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Attorneys for Plaintiff
Scramoge Technology Limited

**UNITED STATES DISTRICT COURT
CENTRAL DISTRICT OF CALIFORNIA**

MR TECHNOLOGIES, GMBH,

Plaintiff,

vs.

WESTERN DIGITAL TECHNOLOGIES,
INC.,

Defendant.

Case No.

**COMPLAINT FOR PATENT
INFRINGEMENT**

JURY TRIAL DEMANDED

1 This is an action for patent infringement arising under the Patent Laws of the
 2 United States of America, 35 U.S.C. § 1 *et seq.*, in which Plaintiff MR Technologies,
 3 GmbH (“MR Technologies” or “Plaintiff”) make the following allegations against
 4 Defendant Western Digital Technologies, Inc. (“Defendant” or “Western Digital”):

5 **INTRODUCTION**

6 1. This complaint arises from Defendant’s unlawful infringement of the
 7 following United States patents owned by Sues: U.S. Patent No. 9,978,413 (“’413
 8 Patent”); U.S. Patent No. 9,928,864 (“’864 Patent”); U.S. Patent No. 11,133,031
 9 (“’031 Patent”); and U.S. Patent No. 11,138,997 (“’997 Patent”) (collectively the
 10 “Asserted Patents”).

11 **PARTIES**

12 2. MR Technologies is a privately held company, having its principal
 13 place of business at Nibelungengasse 11/4, 1010 Vienna, Austria.

14 3. Western Digital Technologies, Inc. is a Delaware corporation with a
 15 principal place of business at 3355 Michelson Dr., Suite 100, Irvine, CA, 92612.
 16 Western Digital, on information and belief, designs and manufactures, among other
 17 things, magnetic recording media such as hard disk drives. Western Digital may be
 18 served with process through its registered agent, the Corporation Service Company,
 19 at 251 Little Falls Drive, Wilmington, Delaware, 19808.

20 **JURISDICTION AND VENUE**

21 4. This action arises under the patent laws of the United States, Title 35 of
 22 the United States Code. This Court has original subject matter jurisdiction pursuant
 23 to 28 U.S.C. §§ 1331 and 1338(a).

24 5. This Court has personal jurisdiction over Defendant in this action
 25 because Defendant has committed acts within this District giving rise to this action
 26 and has established minimum contacts with this forum such that the exercise of
 27 jurisdiction over Defendant would not offend traditional notions of fair play and
 28 substantial justice. Defendant, directly and through subsidiaries or intermediaries,

1 has committed and continue to commit acts of infringement in this District by,
2 among other things, importing, offering to sell, and selling products that infringe the
3 asserted patents.

4 6. Venue is proper in this District under 28 U.S.C. § 1400(b). Upon
5 information and belief, Defendant has transacted business in this District and has
6 committed acts of direct and indirect infringement in this District by, among other
7 things, making, using, offering to sell, selling, and importing products that infringe
8 the asserted patents. Defendant has at least one regular and established place of
9 business in the District. For example, Western Digital has offices at 3355 Michelson
10 Dr., Irvine, CA, 92612.

11 COUNT I

12 INFRINGEMENT OF U.S. PATENT NO. 9,978,413

13 7. Plaintiff realleges and incorporates by reference the foregoing
14 paragraphs as if fully set forth herein.

15 8. MR Technologies is the owner and assignee of United States Patent No.
16 9,978,413 titled “Multilayer exchange spring recording media.” The ‘413 Patent
17 was duly and legally issued by the United States Patent and Trademark Office on
18 May 22, 2018. MR Technologies is the owner and assignee, possessing all
19 substantial rights, to the ’413 Patent. A true and correct copy of the ’413 Patent is
20 attached as Exhibit 1.

21 9. Defendant makes, uses, offers for sale, sells, and/or imports into the
22 United States certain products and services that directly infringe, literally and/or
23 under the doctrine of equivalents, one or more claims of the ’413 Patent, and
24 continue to do so. By way of illustrative example, these infringing products and
25 services include, without limitation, Defendant’s magnetic hard disk drives,
26 including, for example, the Western Digital WD80EFX (8TB), and all versions and
27 variations thereof since the issuance of the ’413 Patent (“Accused Products”).

28 10. Defendant has also infringed, and continue to infringe, claims of the

1 '413 patent by offering to commercially distribute, commercially distributing,
 2 making, and/or importing the Accused Products, which are used in practicing the
 3 process, or using the systems, of the patent, and constitute a material part of the
 4 invention. Defendant knows the components in the Accused Products to be
 5 especially made or especially adapted for use in infringement of the patent, not a
 6 staple article, and not a commodity of commerce suitable for substantial
 7 noninfringing use. Accordingly, Defendant has been, and currently are,
 8 contributorily infringing the '413 patent, in violation of 35 U.S.C. § 271(c).

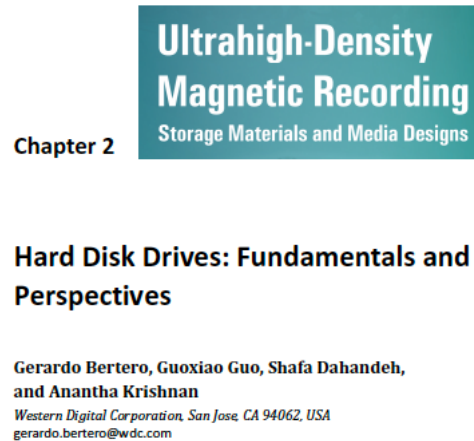
9 11. The Accused Products satisfy all claim limitations of one or more
 10 claims of the '413 Patent. For example, the Accused Products infringe claim 1 of the
 11 '413 Patent. One, non-limiting, example of the Accused Products infringement is
 12 presented below.

13 12. The Accused Products include: “[a] magnetic recording medium,
 14 comprising.” For example, the Accused Products, including the Western Digital
 15 WD80EFX (8TB), have a magnetic recording medium.

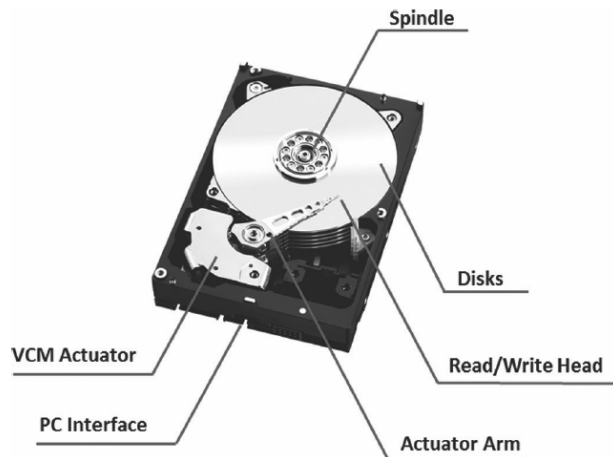


1 [https://www.westerndigital.com/products/internal-drives/wd-red-pro-sata-](https://www.westerndigital.com/products/internal-drives/wd-red-pro-sata-hdd#WD8003FFBX)
 2 [hdd#WD8003FFBX](https://www.westerndigital.com/products/internal-drives/wd-red-pro-sata-hdd#WD8003FFBX)

3 13. Based on information and belief, the Accused Products include: “an
 4 essentially non-magnetic substrate.” For example, the Accused Products, including
 5 the Western Digital WD80EFX (8TB), have a non-magnetic substrate, as
 6 demonstrated by a paper written by engineers at Western Digital, which describes a
 7 disk in an HDD product having a non-magnetic substrate, such as glass.



