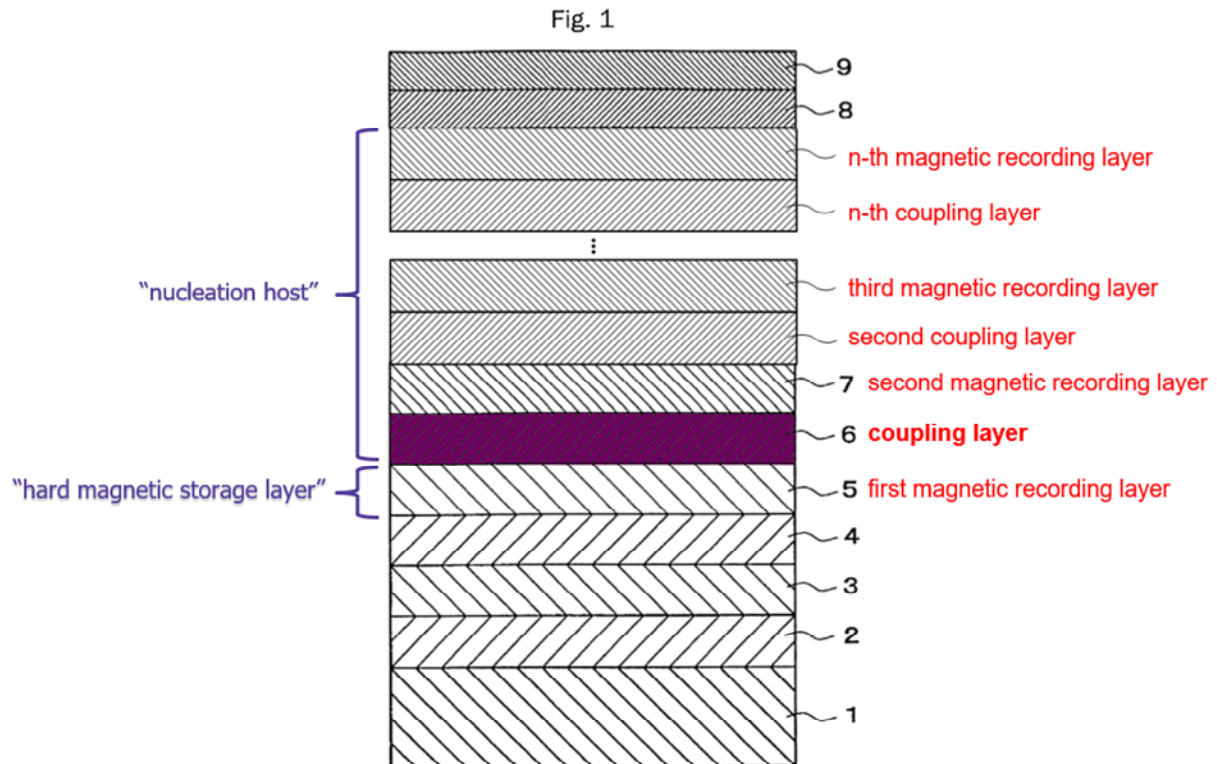
Claim 1 of the ’864 Patent states that the nucleation host “comprises ferromagnetic layers,” not limiting the nucleation host to only ferromagnetic layers. Therefore, for claim 3’s embodiment, Takenoiri’s coupling layer 6 can be considered part of the nucleation host formed on the hard magnetic storage layer. PO’s own

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<sup>13</sup> Because the second and third magnetic recording layers in Takenoiri’s tri-layer structure are ferromagnetic layers and are expected to switch magnetization earlier than the first magnetic recording layer, facilitating the switching of the first magnetic storage layer 5, Takenoiri’s second and third magnetic recording layers, as well as the coupling layer in between, discloses the claimed “nucleation host” consistent with the court’s construction in the WD case: “a structure that includes ferromagnetic layers that assist in switching the hard magnetic storage layer, and optional coupling layers.” Ex-1019, p.17-18. Ex-1003, ¶185.

proposed claim construction of “nucleation host” in the WD case (which was also adopted by the court): “a structure that includes ferromagnetic layers...and **optional coupling layers**” confirms. Ex-1019, p.17-18. Ex-1003, ¶188.

Therefore, for the embodiment claimed in claim 3, Takenoiri’s “nucleation host” includes the coupling layer 6 (purple), so Takenoiri’s “nucleation host” (including the coupling layer 6) and its first magnetic recording layer 5 (i.e., the claimed “hard magnetic storage layer”) are in direct contact. Ex-1003, ¶189.



Ex-1005, Fig. 1 (tri-layer structure in modified Fig. 1).

If the coupling layer 6 cannot be considered part of Takenoiri’s “nucleation host,” a POSITA would have found it obvious to omit that layer from Takenoiri’s tri-layer structure, placing Takenoiri’s first (hard magnetic storage layer) and second

(part of the nucleation host) magnetic recording layers in direct contact. Ex-1003, ¶190.

Although Takenoiri states that a coupling layer is necessary, it does so only “from the viewpoint of leading to an appropriate coupling energy between the magnetic recording layers while retaining the ferromagnetic coupling” to achieve simultaneous improvement of thermal stability and reduction in the switching field. Ex-1005, 7:27-43. This language reflects a desire to improve the device’s performance, not a structural requirement, and confirms that Takenoiri’s magnetic recording medium that could exist without the coupling layer 6. Ex-1003, ¶191.

Moreover, a POSITA seeking to implement or evaluate Takenoiri’s teachings would have been motivated to fabricate and compare versions of Takenoiri’s multilayer structure with and without the coupling layer 6 to assess impact. Since direct contact leads to stronger exchange coupling between the two adjacent magnetic layers, a POSITA seeking stronger exchange coupling (and thereby a further reduction in the structure’s coercivity) would have been motivated to omit the coupling layer 6. Whether to test the efficacy of Takenoiri’s invention or in applications where thermal stability or switching field is less critical, omitting the coupling layer 6 would have simplified fabrication, and a POSITA would have had a reasonable expectation of success. Takenoiri teaches magnetic recording media having three magnetic recording layers in direct contact existed. Ex-1005, 2:3-14

(citing JP 2003-157516); Ex-1027 (“Hikosaka,” US equivalent of JP 2003-157516), ¶¶ 44, 102, Figs. 3 and 8; *see also* Ex-1022, 7:1-13 (“tailoring of the local exchange coupling strength between adjacent sub-layers to achieve a desired coupling strength is accomplished by...forming the adjacent sub-layers positioned in direct contact...”). Ex-1003, ¶192.

**D. Claim 4**

Claim 4 depends from claim 1 (obvious over Takenoiri; Section VIII.B) and further recites “**wherein: the nucleation host and the hard magnetic storage layer comprise ferromagnetic layers with increasing anisotropy constant K values,**” which Takenoiri discloses. Ex-1003, ¶193.<sup>14</sup>

This claim requires a stack of ferromagnetic layers, including the hard magnetic storage layer, arranged so that the anisotropy constant K increases with each layer moving towards the hard magnetic storage layer. Takenoiri discloses this. Ex-1003, ¶194.

Takenoiri discloses that in each of Examples 1-6 (shown below),  $K_{u1} > K_{u2}$ , and a POSITA would have found it obvious to set  $K_{u3} < K_{u2}$ . Section VIII.B.9 (limitation 1[H]). Ex-1003, ¶¶195-196.

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<sup>14</sup> Petitioners reserve right to challenge this claim under 35 U.S.C. § 112 in other proceedings.

|                                   |                          | Ex. 1                                                                                                  | Ex. 2                                                                                                  | Ex. 3                                                             | Ex. 4 | Ex. 5                                                            | Ex. 6                                            |
|-----------------------------------|--------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|-------|------------------------------------------------------------------|--------------------------------------------------|
| second magnetic recording layer 7 | Composition              | (Co <sub>72</sub> Cr <sub>16</sub> Pt <sub>12</sub> ) <sub>90</sub> -(SiO <sub>2</sub> ) <sub>10</sub> | Co <sub>70</sub> Cr <sub>20</sub> Pt <sub>10</sub>                                                     | Co <sub>61</sub> Cr <sub>22</sub> Pt <sub>13</sub> B <sub>4</sub> |       | Co <sub>69</sub> Cr <sub>22</sub> Pt <sub>5</sub> B <sub>4</sub> | Co <sub>76</sub> Cr <sub>20</sub> B <sub>4</sub> |
|                                   | thickness T <sub>2</sub> | 6                                                                                                      | 6                                                                                                      | 6.5                                                               | 6.5   | 6.5                                                              | 6.5                                              |
|                                   | Ku <sub>2</sub>          | 2.5                                                                                                    | 2                                                                                                      | 1.85                                                              | 1.85  | 1.51                                                             | 1.31                                             |
|                                   | Hk <sub>2</sub>          | 13.2                                                                                                   | 11.1                                                                                                   | 13.2                                                              | 13.2  | 10.1                                                             | 8.17                                             |
| coupling layer 6                  | Composition              | Ru                                                                                                     | Cobalt                                                                                                 | Ru                                                                |       |                                                                  |                                                  |
|                                   | Thickness                | 0.2                                                                                                    | 0.3                                                                                                    | 1.6                                                               | 0.25  | 0.25                                                             | 0.25                                             |
| first magnetic recording layer 5  | Composition              | (Co <sub>72</sub> Cr <sub>12</sub> Pt <sub>14</sub> ) <sub>90</sub> -(SiO <sub>2</sub> ) <sub>10</sub> | (Co <sub>72</sub> Cr <sub>10</sub> Pt <sub>18</sub> ) <sub>90</sub> -(SiO <sub>2</sub> ) <sub>10</sub> |                                                                   |       |                                                                  |                                                  |
|                                   | thickness T <sub>1</sub> | 10                                                                                                     | 10                                                                                                     | 9.5                                                               | 9.5   | 9.5                                                              | 9.5                                              |
|                                   | Ku <sub>1</sub>          | 4.2                                                                                                    | 5                                                                                                      | 5.05                                                              | 5.05  | 5.05                                                             | 5.05                                             |
|                                   | Hk <sub>1</sub>          | 18.7                                                                                                   | 20                                                                                                     | 20                                                                | 20    | 20                                                               | 20                                               |

Therefore, Takenoiri renders obvious that “**the nucleation host [e.g., Takenoiri’s second magnetic recording layer 7 with anisotropy constant Ku<sub>2</sub> and third magnetic recording layer with anisotropy constant Ku<sub>3</sub>] and the hard magnetic storage layer [e.g., Takenoiri’s first magnetic recording layer 5 with anisotropy constant Ku<sub>1</sub>] comprise ferromagnetic layers with increasing anisotropy constant K values [e.g., Ku<sub>1</sub>>Ku<sub>2</sub>>Ku<sub>3</sub>].** Ex-1003, ¶197.

#### E. Claim 5

Claim 5 depends from claim 1 (obvious over Takenoiri; Section VIII.B) and further recites “**wherein: the hard magnetic storage layer comprises of [sic] at least one of Cr, Pt, Ta, B, Fe, Cu, Ag, W, Mo, Ru, Si, Ge, Nb, Co, Pd, Sm, Nd, Dy, Hf, Mn and Ni,**” which Takenoiri discloses. Ex-1003, ¶198.

Takenoiri discloses that “[f]irst magnetic recording layer 5 can be composed an alloy material such as **CoPt, CoCrPt, CoCrPtB, or CoCrPtTa**, a multilayered film of **(Co/Pt)<sub>n</sub> or (Co/Pd)<sub>n</sub>**, or a granular material of **CoPt—SiO<sub>2</sub>, CoCrPtO, CoCrPt—SiO<sub>2</sub>, CoCrPt—Al<sub>2</sub>O<sub>3</sub>, CoPt—AlN, or CoCrPt—Si<sub>3</sub>N<sub>4</sub>.**” Ex-1005, 7:5-

9; *see also* material composition for the first magnetic recording layer 5 in each of Takenoiri's Examples 1 to 6. Ex-1003, ¶199.

Therefore, Takenoiri discloses “**wherein: the hard magnetic storage layer comprises of [sic] at least one of Cr, Pt, Ta, B, Fe, Cu, Ag, W, Mo, Ru, Si, Ge, Nb, Co, Pd, Sm, Nd, Dy, Hf, Mn and Ni** [e.g., Takenoiri's first magnetic recording layer 5 composed of CoPt, CoCrPt, CoCrPtB, CoCrPtTa, (Co/Pt)<sub>n</sub>, (Co/Pd)<sub>n</sub>, CoPt—SiO<sub>2</sub>, CoCrPtO, CoCrPt—SiO<sub>2</sub>, CoCrPt—Al<sub>2</sub>O<sub>3</sub>, CoPt—AlN, or CoCrPt—Si<sub>3</sub>N<sub>4</sub>].” Ex-1003, ¶200.

**F. Claim 9**

Claim 9 depends from claim 1 (obvious over Takenoiri; Section VIII.B) and further recites “**wherein: the nucleation host comprises at least one of Fe, Al, Cu, Ag, Ge, Pd, Sm, Nd, Dy, and Mn,**” which Takenoiri discloses. Ex-1003, ¶201.

Takenoiri discloses that “[f]or second magnetic recording layer 7 [part of Takenoiri's nucleation host], the same material and structure as in first magnetic recording layer 5 [Takenoiri's hard magnetic storage layer] can be employed.” Ex-1005, 9:13-15. The first magnetic recording layer 5 “can be composed of...a multilayered film of (Co/Pt)<sub>n</sub> or (Co/**Pd**)<sub>n</sub>, or a granular material of CoPt—SiO<sub>2</sub>,

CoCrPtO, CoCrPt—SiO<sub>2</sub>, CoCrPt—Al<sub>2</sub>O<sub>3</sub>, CoPt—AlN, or CoCrPt—Si<sub>3</sub>N<sub>4</sub>.” *Id.*, 7:5-9.<sup>15</sup> Ex-1003, ¶202.

Therefore, Takenoiri discloses that “**the nucleation host** [e.g., Takenoiri’s nucleation host including the second magnetic recording layer 7] **comprises at least one of Fe, Al** [e.g., Takenoiri’s CoCrPt—Al<sub>2</sub>O<sub>3</sub>, CoPt—AlN], **Cu, Ag, Ge, Pd** [e.g., Takenoiri’s (Co/Pd)<sub>n</sub>], **Sm, Nd, Dy, and Mn.**” Ex-1003, ¶203.

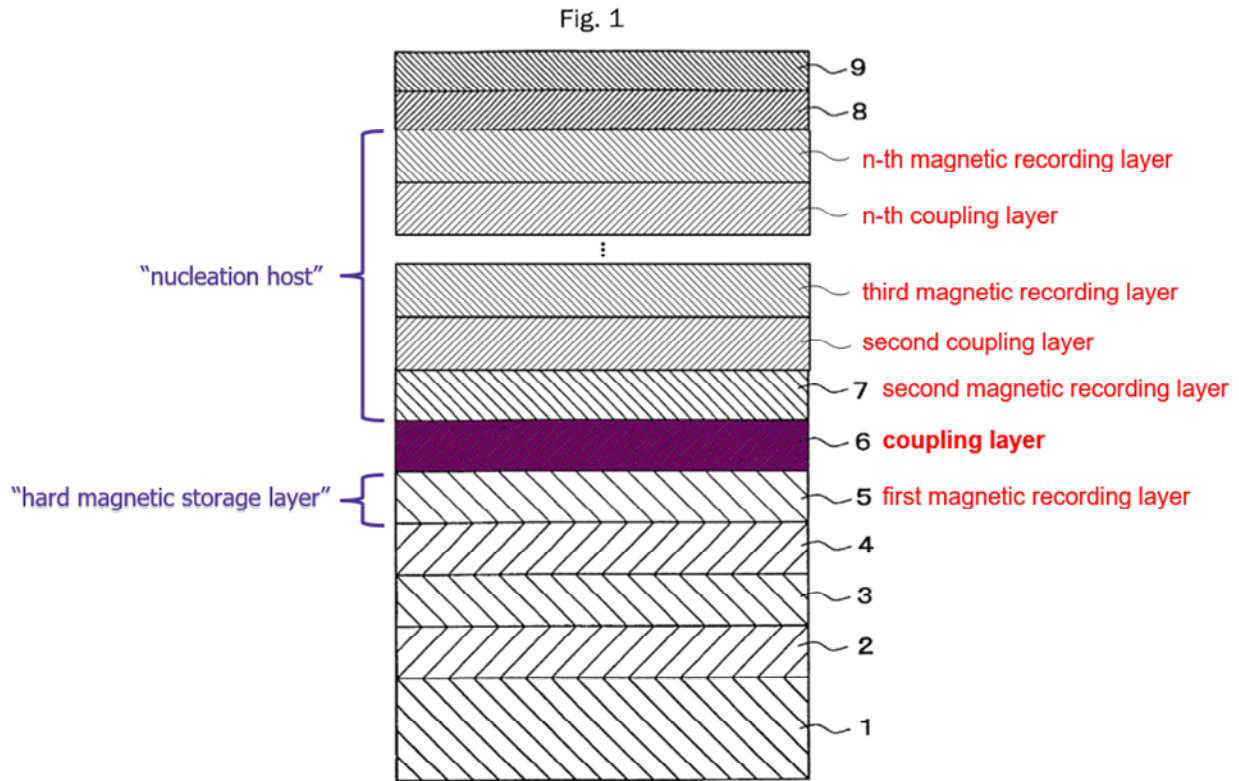
### **G. Claim 13**

Claim 13 depends from claim 1 (obvious over Takenoiri; Section VIII.B). Here, the embodiment claimed in Claim 13 requires “**wherein: a coupling layer is disposed between the nucleation host and the hard magnetic storage layer,**” which Takenoiri discloses. Ex-1003, ¶204.

As shown in revised Figure 1 below, Takenoiri discloses a coupling layer 6 (purple) between second magnetic recording layer 7 and the first magnetic recording layer 5.

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<sup>15</sup> Takenoiri uses “Al<sub>2</sub>O<sub>3</sub>” and “AlN.” A POSITA would have understood them to be a typographical error and “Al” should refer to aluminum “Al.” Ex-1003, ¶202.



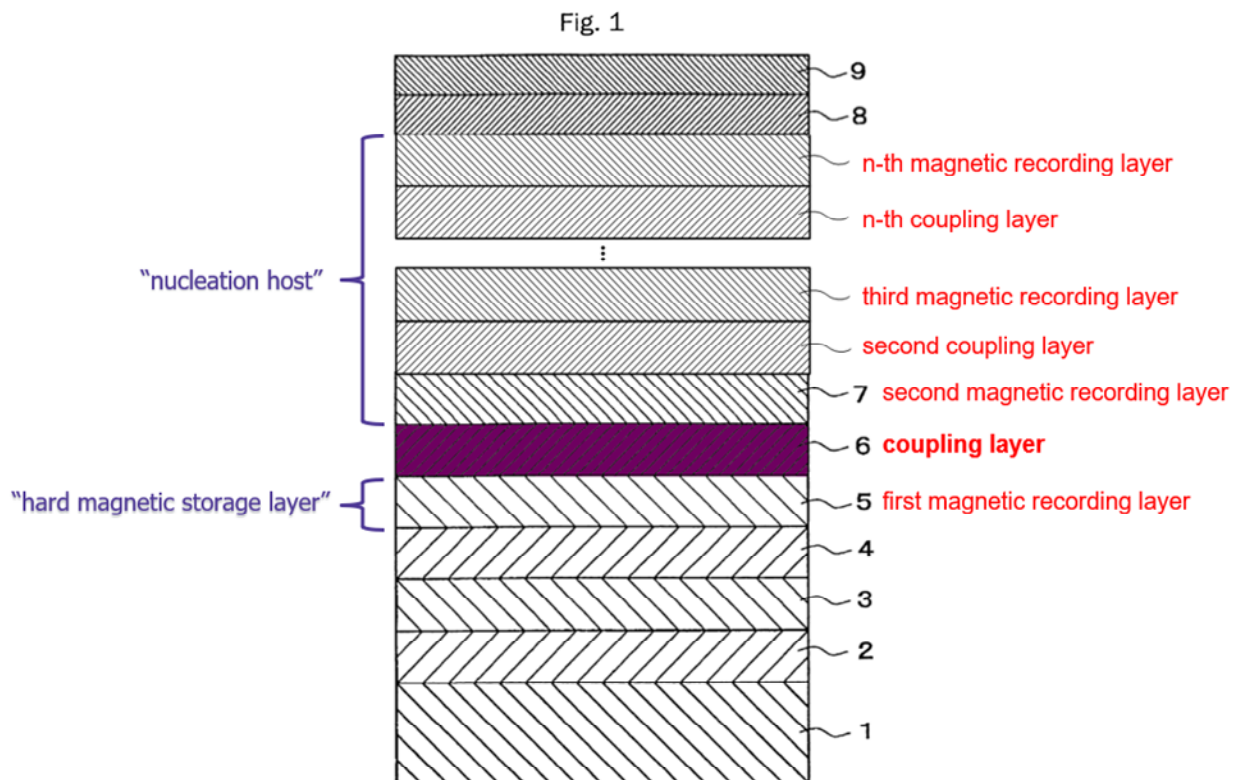
Ex-1005, Fig. 1 (tri-layer structure in modified Fig. 1). For the claim 3 embodiment, Takenoiri’s “nucleation host” includes the second and third magnetic recording layers but does not include the coupling layer 6. Section VIII.C. For this claimed embodiment, Takenoiri’s coupling layer 6 is the coupling layer of claim 13. Ex-1003, ¶¶205-207.

Therefore, Takenoiri discloses that “**a coupling layer** [e.g., Takenoiri’s coupling layer 6] **is disposed between the nucleation host** [e.g., Takenoiri’s “nucleation host” including the second magnetic recording layer 7 at the bottom] **and the hard magnetic storage layer** [e.g., the first magnetic recording layer 5].” Ex-1003, ¶208.

## H. Claim 14

Claim 14 depends from claim 1 (obvious over Takenoiri; Section VIII.B) and further recites “**wherein: the nucleation host is separated from the hard magnetic storage layer by a layer of thickness less than 5 nm,**” which Takenoiri discloses. Ex-1003, ¶209.

As shown below, Takenoiri’s “nucleation host” is separated from the first magnetic recording layer 5 by a coupling layer 6 (purple), the thickness of which is “preferably at most 2 nm... more preferably **0.3 nm or smaller.**” Ex-1005, 8:60-63.