16 86 | Hard Disk Drives

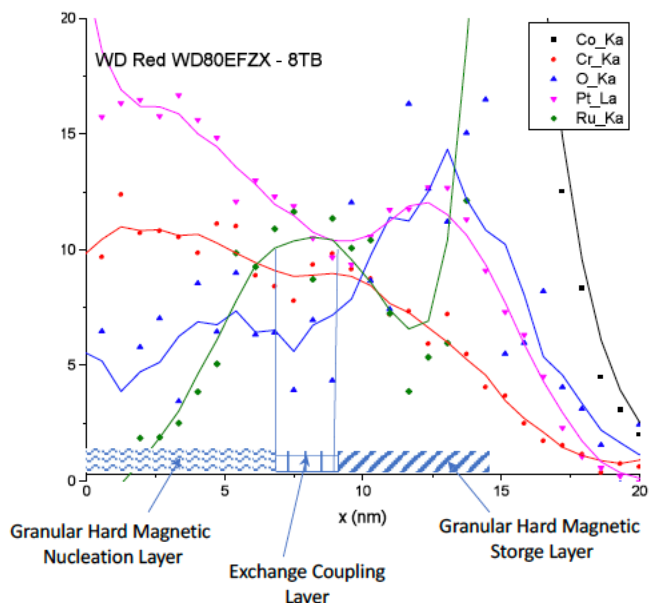


25 **Figure 2.23** Typical hard disk drive.

26 **2.4.1 HDD Servo Basic Components**

27 As shown in Fig. 2.23 an HDD contains magnetic disks rotating about
 28 a spindle motor at a fixed rotating speed ranging from 4,200 to
 15,000 rotations per minute (RPM). The disks are of aluminum or
 glass **substrates** coated with magnetic materials where the user data

1 14. Based on information and belief, the Accused Products include: “a
 2 magnetic bilayer.” For example, energy dispersive x-ray (EDX) chemical analysis
 3 of layers of the Western Digital WD80EFX (8TB) shows a magnetic bilayer.



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More specifically, the ruthenium (“Ru”) peak at about 7-8 nm demonstrates two distinct layers, as Ru is widely used, either alone or in connection with other materials, to provide exchange coupling between magnetic layers. Therefore, there is a “bilayer structure”. The average oxygen (“O”) concentration in the two distinct layers (nucleation host and storage layer) is significantly different. Thus, the Accused Products, including the Western Digital WD80EFX (8TB), have a magnetic bilayer.

15. Based on information and belief, the Accused Products include: “the magnetic bilayer including a granular hard magnetic storage layer with perpendicular anisotropy having a coercive field of H_s without another magnetic layer and a thickness between 3 nm and 30 nm.” For example, the Western Digital WD80EFX (8TB) has a magnetic bilayer including a granular hard magnetic storage layer with perpendicular anisotropy having a coercive field of H_s without another magnetic layer and a thickness between 3 nm and 30 nm.

16. The granular oxide layer is a granular hard magnetic storage layer. The

1 formula from the '413 patent (at col. 6, line 54) provides an equation for the coercive
 2 field, $H_c = 2 \cdot K_{\text{eff}} / M_s$ (where H_c also is referred to as H_s). As shown in IEEE
 3 Transactions of Magnetics (July 2009)¹, at p. 2694 (excerpted below), a granular
 4 oxide layer has values of $M_s \sim 380 \text{ emu/cm}^3 = 0.47\text{T}$ and $K_{\text{eff}} \sim 3.1 \times 10^6 \text{ erg/cm}^3 =$
 5 0.31e6 J/m^3 , and therefore has a coercive field $H_c = 2 \cdot K_{\text{eff}} / M_s = 1.6\text{T}$. Thus, the
 6 Western Digital WD80EFX (8TB) has a granular hard magnetic storage layer with
 7 perpendicular anisotropy having a coercive field of H_s without another magnetic
 8 layer.

9 **Control of Exchange Coupling Between Granular Oxide and Highly**
 10 **Exchange Coupled Cap Layers and the Effect on Perpendicular**
 11 **Magnetic Switching and Recording Characteristics**

12 Gunn Choe¹, Yoshihiro Ikeda², Kezhao Zhang¹, Kai Tang¹, and Mohammad Mirzamaani¹

13 ¹Hitachi Global Storage Technologies, Media Development, San Jose, CA 95193 USA

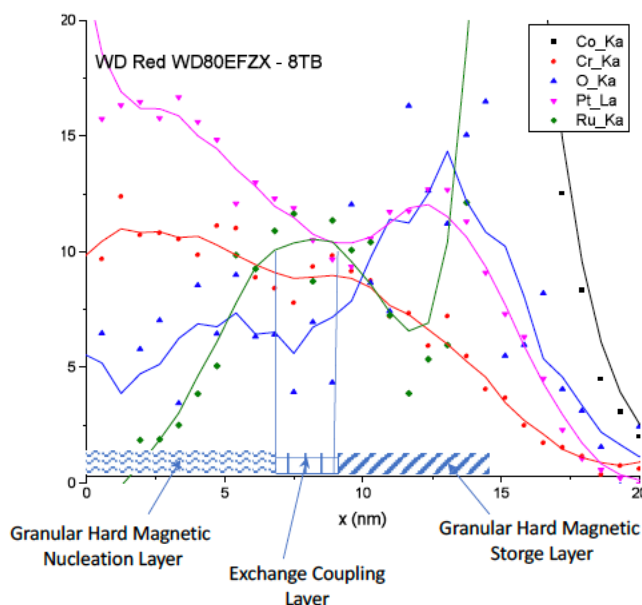
14 ²Hitachi Global Storage Technologies, San Jose Research Center, San Jose, CA 95135 USA

15 recording layer in this study comprises a CoPtCrB continuous
 16 layer exchange coupled to a granular oxide CoPtCrSiO layer
 17 through ECL. The K_{ul} values of granular oxide grain and cap
 18 layer are $\sim 3.1 \times 10^6 \text{ erg/cm}^3$ and $\sim 2.2 \times 10^6 \text{ erg/cm}^3$, respec-
 19 tively. The average M_s value of oxide layer is 380 emu/cm^3
 20 with average packing fraction ~ 0.73 (grain diameter $\sim 8.4 \text{ nm}$,
 21 grain boundary width $\sim 1 \text{ nm}$). Fig. 1 shows the cross-sectional
 22 transmission electron microscope (TEM) view of media struc-

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 28 17. In addition, an energy dispersive x-ray (EDX) chemical analysis of
 layers of the Western Digital WD80EFX (8TB) shows that the granular hard
 magnetic layer has a thickness between 3nm and 30 nm:

¹ The authors of this article are from Hitachi Global Storage Technologies, which has since been
 acquired by Western Digital.

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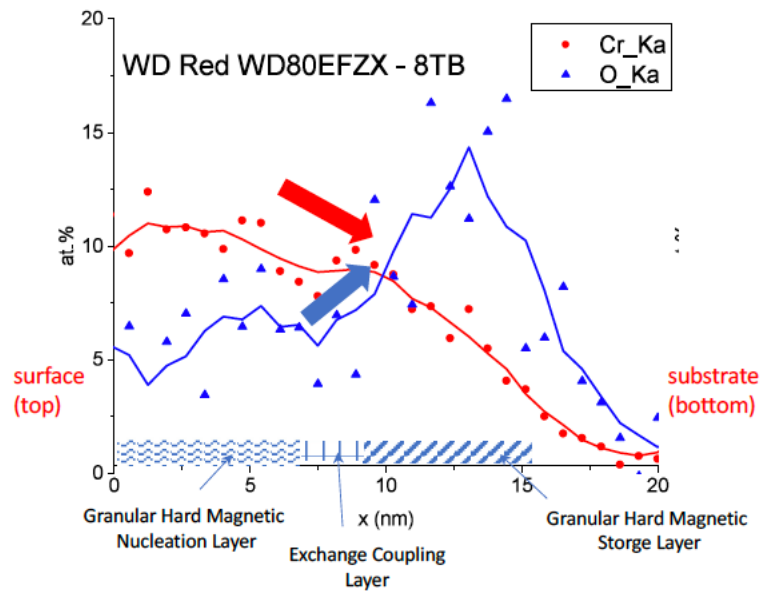
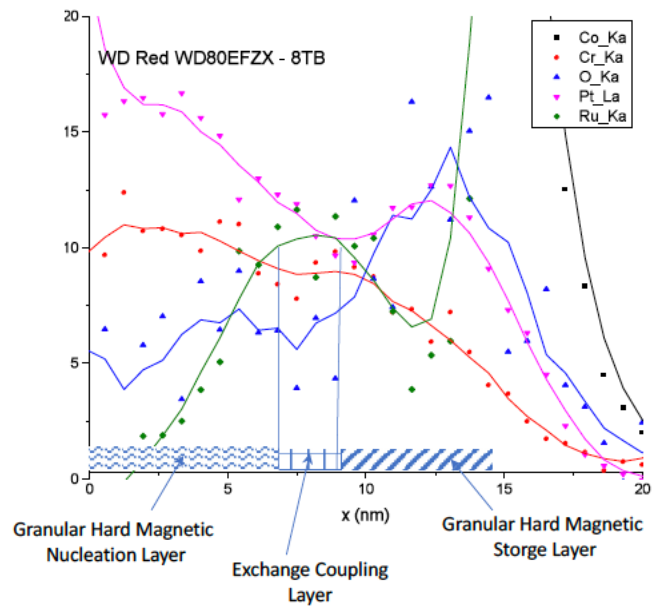


18. Thus, the Accused Products, including the Western Digital WD80EFX (8TB), have a storage layer with a thickness of between 3 and 30 nm.

19. Based on information and belief, the Accused Products include: “the magnetic bilayer including ... a granular hard magnetic nucleation host with perpendicular anisotropy, disposed on the hard magnetic storage layer in a columnar manner, having a coercive field H_n without the hard magnetic storage layer, wherein $0.5 T < H_n < H_s$.” The Accused Products, including the Western Digital WD80EFX (8TB), have a magnetic bilayer with a granular hard magnetic nucleation host with perpendicular anisotropy, disposed on the hard magnetic storage layer in a columnar manner, having a coercive field H_n without the hard magnetic storage layer, wherein $0.5 T < H_n < H_s$.

20. The EDX chemical analysis of layers of the WD80EFX (8TB) shows that the average O concentration increases from a lower level in the approx. 0-7 nm nucleation host to a higher level in the approx. 9-14 nm hard storage layer, while the average chromium (“Cr”) concentration decreases from a higher level in the nucleation host to a lower level in the hard storage layer. Both of these trends establish that H_n , the coercive field of the nucleation host, is lower than H_s , the coercive field of the hard storage layer: $H_n < H_s$. See Jung, H.S., et. al., “Effect of

1 Oxygen Incorporation on Microstructure and Media Performance in CoCrPt-SiO₂
 2 Perpendicular Recording Media, IEEE Transactions on Magnetics, Vol. 43, No. 2,
 3 February 2007.



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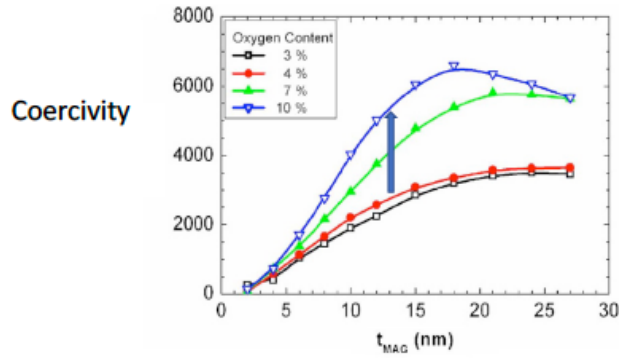


Fig. 1. Effect of CoCrPt-SiO₂ layer thickness (t_{MAG}) on coercivity (H_c) at various oxygen contents.

Jung, H.S., et. al., “Effect of Oxygen Incorporation on Microstructure and Media Performance in CoCrPt-SiO₂ Perpendicular Recording Media, IEEE Transactions on Magnetics, Vol. 43, No. 2, February 2007.

21. Moreover, as shown below, both H_n and H_s are larger than 0.5 T. As demonstrated in IEEE Transactions of Magnetics (July 2009), at p. 2694 (excerpted below), $M_s \sim 380 \text{ emu/cm}^3 = 0.47\text{T}$ and $K_{\text{eff}} \sim 3.1 \times 10^6 \text{ erg/cm}^3 = 0.31\text{e6 J/m}^3$. Using the formula from the ‘413 patent (at col. 6, line 54) that coercive field, $H_c = 2 * K_{\text{eff}} / M_s$, and inputting the values for M_s and K_{eff} , $H_c = 2 * K_{\text{eff}} / M_s = 1.6\text{T}$ (where H_c also is referred to as H_s).

Control of Exchange Coupling Between Granular Oxide and Highly Exchange Coupled Cap Layers and the Effect on Perpendicular Magnetic Switching and Recording Characteristics

Gunn Choe¹, Yoshihiro Ikeda², Kezhao Zhang¹, Kai Tang¹, and Mohammad Mirzamaani¹

¹Hitachi Global Storage Technologies, Media Development, San Jose, CA 95193 USA

²Hitachi Global Storage Technologies, San Jose Research Center, San Jose, CA 95135 USA

transmission electron microscope (TEM) view of media struc-

22. As shown below, differences in O and Cr levels establish that H_n , the coercive field of the nucleation host, is lower than H_s , the coercive field of the hard storage layer: $H_n < H_s$. Specifically, increasing the O concentration increases the anisotropy and thus the coercive field H_c (where H_c also is referred to as H_s). The O concentration average for nucleation layer (0-7nm) in the 8TB disk: $C(\text{ox})=8\%$; the O concentration average for storage layer (9-14nm) in the 8TB disk: $C(\text{ox})=13\%$.

1 Using a linear fit for the change of coercive field as function of the O concentration
 2 gives $H_n = 2 \cdot K_{\text{eff}} / M_s = 1.4\text{T}$. Thus, $0.5\text{T} < H_n(1.4\text{T}) < H_s(1.7\text{T})$. Thus, both H_n and H_s
 3 are greater than 0.5 T.

4 23. The figure below demonstrates the relationship between coercivity and
 5 Oxygen content.