Ex-1005, Fig. 1 (tri-layer structure in modified Fig. 1). Ex-1003, ¶¶210-211.

Therefore, Takenoiri discloses that “**the nucleation host** [e.g., Takenoiri’s “nucleation host” including the second magnetic recording layer 7 at the bottom] **is separated from the hard magnetic storage layer** [e.g., Takenoiri’s first magnetic recording layer 5] **by a layer of thickness less than 5 nm** [e.g., Takenoiri’s coupling layer 6 having a thickness of at most 2 nm, and preferably 0.3 nm or smaller].” Ex-1003, ¶212.

**I. Claim 23**

Claim 23 depends from claim 1 (obvious over Takenoiri; Section VIII.B) and further recites “**wherein: the recording medium is usable for at least one of perpendicular recording or recording on patterned elements,**” which Takenoiri discloses. Ex-1003, ¶213.

Takenoiri is directed to “a **perpendicular magnetic recording medium** mounted on various **magnetic recording devices**, in particular to a **perpendicular magnetic recording medium** mounted on a **hard disk drive...**” Ex-1005, 1:14-19; *see also id.*, 7:1-5 (“The axis of easy magnetization...of the first magnetic recording layer needs to align in the direction **perpendicular to the film surface** for the use in a **perpendicular magnetic recording medium.**”); Fig. 4 (showing magnetization **perpendicular** to the film surface). A POSITA would have understood that

Takenoiri's perpendicular magnetic recording medium is usable for perpendicular recording.<sup>16</sup> Ex-1003, ¶214.

**IX. GROUND 2: CLAIMS 2 AND 6 ARE OBVIOUS OVER TAKENOIRI IN VIEW OF SHEN**

**A. Claim 2**

Claim 2 depends from claim 1 (obvious over Takenoiri; Section VIII.B). Claim 2 further recites further properties of the exchange coupling and nucleation host. *See* Appendix A (claim 2), *infra*. Takenoiri in view of Shen renders obvious claim 2. Ex-1003, ¶215.

Claim 2 adds a mathematical condition to claim 1's magnetic multilayer structure, requiring that within the central portion of the hysteresis loop ( $-0.7 < M_z/M_s < 0.7$ ), the slope of the magnetization curve ( $\frac{dM}{dH}$ ) remains substantially constant, changing by no more than a factor of three. This describes a medium whose magnetization reverses smoothly and uniformly when an external magnetic field is applied. Ex-1003, ¶216.

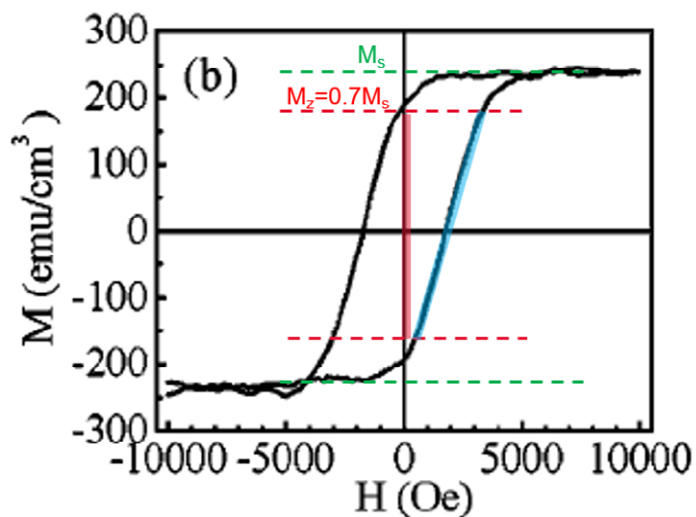
Takenoiri discloses multilayer perpendicular magnetic recording media, including bi-layer and tri-layer structures, in which softer magnetic layers are

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<sup>16</sup> This is consistent with the court's construction of this limitation in the WD case: "the recording medium is capable of being used as either perpendicular recording media or bit patterned media." Ex-1019, p.28-29. Ex-1003, ¶214.

exchange-coupled to a harder magnetic layer to reduce coercivity while maintaining thermal stability. Ex-1005, 10:7-18. Takenoiri provides “a **conceptual** illustration of the hysteresis loop” in Figure 5, recognizing that “[i]n an **actual** perpendicular magnetic recording medium, the hysteresis curve has some slope due to an effect of demagnetization, and accurate calculation of the demagnetizing factor is difficult.” *Id.*, 4:8-10, 8:20-23. Ex-1003, ¶217.

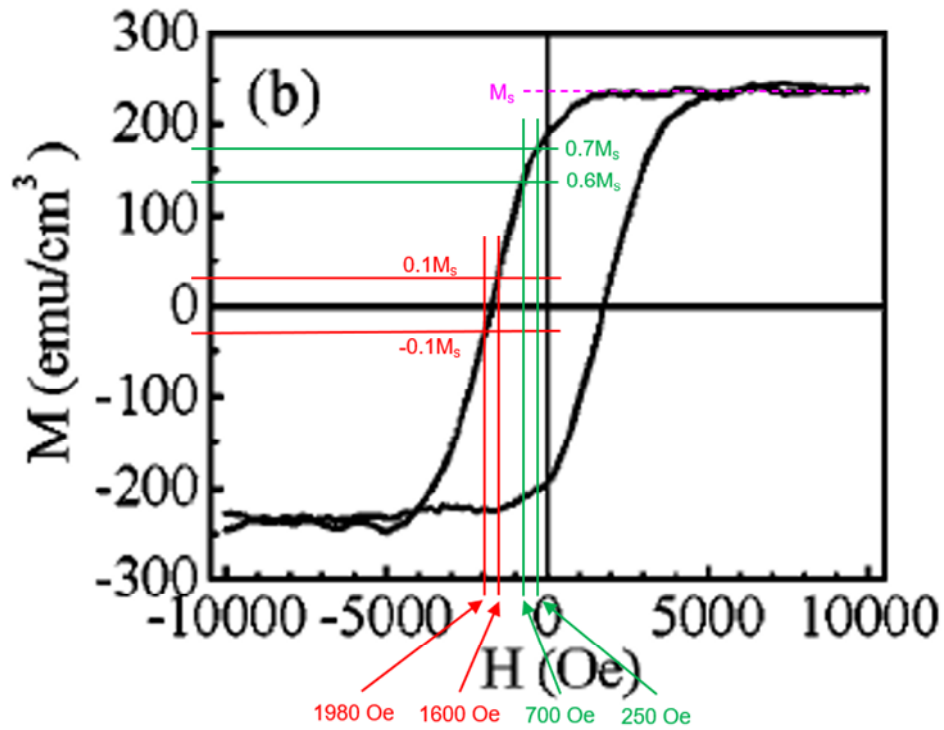
Shen provides experimental data for similar composite magnetic media combining soft and hard magnetic layers. In Shen’s Figure 5(b), the **measured** hysteresis loop shows a long, nearly linear region where magnetization changes evenly over the middle portion of the curve.



Ex-1007, Fig. 5(b); *see also id.*, p.3 (“For the proper coupling layer, uniform switching behavior is observed, while for the decoupling case (c), the switching is divided into 2 phases very clearly.”). Ex-1003, ¶218.

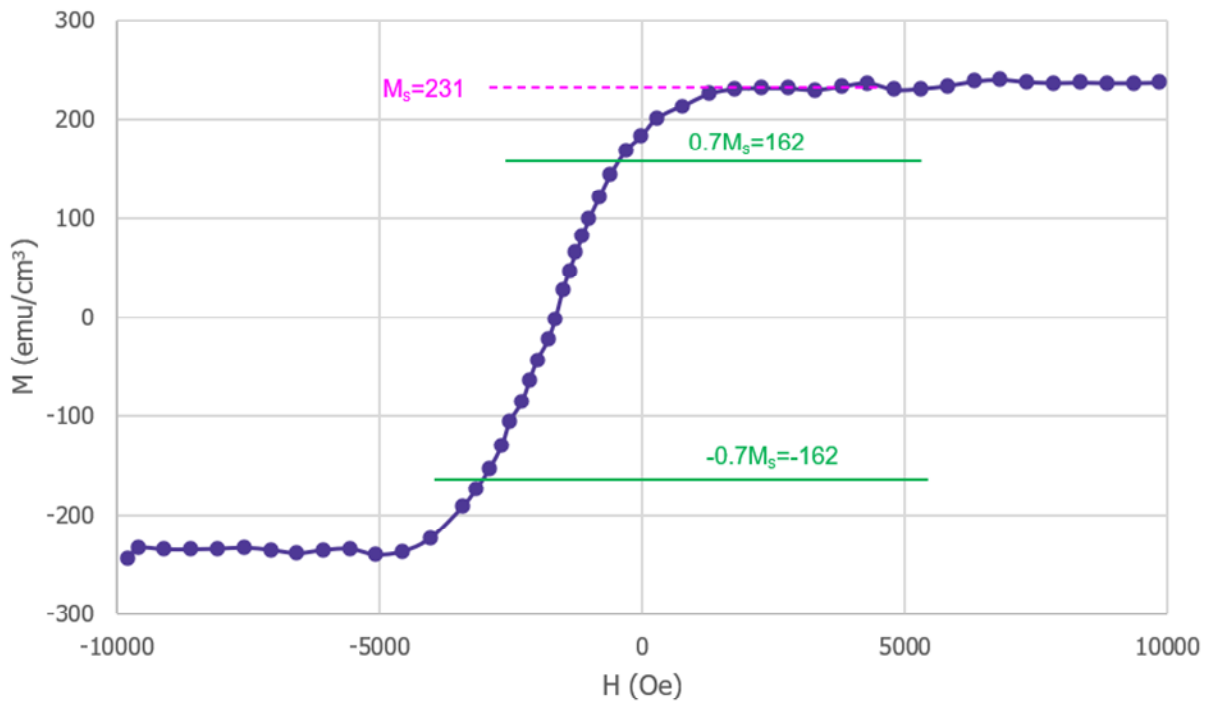
Because the slope  $\frac{dM}{dH}$  (blue) remains substantially constant within the magnetization range  $-0.7 < M_z/M_s < 0.7$  (in red) and the parameters  $H_c$  and  $M_s$  are fixed, the normalized derivative  $k = \frac{dM}{dH} \frac{H_c}{M_s}$  also remains substantially constant. Thus, Shen's hysteresis loop in Figure 5(b) meets claim 12's requirement that  $k$  does not change by more than a factor of three in the specified magnetization range. Ex-1003, ¶ 252.

This is confirmed by the mathematical calculation based on the plot in Shen's Figure 5(b). As illustrated below, within the  $-0.7 < M_z/M_s < 0.7$  range, the smallest  $k$  value is at  $0.7M_s$  to  $0.6M_s$  and is therefore  $\frac{H_c}{4500}$ , and the biggest  $k$  value is at  $0.1M_s$  to  $-0.1M_s$  and is therefore  $\frac{H_c}{1900}$ . The ratio of the two  $k$  values is 2.37, which is smaller than 3. Ex-1003, ¶¶ 219-220.



Ex-1007, Fig. 5(b). Digitizing the above hysteresis loop also confirms that the ratio of the largest  $k$  value and the smallest  $k$  value with the  $-0.7 < M_z/M_s < 0.7$  range is 2.549, which is smaller than 3. Ex-1003, ¶¶221-222.