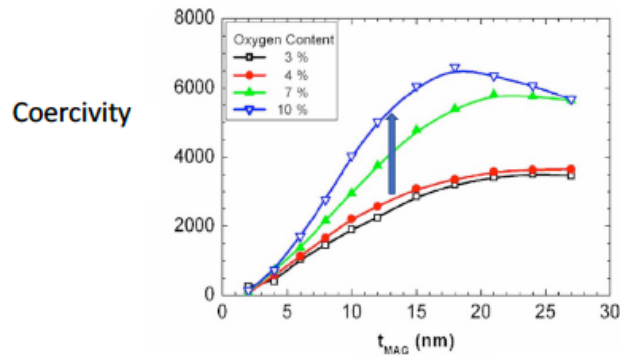


Fig. 1. Effect of CoCrPt-SiO₂ layer thickness (t_{MAG}) on coercivity (H_c) at various oxygen contents.

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 16 *Jung, H.S., et. al., "Effect of Oxygen Incorporation on Microstructure and Media*
 17 *Performance in CoCrPt-SiO₂ Perpendicular Recording Media, IEEE Transactions*
 18 *on Magnetics, Vol. 43, No. 2, February 2007.*

19 24. The granular hard magnetic nucleation host has perpendicular
 20 anisotropy, and is disposed on the hard magnetic storage layer in a columnar manner,
 21 as demonstrated by a paper written by engineers at Western Digital, which describes
 22 a disk in an HDD product having a columnar grains.

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**Ultrahigh-Density
Magnetic Recording**
Storage Materials and Media Designs

Chapter 2

Hard Disk Drives: Fundamentals and Perspectives

Gerardo Bertero, Guoxiao Guo, Shafa Dahandeh,
and Anantha Krishnan
Western Digital Corporation, San Jose, CA 94062, USA
gerardo.bertero@wdc.com

**Ultrahigh-Density
Magnetic Recording**
Storage Materials and Media Designs

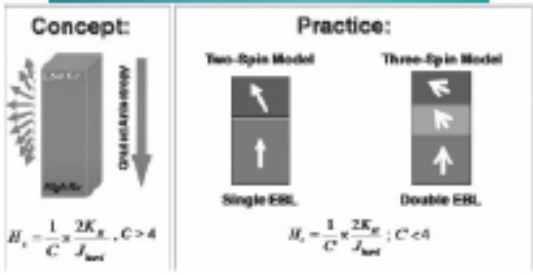


Figure 2.15 Exchange-spring and exchange-coupled composite (ECC) media structures. Inherent rotation in the column of the grain is enabled by the use of exchange break layers (EBLs).

25. Based on information and belief, the Accused Products include: “the nucleation host has a magnetic polarization $J_s = \mu_0 M_s$ between 0.3 T and 1.0 T.” For example, the Western Digital WD80EFX (8TB) includes a nucleation host has a magnetic polarization $J_s = \mu_0 M_s$ between 0.3 T and 1.0.

26. Using the equation $J_s = \mu_0 M_s$, and the typical values provided in the article below, $M_s = 320 \text{ emu/cm}^3$ results in 0.402 T, while M_s of 450 emu/cm^3 results in 0.565 T. Both of these results are between 0.3 T and 1.0 T.

1 Effect of Oxygen Incorporation on Microstructure and
2 Media Performance in CoCrPt–SiO₂ Perpendicular
3 Recording Media

4 H. S. Jung¹, U. Kwon², M. Kuo¹, E. M. T. Velu¹, S. S. Malhotra¹, W. Jiang¹, and G. Bertero¹

¹Komag, Inc., San Jose, CA 95131 USA

²Materials Science and Engineering Department, Stanford University, Stanford, CA 94305 USA

5 increases for $t_{\text{MAG}} \sim 0$ improve with OC = 10%. Even higher
6 OC is necessary to achieve grain isolation in thinner layers.

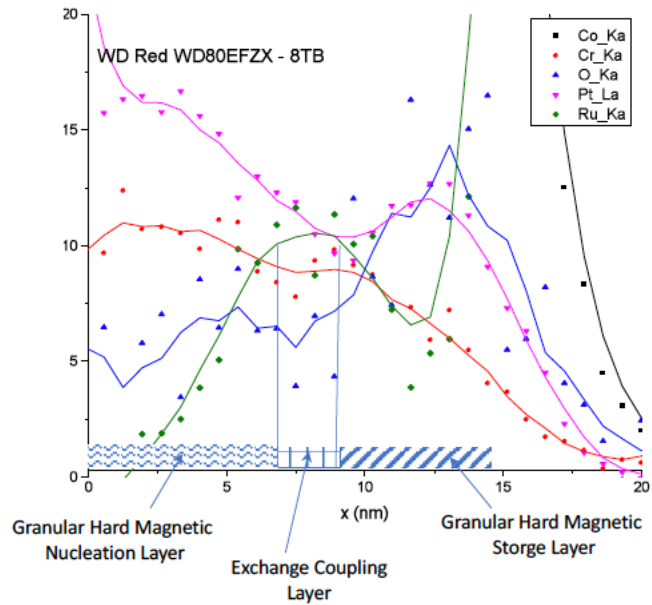
7 Values of M_s , obtained from a slope of saturation mag-
8 netization per-unit area (m_s) versus t_{MAG} , increase from
9 320 emu/cm³ at OC = 3% to 450 emu/cm³ at OC = 10%
10 as shown in Fig. 3. The increase in M_s with increasing OC
11 is not consistent with the reported result [11]. In CoCrPtSiO
12 films with OC < 15%, values of M_s were constant. Under the
13 assumption of constant M_s in core grains, the decrease in M_s

14 *Jung, H.S., et al.*, “Effect of Oxygen Incorporation on Microstructure and Media
15 Performance in CoCrPt-SiO₂ Perpendicular Recording Media, IEEE Transactions
16 on Magnetics, Vol. 43, No. 2, February 2007.

17 27. Based on information and belief, the Accused Products include: “the
18 nucleation host and the hard magnetic storage layer are separated by a coupling layer
19 between 0.1 nm and 3 nm thickness.” The Accused Products, including the Western
20 Digital WD80EFX (8TB), have a nucleation host and a hard magnetic storage layer
21 that are separated by a coupling layer between 0.1 nm and 3 nm thickness.

22 28. An energy dispersive x-ray (EDX) chemical analysis of layers of the
23 Western Digital WD80EFX (8TB) shows that the nucleation host and hard magnetic
24 storage layer are separated by a coupling layer between 0.1 nm and 3 nm:
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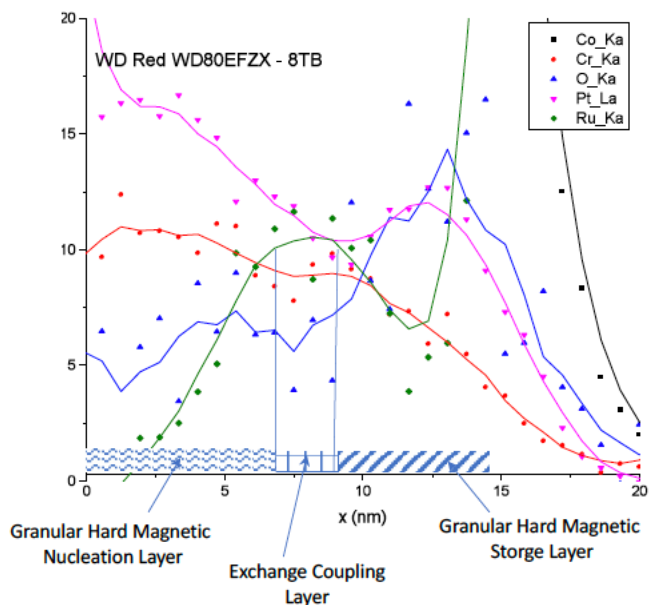
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Thus, the Accused Products, including the Western Digital WD80EFX (8TB), have a nucleation layer and a hard magnetic layer separated by a coupling layer of between 0.1 nm and 3 nm thickness.

29. Based on information and belief, the Accused Products include “the coupling layer is directly between the nucleation host and the storage layer.” The Accused Products, such as the Western Digital WD80EFX (8TB), have a coupling layer that is directly between the nucleation host and the storage layer, as shown by the energy dispersive x-ray (EDX) chemical analysis of layers of the Western Digital WD80EFX (8TB).

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Thus, the Western Digital WD80EFX (8TB) has a coupling layer that is directly between the nucleation host and the storage layer.

30. Based on information and belief, the Accused Products, including the Western Digital WD80EFX (8TB), include: “the coupling between the nucleation host and the hard magnetic storage layer is ferromagnetic.”

31. By making, using, offering for sale, selling and/or importing into the United States the Accused Products, Defendant has injured Plaintiff and is liable for infringement of the '413 Patent pursuant to 35 U.S.C. § 271.

32. As a result of Defendant’s infringement of the '413 Patent, Plaintiff is entitled to monetary damages in an amount adequate to compensate for Defendant’s infringement, but in no event less than a reasonable royalty for the use made of the invention by Defendant, together with interest and costs as fixed by the Court.

COUNT II

INFRINGEMENT OF U.S. PATENT NO. 11,133,031

33. Plaintiff realleges and incorporates by reference the foregoing paragraphs as if fully set forth herein.

34. MR Technologies is the owner and assignee of United States Patent No. 11,133,031 titled “Multilayer exchange spring recording media.” The ‘031 Patent

1 was duly and legally issued by the United States Patent and Trademark Office on
2 September 28, 2021. MR Technologies is the owner and assignee, possessing all
3 substantial rights, to the '031 Patent. A true and correct copy of the '031 Patent is
4 attached as Exhibit 2.

5 35. Defendant makes, uses, offers for sale, sells, and/or imports into the
6 United States certain products and services that directly infringe, literally and/or
7 under the doctrine of equivalents, one or more claims of the '031 Patent, and
8 continue to do so. By way of illustrative example, these infringing products and
9 services include, without limitation, Defendant's magnetic hard disk drives,
10 including, for example, the Western Digital WD80EFX (8TB), and all versions and
11 variations thereof since the issuance of the '031 Patent ("Accused Products").

12 36. Defendant has also infringed, and continue to infringe, claims of the
13 '031 patent by offering to commercially distribute, commercially distributing,
14 making, and/or importing the Accused Products, which are used in practicing the
15 process, or using the systems, of the patent, and constitute a material part of the
16 invention. Defendant knows the components in the Accused Products to be
17 especially made or especially adapted for use in infringement of the patent, not a
18 staple article, and not a commodity of commerce suitable for substantial
19 noninfringing use. Accordingly, Defendant has been, and currently are,
20 contributorily infringing the '031 patent, in violation of 35 U.S.C. § 271(c).

21 37. Based on information and belief, the Accused Products satisfy all claim
22 limitations of one or more claims of the '031 Patent. For example, the Accused
23 Products infringe claim 1 of the '031 Patent. One, non-limiting, example of the
24 Accused Products infringement is presented below.

25 38. Based on information and belief, the Accused Products include: "A
26 magnetic recording system." For example, the Accused Products, including the
27 Western Digital WD80EFX (8TB), have a magnetic recording system.
28 <https://www.westerndigital.com/products/internal-drives/wd-red-pro-sata->

1 [hdd#WD8003FFBX](https://www.westerndigital.com/products/internal-drives/wd-red-pro-sata-hdd#WD8003FFBX)



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17 39. Based on information and belief, the Accused Products include: “a
18 writing head.” For example, the Western Digital WD80EFX (8TB) includes a
19 writing head. [https://www.westerndigital.com/products/internal-drives/wd-red-pro-](https://www.westerndigital.com/products/internal-drives/wd-red-pro-sata-hdd#WD8003FFBX)
20 [sata-hdd#WD8003FFBX](https://www.westerndigital.com/products/internal-drives/wd-red-pro-sata-hdd#WD8003FFBX)

21 40. Based on information and belief, the Accused Products include: “a disk,
22 including a magnetic recording medium.” The Western Digital WD80EFX (8TB)
23 includes a disk, including a magnetic recording medium.
24 [https://www.westerndigital.com/products/internal-drives/wd-red-pro-sata-](https://www.westerndigital.com/products/internal-drives/wd-red-pro-sata-hdd#WD8003FFBX)
25 [hdd#WD8003FFBX](https://www.westerndigital.com/products/internal-drives/wd-red-pro-sata-hdd#WD8003FFBX)

26 41. Based on information and belief, the Accused Products include” “an
27 essentially non-magnetic substrate.” For example, the Accused Products, including
28 the Western Digital WD80EFX (8TB), have a non-magnetic substrate, as

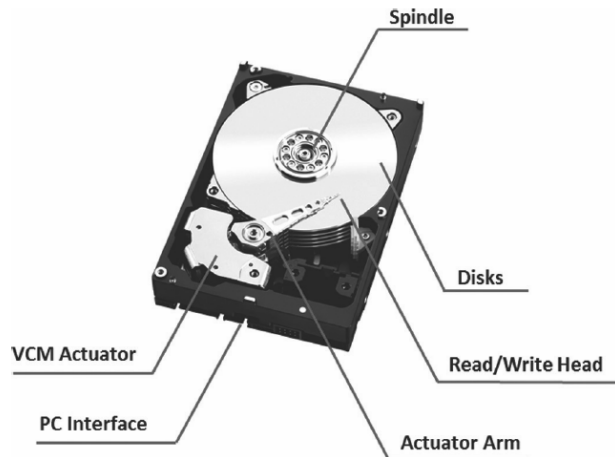
1 demonstrated by a paper written by engineers at Western Digital, which describes a
 2 disk in a HDD product having a non-magnetic substrate, such as glass.

3 **Ultrahigh-Density**
 4 **Magnetic Recording**
 5 Chapter 2 Storage Materials and Media Designs

6 **Hard Disk Drives: Fundamentals and**
 7 **Perspectives**

8 Gerardo Bertero, Guoxiao Guo, Shafa Dahandeh,
 9 and Anantha Krishnan
 10 Western Digital Corporation, San Jose, CA 94062, USA
 11 gerardo.bertero@wdc.com

12 86 | Hard Disk Drives



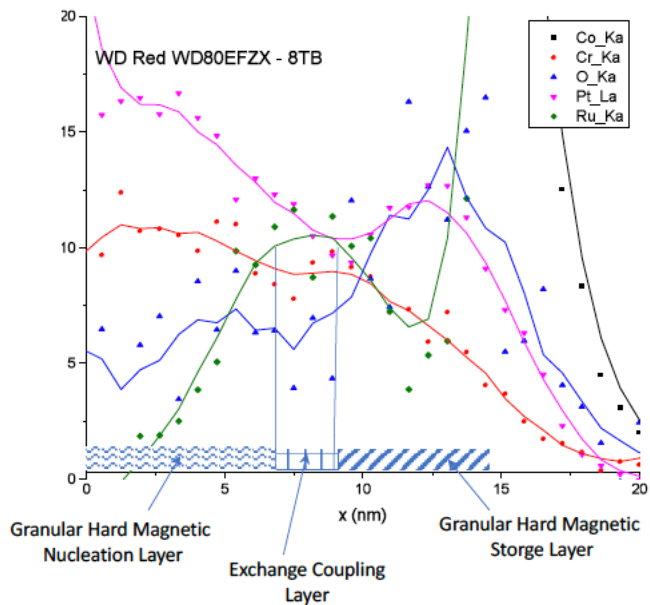
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20 Figure 2.23 Typical hard disk drive.