Shen's Fig. 5(b) - digitized hysteresis loop (left portion)



As detailed in Section IX.C, *infra*, a POSITA would have been motivated to implement Takenoiri's tri-layer structure using Shen's guidance to achieve a similar uniform loop having a smooth slope the same or at least substantially the same as that in Shen's measured curve in Figure 5(b), e.g., by maintaining appropriate exchange coupling between the first and second magnetic recording layers, as well as the coercivity of the second and third magnetic recording layers. Therefore, Takenoiri in view of Shen renders this claim obvious. Ex-1003, ¶223.

#### B. Claim 6

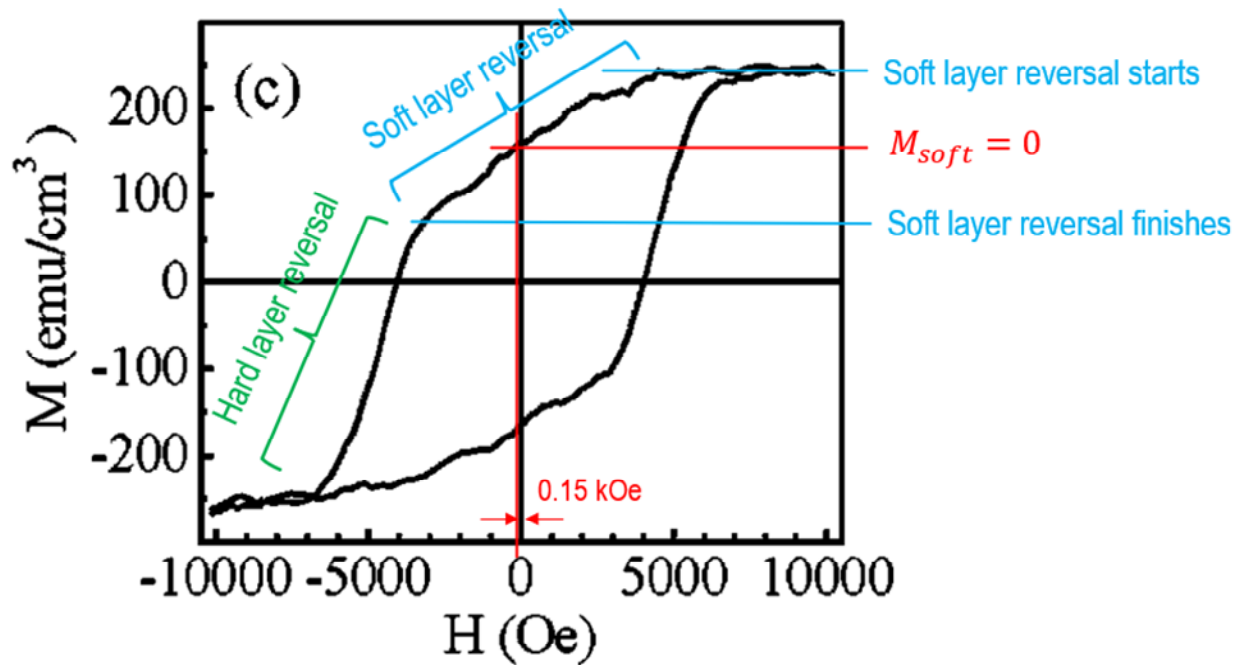
Claim 6 depends from claim 1 (obvious over Takenoiri; Section VIII.B) and further recites “**wherein: the coercive field of the nucleation host  $H_n$  without the hard magnetic storage layer is less than  $\frac{1}{2}$  of the coercive field of the hard**

**magnetic storage layer  $H_s$ ,**” which Takenoiri in view of Shen renders obvious. Ex-1003, ¶224.

As explained in Section VIII.B.6 (limitation 1[E]), the coercive field of Takenoiri’s “nucleation host” ( $H_{c2+3}$ ) is lower than the coercive field of Takenoiri’s first magnetic recording layer ( $H_{c1}$ ). Ex-1003, ¶225.

Like Takenoiri, Shen discloses a multi-layer structure where a soft layer is exchange coupled to a hard layer via an interlayer. Ex-1007, Abstract. Shen discloses that when the interlayer thickness is 0.5 nm, the coercivity of the entire structure is 1.75 kOe. *Id.*, p.3. In order to achieve 1.75 kOe coercivity for the entire structure, the coercivity of Shen’s soft layer without the hard layer must be lower than 1.75 kOe and the hard layer must be higher than 1.75 kOe. Ex-1003, ¶226.

Because the soft and hard layers in Shen’s Figure 5(c) are decoupled, the magnetization reversal in each layer occurs almost independently, allowing estimations of parameters (e.g., coercivity) for each layer. Shen’s Figure 5(c) below confirms that the estimated coercivity of the soft layer alone is approximately 0.15 kOe. Ex-1003, ¶227.



Ex-1007, Fig. 5(c).

Shen explicitly states that the coercivity of the hard layer alone is 4.35 kOe. *Id.*, p.3 (“the original value of a single hard layer ( $H_c = 4.35$  kOe)”); Ex-1003, ¶228.

The above values are consistent with Shen’s Figure 4 reproduced below, which shows how the coercivity of the entire structure varies as the interlayer thickness changes.

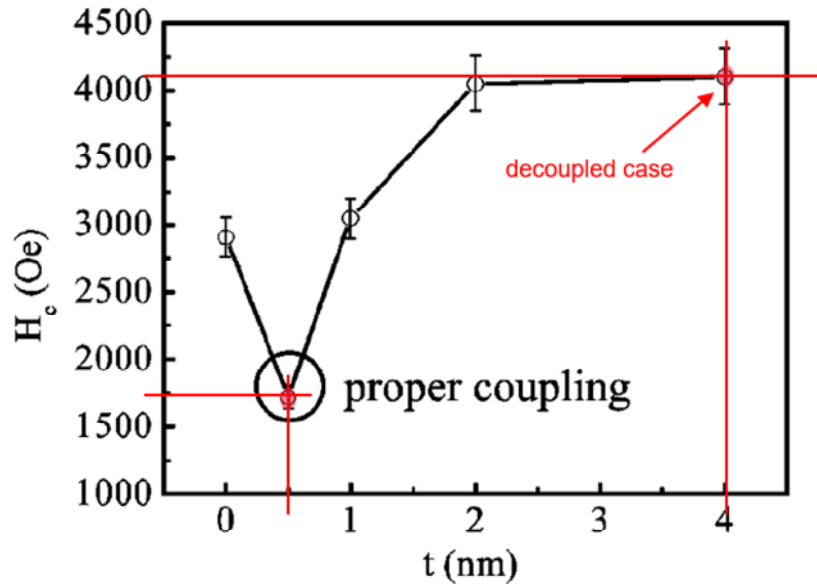


FIG. 4. Coupling dependence of  $H_c$  ( $t$ : thickness of PdSi interlayer).

Ex-1007, Fig 4. The decoupled case illustrated in Figure 4 above corresponds to the hysteresis loop in Shen's Figure 5(c), where the soft and hard layer switch almost independently and therefore the coercivity of the entire structure is very close to the coercivity of the hard layer alone, as Shen explicitly states. Ex-1007, p.3. The proper coupling case in Figure 4 above corresponds to Shen's Figure 5(b), where the coercivity of the entire structure is reduced by having the soft and hard layer properly exchange coupled, and therefore the coercivity of the entire structure must be between the coercivity of the soft layer alone and that of the hard layer alone. Therefore, as shown in Figure 4 above, because the coercivity of the entire structure with proper coupling is 1.75 kOe, the coercivity of the soft layer alone is lower than 1.75 kOe. And in the decoupled case, because the coercivity of

the entire structure is 4.2 kOe, the coercivity of the hard layer alone is greater than 4.2 kOe (consistent with the 4.35 kOe value mentioned in Shen). Ex-1003, ¶229.

Accordingly, Shen teaches that the coercive field of Shen's soft layer without the hard layer (i.e., is less than 1.75 kOe, e.g., approximately 0.15 kOe) is less than  $\frac{1}{2}$  of the coercive field of the hard layer (i.e., is greater than 4.2 kOe, or at least greater than 4.05 kOe). Ex-1003, ¶230.

If the recited "coercive field of the hard magnetic storage layer  $H_s$ " were interpreted as the coercive field of the hard magnetic storage layer together with the nucleation host attached, Shen's coupled layers example also discloses claim 6's coercivity relationship, because the coercivity of Shen's soft layer alone (i.e., approximately 0.15 kOe) is less than  $\frac{1}{2}$  of the coercive field of the hard layer with the soft layer attached (i.e., 1.75 kOe). Ex-1003, ¶231.

As explained in Section IX.C below, a POSITA would have been motivated to implement Takenoiri's multilayer structure such that the coercivity of Takenoiri's "nucleation host" and that of Takenoiri's first magnetic recording layer 5 also maintains the same or similar relative relationship as taught in Shen. Therefore, Takenoiri in view of Shen renders claim 6 obvious. Ex-1003, ¶232.

**C. Motivation to combine Takenoiri with Shen**

Both Takenoiri and Shen are analogous art to the '864 Patent because they are in the same field of endeavor as the '864 patent, e.g., perpendicular magnetic

recording media. Ex-1001, Abstract; Ex-1005, Title; Ex-1007, Abstract. Similar to Takenoiri and the '864 Patent, Shen also aims to achieve improved recordability without sacrificing thermal stability by introducing a “softer” magnetic layer. Ex-1007, Abstract. At minimum, like Takenoiri, Shen is also reasonably pertinent to at least one problem identified in the '864 Patent—how to “overcome the writability problem of extremely hard magnetic storage layers” without impairing “thermal stability.” Ex-1001, 3:58-61; Ex-1005, 2:54-57; Ex-1007, Abstract. Ex-1003, ¶233.

**Derivative K.** Takenoiri provides the multilayer structure and teaches control of coupling strength through layer thickness. Ex-1005, 8:32-35. Shen shows that proper coupling produces the desired uniform switching behavior and smooth hysteresis loop. Ex-1007, Fig. 5. A POSITA would therefore have been motivated to implement Takenoiri's multilayer structure using Shen's guidance to achieve a similar uniform loop, e.g., having a smooth slope the same or at least substantially the same as that in Shen's measured curve in Figure 5(b). Ex-1003, ¶¶234-238.

Even if the hysteresis loop of Takenoiri's multilayer structure, including the tri-layer structure, is not as smooth as Shen's Figure 5(b), a POSITA would have been motivated to further improve Takenoiri's multilayer structure such that the hysteresis loop for the resulting structure has a smooth slope the same or at least substantially the same as that in Shen's measured curve in Figure 5(b). Ex-1003, ¶239. By adjusting the coupling layer thickness in Takenoiri's tri-layer structure to

strengthen coupling, the resulting hysteresis loop would exhibit the same smooth slope as Shen's measured curve. *Id.*, ¶¶240-242.