21 2.4.1 HDD Servo Basic Components

22 As shown in Fig. 2.23 an HDD contains magnetic disks rotating about
 23 a spindle motor at a fixed rotating speed ranging from 4,200 to
 24 15,000 rotations per minute (RPM). The disks are of aluminum or
 25 glass **substrates** coated with magnetic materials where the user data

26 42. Based on information and belief, the Accused Products include: “a
 27 magnetic bilayer.” For example, energy dispersive x-ray (EDX) chemical analysis
 28 of layers of the Western Digital WD80EFX (8TB) shows a magnetic bilayer.

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More specifically, the ruthenium (“Ru”) peak at about 7-8 nm demonstrates two distinct layers, as Ru, either alone or with other materials, is widely used to provide exchange coupling between magnetic layers. Therefore, there is a “bilayer structure”. The average oxygen (“O”) concentration in the two distinct layers (nucleation host and storage layer) is significantly different. Thus, the Accused Products, including the Western Digital WD80EFX (8TB), have a magnetic bilayer.

43. Based on information and belief, the Accused Products include: “the magnetic bilayer including a granular hard magnetic storage layer with perpendicular anisotropy having a coercive field of H_s without another magnetic layer and a thickness between 3 nm and 30 nm.” For example, the Western Digital WD80EFX (8TB) has a magnetic bilayer including a granular hard magnetic storage layer with perpendicular anisotropy having a coercive field of H_s without another magnetic layer and a thickness between 3 nm and 30 nm.

44. The granular oxide layer is a granular hard magnetic storage layer. The formula from the ‘413 patent (at col. 6, line 54) provides an equation for a coercive field, $H_c = 2 \cdot K_{eff} / M_s$ (where H_c also is referred to as H_s). As shown in IEEE Transactions of Magnetics (July 2009), at p. 2694 (excerpted below), a granular oxide layer has values of $M_s \sim 380 \text{ emu/cm}^3 = 0.47\text{T}$ and $K_{eff} \sim 3.1 \times 10^6 \text{ erg/cm}^3 =$

1 0.31e6 J/m³, and therefore has a coercive field $H_c = 2 \cdot K_{\text{eff}} / M_s = 1.6\text{T}$. Thus, the
 2 Western Digital WD80EFX (8TB) has a granular hard magnetic storage layer with
 3 perpendicular anisotropy having a coercive field of H_s without another magnetic
 4 layer.

5 **Control of Exchange Coupling Between Granular Oxide and Highly**
 6 **Exchange Coupled Cap Layers and the Effect on Perpendicular**
 7 **Magnetic Switching and Recording Characteristics**

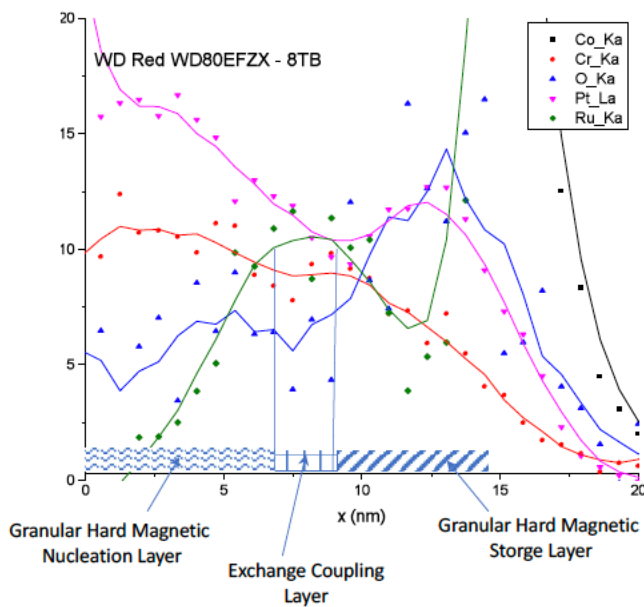
8 Gunn Choe¹, Yoshihiro Ikeda², Kezhao Zhang¹, Kai Tang¹, and Mohammad Mirzamaani¹

9 ¹Hitachi Global Storage Technologies, Media Development, San Jose, CA 95193 USA

10 ²Hitachi Global Storage Technologies, San Jose Research Center, San Jose, CA 95135 USA

11 recording layer in this study comprises a CoPtCrB continuous
 12 layer exchange coupled to a granular oxide CoPtCrSiO layer
 13 through ECL. The K_{11} values of granular oxide grain and cap
 14 layer are $\sim 3.1 \times 10^6 \text{ erg/cm}^3$ and $\sim 2.2 \times 10^6 \text{ erg/cm}^3$, respec-
 15 tively. The average M_s value of oxide layer is 380 emu/cm^3
 16 with average packing fraction ~ 0.73 (grain diameter $\sim 8.4 \text{ nm}$,
 17 grain boundary width $\sim 1 \text{ nm}$). Fig. 1 shows the cross-sectional
 18 transmission electron microscope (TEM) view of media struc-

19 45. In addition, an energy dispersive x-ray (EDX) chemical analysis of
 20 layers of the Western Digital WD80EFX (8TB) shows that the granular hard
 21 magnetic layer has a thickness between 3nm and 30 nm:
 22



23 46. Thus, the Accused Products, including the Western Digital WD80EFX
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1 (8TB), have a storage layer with a thickness of between 3 and 30 nm.

2 47. Based on information and belief, the Accused Products include: “the
3 magnetic bilayer including ... a granular hard magnetic nucleation host with
4 perpendicular anisotropy, disposed on the hard magnetic storage layer in a columnar
5 manner, having a coercive field H_n without the hard magnetic storage layer, wherein
6 $0.5 T < H_n < H_s$.” The Accused Products, including the Western Digital WD80EFX
7 (8TB), have a magnetic bilayer with a granular hard magnetic nucleation host with
8 perpendicular anisotropy, disposed on the hard magnetic storage layer in a columnar
9 manner, having a coercive field H_n without the hard magnetic storage layer, wherein
10 $0.5 T < H_n < H_s$.

11 48. The EDX chemical analysis of layers of the WD80EFX (8TB) shows
12 that the average O concentration increases from a lower level in the approx. 0-7 nm
13 nucleation host to a higher level in the approx. 9-14 nm hard storage layer, while the
14 average chromium (“Cr”) concentration decreases from a higher level in the
15 nucleation host to a lower level in the hard storage layer. Both of these trends
16 establish that H_n , the coercive field of the nucleation host, is lower than H_s , the
17 coercive field of the hard storage layer: $H_n < H_s$. See Jung, H.S., et. al., “Effect of
18 Oxygen Incorporation on Microstructure and Media Performance in CoCrPt-SiO₂
19 Perpendicular Recording Media, IEEE Transactions on Magnetics, Vol. 43, No. 2,
20 February 2007.