**Relative Coercivity Relationship.** As discussed above, both Takenoiri and Shen teach introducing softer layer(s) to reduce the coercivity of the overall magnetic medium. Existence of soft layer(s) allows using a high anisotropy/coercivity material for the hard layer to maintain thermal stability. Thus, a POSITA would have been motivated to design Takenoiri's tri-layer structure so with the first magnetic recording layer 5 having higher coercivity (and therefore better thermal stability) and the "nucleation host" having lower coercivity (and therefore good writeability), such that the difference between the coercivity of Takenoiri's "nucleation host" and the first magnetic recording layer 5 is the same as or similar to Shen's proper coupling case. For example, a POSITA would have been motivated to configure the coercivity of Takenoiri's third magnetic recording layer to have relatively low coercivity, like Shen's soft layer, to reduce the coercivity of Takenoiri's "nucleation host," and thereby the coercivity of the entire structure. A POSITA would have readily configured the coercivity of Takenoiri's magnetic layers to obtain Shen's relative coercivity relationship, as Takenoiri expressly teaches tuning  $H_c$  via layer thickness and composition. Ex-1005, 9:23-29; *see also id.*, 9:63-67. A POSITA would also understand that adjusting the exchange coupling between Takenoiri's second and third magnetic layers also helps reduce the

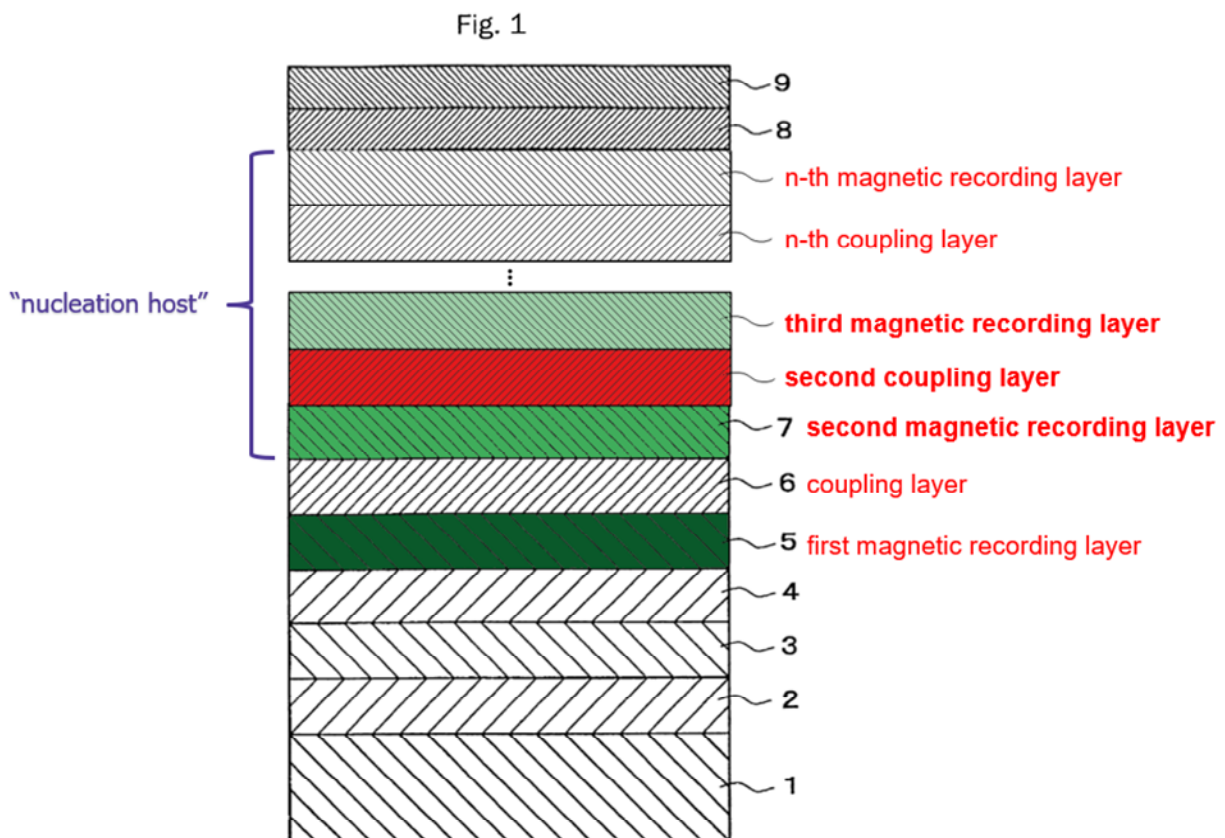
coercivity of Takenoiri's "nucleation host." Ex-1005, Fig. 3. Ex-1003, ¶¶243-244.

**X. GROUND 3: CLAIMS 10-12 ARE OBVIOUS OVER TAKENOIRI IN VIEW OF LI**

**A. Claim 10**

Claim 10 depends from claim 1 (obvious over Takenoiri; Section VIII.B) and further recites **"wherein: the nucleation host has a thickness smaller than 30 nm,"** Takenoiri in view of Li renders obvious. Ex-1003, ¶245.

Takenoiri's "nucleation host" includes at least the second magnetic recording layer 7 (green), the third magnetic recording layer (light green), and the coupling layer (red) in between. Section VIII.B.6 (limitation 1[E]).



Ex-1005, Fig. 1 (tri-layer structure in modified Fig. 1). Ex-1003, ¶246.

Thickness T<sub>2</sub> for the second magnetic recording layer 7. Takenoiri discloses that “[t]he thickness of the first magnetic recording layer is preferably at most 30 nm, **more preferably at most 15 nm**, from the viewpoint of productivity and high density recording.” Ex-1005, 7:23-26; *see also* thickness T<sub>1</sub> in table below. Ex-1003, ¶247.

|                                   |                          | Ex. 1                                                                                                  | Ex. 2                                                                                                  | Ex. 3                                                             | Ex. 4 | Ex. 5                                                            | Ex. 6                                            |
|-----------------------------------|--------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|-------|------------------------------------------------------------------|--------------------------------------------------|
| second magnetic recording layer 7 | Composition              | (Co <sub>72</sub> Cr <sub>16</sub> Pt <sub>12</sub> ) <sub>90</sub> -(SiO <sub>2</sub> ) <sub>10</sub> | Co <sub>70</sub> Cr <sub>20</sub> Pt <sub>10</sub>                                                     | Co <sub>61</sub> Cr <sub>22</sub> Pt <sub>13</sub> B <sub>4</sub> |       | Co <sub>69</sub> Cr <sub>22</sub> Pt <sub>5</sub> B <sub>4</sub> | Co <sub>76</sub> Cr <sub>20</sub> B <sub>4</sub> |
|                                   | thickness T <sub>2</sub> | 6                                                                                                      | 6                                                                                                      | 6.5                                                               | 6.5   | 6.5                                                              | 6.5                                              |
|                                   | Ku <sub>2</sub>          | 2.5                                                                                                    | 2                                                                                                      | 1.85                                                              | 1.85  | 1.51                                                             | 1.31                                             |
|                                   | Hk <sub>2</sub>          | 13.2                                                                                                   | 11.1                                                                                                   | 13.2                                                              | 13.2  | 10.1                                                             | 8.17                                             |
| coupling layer 6                  | Composition              | Ru                                                                                                     | Cobalt                                                                                                 | Ru                                                                |       |                                                                  |                                                  |
|                                   | Thickness                | 0.2                                                                                                    | 0.3                                                                                                    | 1.6                                                               | 0.25  | 0.25                                                             | 0.25                                             |
| first magnetic recording layer 5  | Composition              | (Co <sub>74</sub> Cr <sub>12</sub> Pt <sub>14</sub> ) <sub>90</sub> -(SiO <sub>2</sub> ) <sub>10</sub> | (Co <sub>72</sub> Cr <sub>10</sub> Pt <sub>18</sub> ) <sub>90</sub> -(SiO <sub>2</sub> ) <sub>10</sub> |                                                                   |       |                                                                  |                                                  |
|                                   | thickness T <sub>1</sub> | 10                                                                                                     | 10                                                                                                     | 9.5                                                               | 9.5   | 9.5                                                              | 9.5                                              |
|                                   | Ku <sub>1</sub>          | 4.2                                                                                                    | 5                                                                                                      | 5.05                                                              | 5.05  | 5.05                                                             | 5.05                                             |
|                                   | Hk <sub>1</sub>          | 18.7                                                                                                   | 20                                                                                                     | 20                                                                | 20    | 20                                                               | 20                                               |

Takenoiri further discloses that the second magnetic recording layer 7 can employ “the same material and structure as in first magnetic recording layer 5” (*id.*, 9:13-15), and a POSITA would have understood that “same... structure” includes same or similar thickness. Consistent with this disclosure, the thickness T<sub>2</sub> for the second magnetic recording layer 7 in each of Takenoiri’s Examples 1 to 6 is 6 nm or 6.5 nm, as shown in table above. Ex-1003, ¶248.

Thickness T<sub>3</sub> for the third magnetic recording layer. As explained in Section X.D, *infra*, a POSITA would have found it obvious to employ the same or similar thickness (as taught by Li) as the first and second magnetic recording layers, i.e.,

around 6 nm or 10 nm, or at most 15 nm, because maintaining comparable layer thicknesses ensures effective exchange coupling and sequential magnetization reversal across all magnetic layers, which are the very mechanisms Takenoiri relies on to achieve improved writability and thermal stability. Ex-1022, 6:8-9 (“[T]he thickness of each of the three sub-layers is about 6-8 nm.”); Ex-1003, ¶249.

Thickness for the coupling layer between the second and third magnetic recording layers. Takenoiri discloses that “[t]he thickness of coupling layer 6 is preferably at most 2 nm,” and “more preferably 0.3 nm or smaller.” Ex-1005, 8:60-63. A POSITA would have understood that Takenoiri’s second coupling layer has a thickness similar to the coupling layer 6 at least because (i) it couples two magnetic recording layers as the coupling layer 6 does, and (ii) it has the same function as the coupling layer 6, i.e., “to attain [*sic*] an exchange coupling energy per unit area between” adjacent magnetic recording layers and “to retain favorable crystal alignment of” the magnetic recording layer on top. *See id.*, 8:45-50; 10:8-10. Therefore, the thickness of the coupling layer between the second and third magnetic recording layers is similar to that of the coupling layer 6, i.e., preferably 0.3 nm or smaller. Ex-1003, ¶250.

Based on the above, in Takenoiri’s tri-layer structure, the thickness  $T_2$  of the second magnetic recording layer 7 is 6 nm, the thickness  $T_3$  of the third magnetic recording layer is around 6 nm or 10 nm, or at most 15 nm, and the thickness of

coupling layer between the second and third magnetic recording layers is no greater than 0.3 nm. Adding these numbers together, Takenoiri in view of Li renders obvious that the thickness of its “nucleation host,” (which contains only two magnetic recording layers and a coupling layer in between) is around 12.3 nm or 16.3 nm, or at most 21.3 nm—all of which are smaller than the thickness of 30 nm as required by claim 10. Ex-1003, ¶251.

**B. Claim 11**

Claim 11 depends from claim 1 (obvious over Takenoiri; Section VIII.B) and further recites “**wherein: the nucleation host comprises grains with an average diameter greater than 2 nm and less than 10 nm,**” which Takenoiri in view of Li renders obvious. Ex-1003, ¶252.