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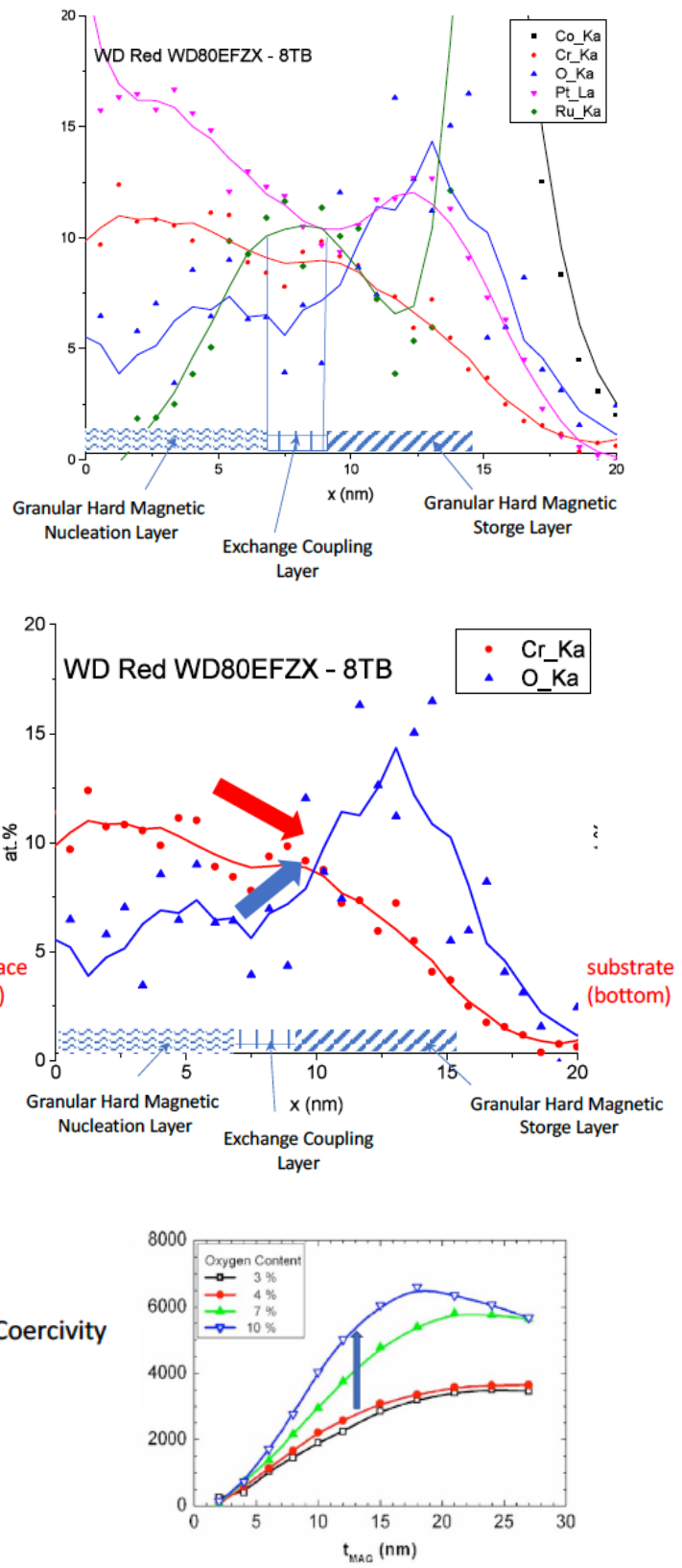


Fig. 1. Effect of CoCrPt-SiO₂ layer thickness (t_{MAG}) on coercivity (H_c) at various oxygen contents.

1 Performance in CoCrPt-SiO₂ Perpendicular Recording Media, IEEE Transactions
2 on Magnetics, Vol. 43, No. 2, February 2007.

3 49. Moreover, as shown below, both H_n and H_s are larger than 0.5 T. As
4 demonstrated in IEEE Transactions of Magnetics (July 2009), at p. 2694 (excerpted
5 below), M_s ~ 380 emu/cm³ = 0.47T and K_{eff} ~ 3.1x10⁶ erg/cm³ = 0.31e6 J/m³. Using
6 the formula from the '413 patent (at col. 6, line 54) that coercive field, H_c =
7 2*K_{eff}/M_s, and inputting the values for M_s and K_{eff}, H_c = 2*K_{eff}/M_s = 1.6T (where H_c
8 also is referred to as H_s).

9 **Control of Exchange Coupling Between Granular Oxide and Highly**
10 **Exchange Coupled Cap Layers and the Effect on Perpendicular**
11 **Magnetic Switching and Recording Characteristics**

Gunn Choe¹, Yoshihiro Ikeda², Kezhao Zhang¹, Kai Tang¹, and Mohammad Mirzamaani¹

¹Hitachi Global Storage Technologies, Media Development, San Jose, CA 95193 USA

²Hitachi Global Storage Technologies, San Jose Research Center, San Jose, CA 95135 USA

12
13 recording layer in this study comprises a CoPtCrB continuous
14 layer exchange coupled to a granular oxide CoPtCrSiO layer
15 through ECL. The K₁₁ values of granular oxide grain and cap
16 layer are ~3.1 × 10⁶ erg/cm³ and ~2.2 × 10⁵ erg/cm³, respec-
17 tively. The average M_s value of oxide layer is 380 emu/cm³
18 with average packing fraction ~0.73 (grain diameter ~8.4 nm,
19 grain boundary width ~1 nm). Fig. 1 shows the cross-sectional
20 transmission electron microscope (TEM) view of media struc-

21 50. As shown, differences in O and Cr levels establish that H_n, the coercive
22 field of the nucleation host, is lower than H_s, the coercive field of the hard storage
23 layer: H_n<H_s. Specifically, increasing the O concentration increases the anisotropy
24 and thus the coercive field H_c (where H_c also is referred to as H_s). The O
25 concentration average for nucleation layer (0-7nm) in the 8TB disk: C(ox)=8%; the
26 O concentration average for storage layer (9-14nm) in the 8TB disk: C(ox)=13%.
27 Using a linear fit for the change of coercive field as function of the O concentration
28 gives H_n = 2*K_{eff}/M_s = 1.4T. Thus, 0.5T<H_n(1.4T) <H_s(1.7T). Thus, both H_n and H_s
are greater than 0.5 T.

51. The figure below determines the relationship between coercivity and

1 Oxygen content.

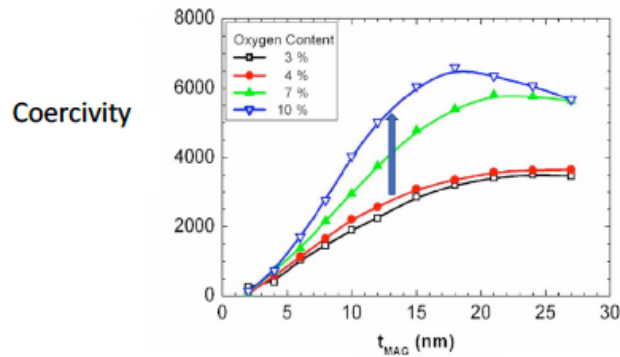
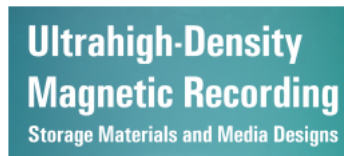


Fig. 1. Effect of CoCrPt-SiO₂ layer thickness (t_{MAG}) on coercivity (H_c) at various oxygen contents.