Takenoiri discloses that “the second magnetic recording layer has a granular structure that is composed of a matrix of a nonmagnetic oxide or a nonmagnetic nitride and **magnetic crystal grains** dispersed in the matrix.” Ex-1005, claim 5. Using of the same CoCr-based magnetic materials with similar H<sub>k</sub> value and thickness as taught in Takenoiri, Li teaches “a grain size from about 4 to about 10 nm.” Ex-1022, 11:58-66; 12:6-7; *see also, e.g.*, Ex-1005, 7:5-9, 11:35-36; 7:23-24. Ex-1003, ¶253.

As explained in Section X.D, *infra*, a POSITA would have been motivated to implement Takenoiri’s grains in the second magnetic recording layer using the

dimension taught by Li, i.e., grain size from about 4 to 10 nm, in its second magnetic recording layer, which is part of Takenoiri's "nucleation host" (see Section VIII.B.6 (limitation 1[E])). Ex-1003, ¶254.

Li's grain size is the recited grain diameter because like the '864 patent, Li's "grain size" refers to the "width[] (as measured in a horizontal direction)" of a grain, which is "columnar-shaped." Ex-1022, 2:20-24, 13:3-7; *see also id.*, 10:62-11:2 ("cross-sectional dimensions of the underlying grains (i.e., grain sizes)"). A POSITA would have understood that because the grains all have a grain diameter between 4 to 10 nm, the average diameter of these grains must be between 4 to 10 nm. Ex-1003, ¶¶255-256.

Therefore, Takenoiri in view of Li renders obvious that **"the nucleation host [e.g., Takenoiri's "nucleation host" including its second magnetic recording layer 7] comprises grains with an average diameter greater than 2 nm and less than 10 nm [e.g., Takenoiri's magnetic crystal grains with diameters between 4 to 10 nm as taught by Li]."** Ex-1003, ¶257.

### C. Claim 12

Claim 12 depends from claim 1 (obvious over Takenoiri; Section VIII.B) and further recites **"wherein: a height of a plurality of grains is greater than a**

**diameter of the grains,”** which Takenoiri in view of Li renders obvious. Ex-1003, ¶258.<sup>17</sup>

Claim 12 recites “a height of a plurality of grains” without defining the term “height.” If the term “height” refers to the height of grains **within a particular magnetic recording layer**, Takenoiri in view of Li discloses the additional limitation in claim 12. Takenoiri discloses that both “the first magnetic recording layer and the second magnetic recording layer ha[ve] a **granular structure** that is composed of a matrix of a nonmagnetic oxide or a nonmagnetic nitride and **magnetic crystal grains** dispersed in the matrix.” Ex-1005, claim 5. The thickness of the first magnetic recording is “preferably at most 30 nm, more preferably at most 15 nm.” *Id.*, 7:23-24. Because the grains within each of the first and second magnetic recording layers extend the full thickness of each layer, the thickness of these layers, i.e.,  $T_1$  and  $T_2$ , respectively, is also the “height” of these plurality of grains **within the first and second magnetic recording layers, respectively**. *See, e.g.*, Ex-1023, p.4 (“a fixed grain height equal to the medium thickness is assumed.”); Ex-1036, ¶86. As explained in Section X.B, *supra*, Takenoiri in view of Li renders obvious that the average diameter for these grains is from 4 to 10 nm. Therefore, Takenoiri

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<sup>17</sup> Petitioners reserve right to challenge this claim under 35 U.S.C. § 112 in other proceedings.

in view of Li renders obvious that “**a height of a plurality of grains** [e.g., Takenoiri’s first or second magnetic recording layer comprised of grains having a thickness of at most 30 nm, more preferably at most 15 nm] **is greater than a diameter of the grains** [e.g., Takenoiri’s grains with diameters from about 4 to 10 nm as taught by Li].” Ex-1003, ¶259.

If the term “height” refers to the height of grains **across the entire stack of magnetic recording layers** (e.g., when the grains of different magnetic recording layers are at least substantially aligned), Takenoiri in view of Li also discloses claim 12 because the height of these grains (i.e., the thickness of the entire stack of magnetic recording layers) is even greater than that of only the first or only the second magnetic recording layer, and is therefore greater than a diameter of the grains (e.g., from about 4 to 10 nm as taught by Li). Ex-1003, ¶260.

#### **D. Motivation to combine Takenoiri with Li**

Both Takenoiri and Li are analogous art to the ’864 Patent because they are in the same field of endeavor, e.g., perpendicular magnetic recording media. Ex-1001, Abstract (“The invention proposes a recording media that overcomes the writeability problem of perpendicular recording media.”); Ex-1005, Title (“Perpendicular Magnetic Recording Medium”); Ex-1022, Title (“Perpendicular Magnetic Recording Media with Magnetic Anisotropy/Coercivity Gradient and Local Exchange Coupling”). Each of Takenoiri, Li, and the ’864 Patent is directed to

**granular** magnetic recording media with **anisotropy/coercivity gradient**. Ex-1001, claim 1, 5:38-40; Ex-1005, claim 1, Abstract; Ex-1022, claim 1, 1:9-12. The '864 Patent, Takenoiri, and Li are all in Cooperative Patent Classification (CPC) class G11B 5/66. Both references and the '864 Patent achieve improved recordability without sacrificing thermal stability by introducing a “softer” magnetic layer. *See, e.g.*, Ex-1005, 5:56-59; 5:41-46; Ex-1022, 13:4-13; Ex-1001, 2:48-60. At minimum, both Takenoiri and Li are reasonably pertinent to at least the problem identified in the '864 Patent of how to “overcome the writability problem of extremely hard magnetic storage layers” without impairing “thermal stability.” *See, e.g.*, Ex-1001, 3:58-61; Ex-1005, 2:54-57; Ex-1022, 13:4-13. Ex-1003, ¶261.

**Grain Size.** A POSITA would have been motivated to incorporate the grain size range disclosed in Li into Takenoiri's magnetic recording layers. Both references aim to optimize the microstructure of perpendicular magnetic recording layers to improve performance parameters including writability, thermal stability, and signal-to-noise ratio. More specifically, both Takenoiri and Li disclose using granular perpendicular magnetic recording layers having magnetic anisotropy gradient to enable a progressive reversal process. Ex-1005, 7:5-9, 10:7-18; Ex-1022, 1:9-12, 5:4-16. These performance parameters ultimately enable higher areal data density. Ex-1005, 2:57-62; Ex-1022, 4:38-40. Ex-1003, ¶262.

Takenoiri discloses that both “the first magnetic recording layer and the second magnetic recording layer ha[ve] a granular structure that is composed of a matrix of a nonmagnetic oxide or a nonmagnetic nitride and magnetic crystal grains dispersed in the matrix.” Ex-1005, claim 5. Takenoiri also discloses using underlayer 3 and nonmagnetic intermediate layer 4 to control the grain size of the first magnetic recording layer. *Id.*, 6:29-32 (“Underlayer 3 is preferably formed to control the crystalline orientation and the grain size of the layer formed on the underlayer: nonmagnetic intermediate layer 4 or first magnetic recording layer 5.”); 6:52-55 (“Nonmagnetic intermediate layer 4 is formed to appropriately control the crystal alignment, the grain size, and the grain boundary segregation in first magnetic recording layer 5.”). Ex-1003, ¶263.

While Takenoiri recognizes the importance of grain size, it does not provide a numerical reference. Li does so. Using of the same CoCr-based magnetic materials with similar Hk value and thickness as taught in Takenoiri, Li teaches “a grain size from about 4 to about 10 nm.” Ex-1022, 12:6-7, 11:58-66; Ex-1005, 7:5-9, 11:35-36, 7:23-24. With such grain size, Li enables “ultra-high recording densities (i.e.,  $>\sim 250$  Gbits/in<sup>2</sup>) and high data recording rates (i.e.,  $>\sim 2,000$  Mbits/sec)...” Ex-1022, 8:45-54. Therefore, a POSITA implementing Takenoiri’s structure, with the understanding that Takenoiri aims for “high density recording” (Ex-1005, 7:25-26), would have been motivated to look to other references including

Li that describe grain size, to design and/or fabricate the first magnetic recording layer 5. Because Takenoiri teaches using “the same material and structure” for both the first and second magnetic recording layers (*id.*, 9:13-15), and because Li teaches multiple sub-layers having matching grain size (Ex-1022, 5:46-54), a POSITA would have found it obvious to design and/or fabricate Takenoiri’s second magnetic recording layer 7 also with a grain size from about 4 to 10 nm, as taught by Li. In fact, Dr. Suess, the inventor of the ’864 acknowledged that “[i]n order to achieve an areal density of 10 Tbit/in<sup>2</sup> in perpendicular recording, grains with diameters of about 3 nm are required.” Ex-1008, Abstract; Ex-1036, ¶66. A POSITA looking to achieve high areal density for Takenoiri’s magnetic recording medium would have been motivated to set the grain size to be at least within the 4 to 10 nm range as taught by Li. Ex-1003, ¶264. While Li’s stack of layers is arranged with anisotropy increasing toward the substrate, this does not affect the motivations to combine Takenoiri with Li because the grain size is not dependent on layer order. *Id.*, ¶265.

A POSITA would have had **reasonable expectation of success** in implementing Takenoiri’s magnetic recording layers with the grain size (i.e., from about 4 to 10 nm) disclosed in Li because both Takenoiri and Li teach controlling the grain size using conventional techniques. Ex-1005, 6:29-32; 6:52-55, 11:6-8; Ex-1022, 11:51-54, 11:2-5. Therefore, adopting about 4 to 10 nm in grain size would

have been a routine implementation of and obvious microstructural refinement to Takenoiri's design. Ex-1003, ¶266.

**Layer Thickness.** Takenoiri teaches that the thickness of its first magnetic recording layer is “preferably at most 15 nm, from the viewpoint of productivity and high density recording.” Ex-1005, 7:23-26; *see also* Takenoiri's Examples 1-6 ( $T_1$  is 10 nm or 9.5 nm). The thickness for Takenoiri's second magnetic recording layer is in the same range. *See* Ex-1005, 9:13-15; Takenoiri's Examples 1-6 ( $T_2$  is 6 nm or 6.5 nm). Li teaches a magnetic recording medium having “three overlying sub-layers” with different “perpendicular magnetic anisotropy field[s]” ( $H_k$ ), the thickness of each of the three sub-layers is in the same range, e.g., “about 6-8 nm.” Ex-1022, 5:66-6:9. Ex-1003, ¶267.

A POSITA would have been motivated to set Takenoiri's third magnetic recording layer ( $T_3$ ) thickness to be in the same range as the first and second magnetic recording layers as taught by Li because Takenoiri explicit teaches limiting the thickness of the magnetic recording layers “from the viewpoint of productivity and high density recording.” Ex-1005, 7:23-26. A POSITA designing Takenoiri's tri-layer structure looking to preserve the same or similar productivity and recording density would have been motivated to look to analogous references, including Li, for guidance about suitable thickness range for its third magnetic recording layer. Ex-1003, ¶268.

Moreover, like Takenoiri, Li's tri-layer structure also utilizes "gradient of  $H_k$ " to achieve "multi-step incoherent magnetization reversal." Ex-1022, 10:7-16; Ex-1005, 10:7-18; *see also* Ex-1022, 10:16-20; 10:54-57. A POSITA would have been motivated to adopt Li's thickness teachings in designing Takenoiri's tri-layer structure in order to optimize the overall magnetization reversal/re-orientation process and to obtain desirable local magnetic properties. Ex-1003, ¶269.

A POSITA would have been motivated to configure the thickness of the third magnetic layer to be no greater than that of the second magnetic recording layer 7 for several reasons. *First*, smaller thickness  $T_3$  contributes to lower coercive field  $H_{c3}$  for the third magnetic recording layer, which Takenoiri renders obvious as explained in Section VIII.B.6 (limitation 1[E]). *Second*, smaller thickness  $T_3$  contributes to lower  $Ku_3T_3$ , thereby making it easier to satisfy  $Ku_2T_2 > Ku_3T_3$  when  $Hk_2 > Hk_3$ , which Takenoiri renders obvious as explained in Section VIII.B.9 (limitation 1[H]). *Third*, because in each of Takenoiri's Examples 1 to 6, the thickness of the second magnetic recording layer 7 is smaller than that of the first magnetic recording layer 5, a POSITA would have been motivated to follow the same trend in configuring the third magnetic recording layer, such that the thickness of the third magnetic recording layer is smaller than that of the second magnetic recording layer 7. *Finally*, there are only a finite number of options for configuring  $T_3$  as compared to  $T_2$ : (i)  $T_3 > T_2$ ; (ii)  $T_3 = T_2$ ; and (iii)  $T_3 < T_2$ . A POSITA would have

found it obvious to try each of these three configurations, including  $T_3 < T_2$ . Thus, Takenoiri renders obvious that the thickness  $T_3$  is no greater than  $T_2$ , e.g., no greater than 6 nm. Ex-1003, ¶270.

While Li describes its multi-layer structure as a single recording layer having a plurality of grains, each grain having a plurality of sub-layers, a POSITA would have understood that Li's single recording layer corresponds to Takenoiri's stack of magnetic recording layers and each of Li's sub-layers corresponds to each of Takenoiri's magnetic recording layers. Ex-1003, ¶271. While Li's layer stack is arranged with anisotropy increasing toward the substrate, this does not affect the motivations to combine Takenoiri with Li because the magnetic layer thickness is not dependent on layer order. Ex-1003, ¶272.

A POSITA would have had **reasonable expectation of success** in making the thickness of the third magnetic recording layer in Takenoiri's tri-layer structure in the same range as the first and second magnetic recording layers, as taught by Li, because it was well known that controlling the condition for the sputtering process (used in both Takenoiri and Li) allows control of magnetic layer thickness. Ex-1003, ¶273.

**XI. GROUND 4: CLAIM 15 IS OBVIOUS OVER TAKENOIRI IN VIEW OF ASTI**

**A. Claim 15**

Claim 15 depends from claim 1, which is obvious over Takenoiri (*see* Section VIII.B) and further recites a domain wall property resulting from the exchange coupling of the nucleation host and hard magnetic storage layer (*see* Appendix A (claim 15), *infra*), which Takenoiri in view of Asti renders obvious. Ex-1003, ¶274.

As shown in Section VIII.G (claim 13), Takenoiri's coupling layer 6 is an exchange coupling layer between the second magnetic recording layer 7 (as part of Takenoiri's "nucleation host") and the first magnetic recording layer 5. Takenoiri discloses that the exchange coupling between the first and second magnetic layers must be sufficiently strong to "provide the function that the thermal stability is improved and simultaneously the switching field is reduced by individually reversing the magnetization." Ex-1005, 7:27-35; *see also id.*, 7:34-38 ("If the exchange coupling...completely disappears, the energy barrier lowers,..., thus the thermal stability is not improved."); 3:21-23 ("Advantageously, an exchange coupling energy per unit area between the first magnetic recording layer and the second magnetic recording layer is **at least**  $5 \times 10^{-3}$  erg/cm<sup>2</sup>."); *see also*, Section VIII.G, *supra* (claim 13, which recites a "coupling layer"). Ex-1003, ¶275.

While Takenoiri does not explicitly mention domain wall formation, Asti discloses that the reversal process for perpendicular exchange-spring multilayers

includes “nucleation and propagation of domain walls.” Ex-1030, p.12; *see also id.*, p.13 (“presence of domain walls nucleation and pinning”). Asti further discloses that domain wall is formed across the interface between the soft and hard layers during reversal. *See id.*, p.5 (“Because of high effective anisotropy of both phases...**the variation of magnetization orientation is confined within narrow regions**, of the order of the exchange lengths, **around the interface** [see Fig. 3(b)].”).<sup>18</sup> Figure 3(b) shows the domain wall formed across the interface at the 80 nm (the interface between “soft” and “hard” layers):

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<sup>18</sup> This is consistent with the court’s construction of “domain wall” in the WD case: “The domain wall is the region over which magnetic moments of the material are changing from one direction to another in response to magnetic field.” Ex-1019, p.25-27. Ex-1003, ¶279.

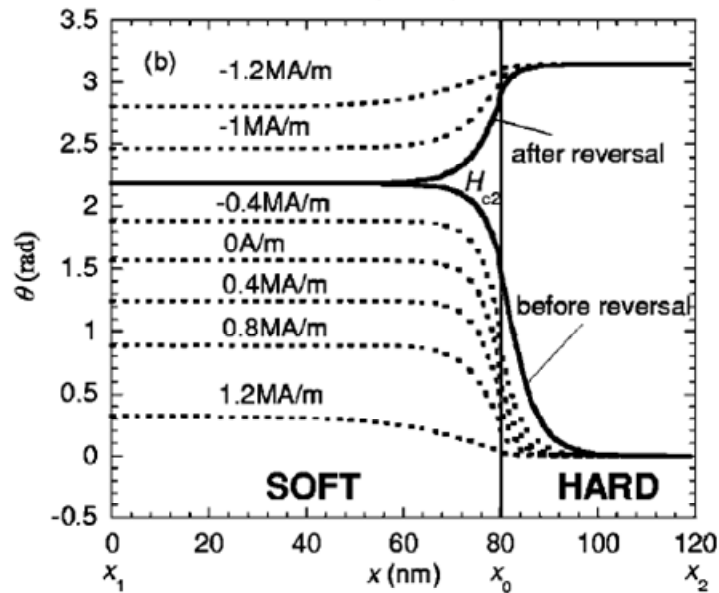


FIG. 3. (a) Major hysteresis loop for a FeRh/FePt bilayer with the parameters considered in Fig. 16, calculated assuming an inter-layer coupling constant  $J_s$  with the same value of bulk coupling. (b) Behavior of the  $\vartheta(x)$  function in correspondence to different magnetic field values along the hysteresis loop.

Ex-1030, Fig. 3(b) (excerpted); *see also id.*, Fig. 1. Ex-1003, ¶¶276-278.

As explained in Section XI.B, *infra*, a POSITA would have been motivated to look to Asti to better understand and/or further optimize the switching process within the magnetic layers of Takenoiri's structure, including domain wall formation. Ex-1003, ¶280.

## B. Motivation to combine Takenoiri with Asti

Takenoiri and Asti are analogous art to the '864 Patent because they are all in the same field of endeavor, e.g., perpendicular magnetic recording media. Ex-1001, Abstract ("The invention proposes a recording media that overcomes the writeability problem of perpendicular recording media."); Ex-1005, Title ("Perpendicular

Magnetic Recording Medium”); Ex-1030, Title (“Magnetic phase diagram and demagnetization processes in perpendicular exchange-spring multilayers”). Each of Takenoiri, Asti, and the ’864 Patent is directed to magnetic recording media with multiple magnetic layers. Ex-1001, Title; Ex-1005, 10:7-8; Ex-1030, Abstract. Both the ’864 patent and Takenoiri are in Cooperative Patent Classification (CPC) class G11B 5/66. Both references and the ’864 Patent achieve improved recordability without sacrificing thermal stability by introducing a “softer” magnetic layer. *See, e.g.*, Ex-1005, 5:56-59; 5:41-46; Ex-1030, Abstract; Ex-1001, 2:48-60. At minimum, both Takenoiri and Asti are reasonably pertinent to at least one problem identified in the ’864 Patent—how to “overcome the writability problem of extremely hard magnetic storage layers” without impairing “thermal stability.” *See, e.g.*, Ex-1001, 3:58-61; Ex-1005, 2:54-57; Ex-1030, Introduction. Ex-1003, ¶281.

While Takenoiri provides some “conceptual illustration[s],” e.g., Figures 4 and 5, to explain the switching process, Takenoiri does not provide further physical details or mathematical analysis for the switching process. A POSITA would have been motivated to look to analogous references with detailed model analysis, including Asti, to better understand the switching process mechanism behind Takenoiri’s multilayer structure, as well as to adopt and use the simulation and calculation methods taught by Asti to evaluate, analyze, and/or optimize the performance of Takenoiri’s structure. For example, Takenoiri acknowledges that its

hysteresis loop in Figure 5 does not take into account “an effect of demagnetization” because “accurate calculation of the demagnetizing factor is difficult.” Ex-1005, 8:20-23. A POSITA looking to better understand the demagnetization process of Takenoiri’s structure and to obtain a hysteresis loop that more approximate the actual system would have been motivated to look to Asti, which provides a “model [that] gives a good qualitative description of the behavior of magnetization and demagnetization processes...” Ex-1030, p.15. A POSITA would also have been motivated to optimize the performance of Takenoiri’s structure using Asti’s guidance, which offers “the capability of tailoring the magnetic properties of composite systems on the basis of the extrinsic (thickness, orientation) and intrinsic (anisotropy, magnetization, exchange) characteristics of the combined [soft and hard] phases.” *Id.*, p.1; Ex-1003, ¶282.

Because both Takenoiri and Asti concern perpendicular magnetic recording media—in particular a multilayer structure where one or more softer magnetic layers are configured on top of a hard magnetic layer to reduce the overall coercive force while maintain thermal stability—a POSITA would have understood that the simulations and conclusions in Asti also apply to the structures in Takenoiri, especially because Asti explicitly teaches that the magnetic behavior analyzed is applicable to both “bilayer and multilayer.” Ex-1030, Abstract. A POSITA would have understood that the domain wall formation across the hard/soft interface as

taught in Asti would occur for each layer interface in Takenoiri's tri-layer structure, including across the hard/soft interface between Takenoiri's first magnetic recording layer and Takenoiri's "nucleation host," where "an appropriate coupling energy between the magnetic recording layers" is deemed necessary (Ex-1005, 7:39-43). Combining Takenoiri with Asti does not involve any modifications to Takenoiri's existing multilayer structure, and a POSITA would have had **reasonable expectation of success** in understanding Takenoiri's structures, including domain wall formation in view of Asti's models, simulations and findings for similar structures. Ex-1003, ¶283.

At minimum, a POSITA would have understood that as the exchange coupling energy between Takenoiri's first magnetic recording layer and its "nucleation host" increases, the soft magnetic layer will become more stable and the domain wall formed in the soft layer during the switching process will be easier to move across the interlayer to the hard layer for switching the hard layer, leading to the effect achieved by Takenoiri's multilayer structures: "increase of the exchange coupling energy enhances thermal stability, and at the same time, improves the recordability." Ex-1005, 5:6-8. A POSITA would have been motivated to increase the exchange coupling energy between Takenoiri's first magnetic recording layer and its "nucleation host" because, as Takenoiri teaches, "increase of the exchange coupling energy enhances thermal stability, and at the same time, improves the recordability."

Ex-1005, 5:6-8; Fig. 3; Ex-1003, ¶284. A POSITA would have had **reasonable expectation of success** in increasing the exchange coupling energy between Takenoiri's first magnetic recording layer and its "nucleation host" because Takenoiri explicitly teaches "the material, thickness, and other conditions of the coupling layer for controlling the exchange coupling energy between the magnetic recording layers." Ex-1005, 5:60-65. Ex-1003, ¶284.

## **XII. GROUND 5: CLAIM 22 IS OBVIOUS OVER TAKENOIRI IN VIEW OF CHANG**

### **A. Claim 22**

Claim 22 depends from claim 1 (obvious over Takenoiri; Section VIII.B) and further recites "**wherein: a thickness of the nucleation host has a value such that the in plane component of a magnetization of a remanent state is less than 20% of a total magnetization,**" which Takenoiri in view of Chang renders obvious. Ex-1003, ¶285.<sup>19</sup>

The claim is unclear whether "20% of a total magnetization" applies to the nucleation host or the entire magnetic multilayer structure. A POSITA would have no way to measure the remanent magnetization for the nucleation host itself. Ex-1003, ¶286. Moreover, the claim recites "a **total** magnetization." Thus, for this

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<sup>19</sup> Petitioners reserve right to challenge this claim under 35 U.S.C. § 112 in other proceedings.

IPR's purposes, Petitioners assume that the recited 20% requirement is for the entire magnetic multilayer structure because a POSITA designing perpendicular magnetic recording media would be concerned about the magnetization of the entire magnetic multilayer structure. *Id.*

Chang recognizes a "clear need" for perpendicular magnetic recording media with remanent squareness of about 1 and teaches a perpendicular magnetic recording medium having such remanent squareness, i.e., the perpendicular component of a magnetization of a remanent state is 100% of a total magnetization, and the in-plane component of a magnetization of a remanent state is 0% of a total magnetization. Ex-1010, 3:32-38. As explained in Section XII.B, *infra*, a POSITA would have been motivated to implement Takenoiri's multilayer structure with remanent squareness of about 1 as taught by Chang. A POSITA would have understood that remanent squareness of about 1 refers to the perpendicular component of a magnetization of a remanent state where the in-plane component of the remanent magnetization must be substantially lower than that of the perpendicular component to qualify as perpendicular magnetic recording media. When the perpendicular component of Takenoiri's remanent magnetization is about 1, the in-plane component must be zero (or very close to zero), and therefore much lower than 20%. Ex-1003, ¶288.

**B. Motivation to combine Takenoiri with Chang**

Takenoiri and Chang are both analogous art to the '864 Patent because they are all in the same field of endeavor, e.g., perpendicular magnetic recording media. Ex-1001, Abstract (“The invention proposes a recording media that overcomes the writeability problem of perpendicular recording media.”); Ex-1005, Title (“Perpendicular Magnetic Recording Medium”); Ex-1010, Title (“Perpendicular Magnetic Recording Media with Improved Interlayer”). The '864 patent, Takenoiri, and Chang are all in Cooperative Patent Classification (CPC) class G11B 5/66. At minimum, both Takenoiri and Chang are reasonably pertinent to at least one problem identified in the '864 Patent—how to “overcome the writability problem of extremely hard magnetic storage layers” without impairing “thermal stability.” *See, e.g.,* Ex-1001, 3:58-61; Ex-1005, 2:54-57; Ex-1010, 1:48-50, 3:32-38. Ex-1003, ¶289.

Takenoiri discloses “[t]he axis of easy magnetization...of the first magnetic recording layer needs to align in the direction perpendicular to the film surface for the use in a perpendicular magnetic recording medium.” Ex-1005, 7:1-5. The same is true for the second magnetic recording layer. *Id.*, 9:13-15. Ex-1003, ¶290.

Since Takenoiri teaches the importance of magnetization alignment for perpendicular magnetic recording media, a POSITA would have been motivated to look to analogous references, including Chang, for specific numerical values to

better understand, to better evaluate and/or to further optimize the magnetization alignment in Takenoiri's multilayer structures. Chang teaches that "[a] high remanent squareness... [is] required in order to obtain good bit stability," and that "there exists a clear need for improved, high areal recording density, perpendicular magnetic...recording, storage, and retrieval media... which exhibit... remanent squareness of about 1..." Ex-1010, 3:7-9, 3:32-38. It was well-recognized in the field that a remanence squareness of 1 is preferred for PMR. *See, e.g.*, Ex-1029, Fig. 7; Ex-1036, ¶94. Therefore, a POSITA implementing Takenoiri's multilayer structure, seeking to improve the structure's bit stability (or thermal stability), would have been motivated to ensure that Takenoiri's structure exhibits high remanent squareness of about 1, as taught by Chang. Ex-1003, ¶291.

A POSITA would have had **reasonable expectation of success** in implementing Takenoiri's multilayer structure with a remanent squareness of about 1, because Takenoiri and Chang teach ways to improve the remanent squareness, including use of underlayers, selection of alloy composition, structure/composition of the non-magnetic interlayer, and control of exchange coupling between magnetic layers. Ex-1005, 6:29-30, 6:52-55, 5:60-65; Ex-1010, 7:14-25; Fig. 5. Therefore, a POSITA would have had various ways to ensure the remanent squareness in Takenoiri is close to 1. Ex-1003, ¶292.

### **XIII. CONCLUSION**

Trial should be instituted and the Challenged Claims cancelled as unpatentable.

Dated: October 8, 2025

Respectfully Submitted,

/Dion M. Bregman/

Dion M. Bregman, Reg. No. 45,645

**CERTIFICATION OF COMPLIANCE WITH TYPE-VOLUME LIMITS**

This Petition includes 13,945 words as counted by Microsoft Word and is therefore in compliance with the 14,000-word limit established by 37 C.F.R. 42.24(a)(1)(i). Accordingly, pursuant to 37 C.F.R. 42.24(d), lead counsel for the Petitioners hereby certify that this Petition complies with the type-volume limits established for a petition requesting IPR.

Dated: October 8, 2025

Respectfully Submitted,

/Dion M. Bregman/

Dion M. Bregman, Reg. No. 45,645

**CERTIFICATE OF SERVICE**

Pursuant to 37 C.F.R. 42.6(e)(4) and 42.105, lead counsel for Petitioners hereby certifies that on October 8, 2025, copies of this Petition and all supporting exhibits were sent via Priority Mail Express to the correspondence address of record for the '864 Patent:

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Berkeley, CA

Courtesy copies have also been delivered electronically to counsel of record in the parallel District Court proceeding:

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**Appendix A****U.S. PATENT NO. 9,928,864 – Claim Listing**

| No.     | Claim Elements                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1[P]    | A magnetic recording medium, comprising:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 1[A]    | an essentially non-magnetic substrate;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 1[B]    | an underlayer formed on the non-magnetic substrate; and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 1[C]    | an exchange coupled magnetic multilayer structure, including                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 1[D]    | a hard magnetic storage layer, having a first coercive field $H_s > 0.5$ T, formed on the underlayer; and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 1[E]    | a nucleation host, having a second coercive field $H_n$ without the hard magnetic storage layer, lower than the first coercive field, $H_n < H_s$ , wherein                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1[F]    | said nucleation host is formed on the hard magnetic storage layer such that the hard magnetic storage layer is between the nucleation host and the non-magnetic substrate,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 1[G]    | is exchange coupled to the hard magnetic storage layer, and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1[H]    | comprises ferromagnetic layers with increasing anisotropy constant $K$ from layer to layer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Claim 2 | 2. The magnetic recording medium of claim 1, wherein: an exchange coupling between the nucleation host and the hard magnetic storage layer is sufficiently strong and the nucleation host is sufficiently hard so that a derivative $k$ of a normalized magnetization with respect to an external magnetic field, normalized to a coercive field of the recording medium, does not change by more than a factor of 3 in a magnetization interval $-0.7 < M_z/M_s < 0.7$ , wherein $k = \frac{dM}{dH} \frac{H_c}{M_s}$ , $M$ being a magnetization of the recording medium, $M_z$ being a component of $M$ perpendicular to a plane of the recording medium, $H$ being an external magnetic field parallel to a normal of the recording medium, $\frac{dM}{dH}$ being a derivative of the magnetization of the recording medium with respect to the external magnetic field, $H_c$ being the coercive field of the recording medium, $M_s$ being a saturation magnetization of the recording medium. |
| Claim 3 | 3. The magnetic recording medium of claim 1, wherein: the nucleation host and the hard magnetic storage layer are in direct contact.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Claim 4 | 4. The magnetic recording medium of claim 1, wherein: the nucleation host and the hard magnetic storage layer comprise ferromagnetic layers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

|          |                                                                                                                                                                                                                                                                                                                                                   |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          | with increasing anisotropy constant K values.                                                                                                                                                                                                                                                                                                     |
| Claim 5  | 5. The magnetic recording medium of claim 1, wherein: the hard magnetic storage layer comprises of at least one of Cr, Pt, Ta, B, Fe, Cu, Ag, W, Mo, Ru, Si, Ge, Nb, Co, Pd, Sm, Nd, Dy, Hf, Mn and Ni.                                                                                                                                           |
| Claim 6  | 6. The magnetic recording medium of claim 1, wherein: the coercive field of the nucleation host $H_n$ without the hard magnetic storage layer is less than $\frac{1}{2}$ of the coercive field of the hard magnetic storage layer $H_s$ .                                                                                                         |
| Claim 9  | 9. The magnetic recording medium of claim 1, wherein: the nucleation host comprises at least one of Fe, Al, Cu, Ag, Ge, Pd, Sm, Nd, Dy, and Mn.                                                                                                                                                                                                   |
| Claim 10 | 10. The magnetic recording medium of claim 1, wherein: the nucleation host has a thickness smaller than 30 nm.                                                                                                                                                                                                                                    |
| Claim 11 | 11. The magnetic recording medium of claim 1, wherein: the nucleation host comprises grains with an average diameter greater than 2 nm and less than 10 nm.                                                                                                                                                                                       |
| Claim 12 | 12. The magnetic recording medium of claim 1, wherein: a height of a plurality of grains is greater than a diameter of the grains.                                                                                                                                                                                                                |
| Claim 13 | 13. The magnetic recording medium of claim 1, wherein: a coupling layer is disposed between the nucleation host and the hard magnetic storage layer.                                                                                                                                                                                              |
| Claim 14 | 14. The magnetic recording medium of claim 1, wherein: the nucleation host is separated from the hard magnetic storage layer by a layer of thickness less than 5 nm.                                                                                                                                                                              |
| Claim 15 | 15. The magnetic recording medium of claim 1, wherein: the nucleation host is coupled to the hard magnetic storage layer by an exchange coupling layer to provide an exchange coupling sufficiently strong to enable a formation of a domain wall across an interface of the hard magnetic storage layer and the nucleation host during reversal. |
| Claim 22 | 22. The magnetic recording medium of claim 1, wherein: a thickness of the nucleation host has a value such that the in plane component of a magnetization of a remanent state is less than 20% of a total magnetization.                                                                                                                          |
| Claim 23 | 23. The magnetic recording medium of claim 1, wherein: the recording medium is usable for at least one of perpendicular recording or recording on patterned elements.                                                                                                                                                                             |