10 *Jung, H.S., et. al.*, “Effect of Oxygen Incorporation on Microstructure and Media
 11 Performance in CoCrPt-SiO₂ Perpendicular Recording Media, IEEE Transactions
 12 on Magnetics, Vol. 43, No. 2, February 2007.

13 52. The granular hard magnetic nucleation host has perpendicular
 14 anisotropy, and is disposed on the hard magnetic storage layer in a columnar manner,
 15 as demonstrated by a paper written by engineers at Western Digital, which describes
 16 a disk in a HDD product having a columnar grains.



Chapter 2

21 **Hard Disk Drives: Fundamentals and**
 22 **Perspectives**

23 Gerardo Bertero, Guoxiao Guo, Shafa Dahandeh,
 24 and Anantha Krishnan
 Western Digital Corporation, San Jose, CA 94062, USA
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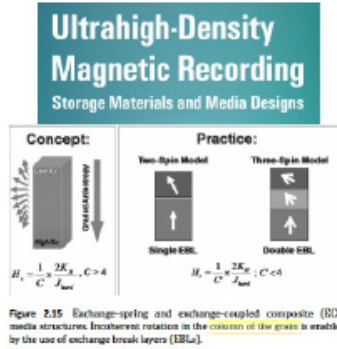


Figure 2.15 Exchange-spring and exchange-coupled composite (ECC) media structures. Inherent rotation in the corners of the grains is enabled by the use of exchange break layers (EBLs).

53. Based on information and belief, the Accused Products include: “the nucleation host has a magnetic polarization $J_s = \mu_0 M_s$ between 0.3 T and 1.0 T.” For example, the Western Digital WD80EFX (8TB) includes a nucleation host has a magnetic polarization $J_s = \mu_0 M_s$ between 0.3 T and 1.0.

54. Using the equation $J_s = \mu_0 M_s$, and the typical values provided in the article below, $M_s = 320 \text{ emu/cm}^3$ results in 0.402 T, while M_s of 450 emu/cm^3 results in 0.565 T. Both of these results are between 0.3 T and 1.0 T.

Effect of Oxygen Incorporation on Microstructure and Media Performance in CoCrPt–SiO₂ Perpendicular Recording Media

H. S. Jung¹, U. Kwon², M. Kuo¹, E. M. T. Velu¹, S. S. Malhotra¹, W. Jiang¹, and G. Bertero¹

¹Komag, Inc., San Jose, CA 95131 USA

²Materials Science and Engineering Department, Stanford University, Stanford, CA 94305 USA

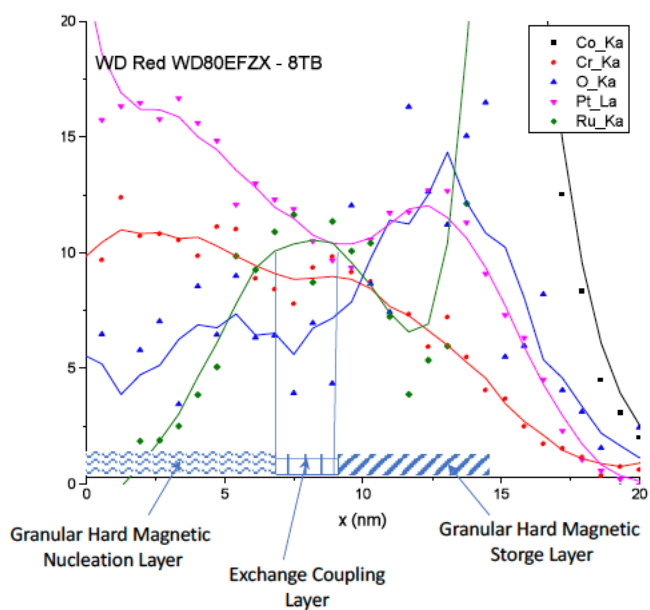
increases for $t_{MAG} \sim 0$ improve which OC = 10%. Even higher OC is necessary to achieve grain isolation in thinner layers.

Values of M_s , obtained from a slope of saturation magnetization per-unit area (m_s) versus t_{MAG} , increase from 320 emu/cm^3 at OC = 3% to 450 emu/cm^3 at OC = 10% as shown in Fig. 3. The increase in M_s with increasing OC is not consistent with the reported result [11]. In CoCrPtSiO films with OC < 15%, values of M_s were constant. Under the assumption of constant M_s in core grains, the decrease in M_s

Jung, H.S., et al., “Effect of Oxygen Incorporation on Microstructure and Media Performance in CoCrPt-SiO₂ Perpendicular Recording Media, IEEE Transactions on Magnetism, Vol. 43, No. 2, February 2007.

1 55. Based on information and belief, the Accused Products include: “the
 2 nucleation host and the hard magnetic storage layer are separated by a coupling layer
 3 between 0.1 nm and 3 nm thickness.” The Accused Products, including the Western
 4 Digital WD80EFX (8TB), have a nucleation host and a hard magnetic storage layer
 5 that are separated by a coupling layer between 0.1 nm and 3 nm thickness.

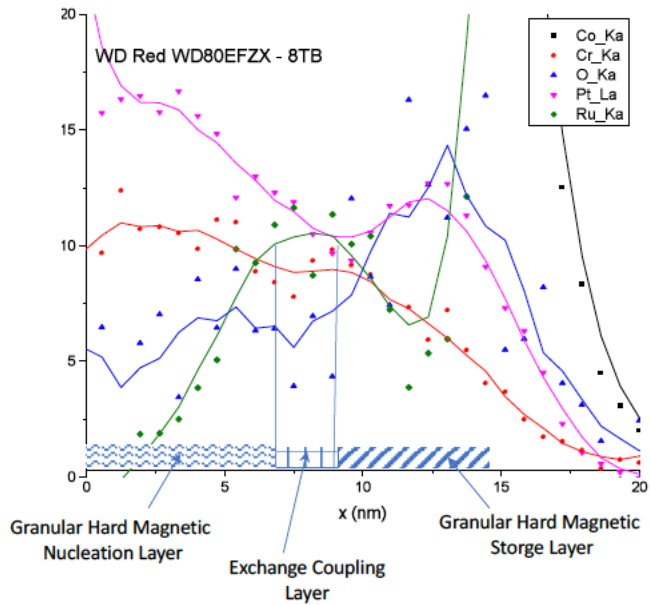
6 56. An energy dispersive x-ray (EDX) chemical analysis of layers of the
 7 Western Digital WD80EFX (8TB) shows that the nucleation host and hard magnetic
 8 storage layer are separated by a coupling layer between 0.1 nm and 3 nm:



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 19 Thus, the Accused Products, including the Western Digital WD80EFX (8TB), have
 20 a nucleation layer and a hard magnetic layer separated by a coupling layer of
 21 between 0.1 nm and 3 nm thickness.

22 57. Based on information and belief, the Accused Products include: “the
 23 coupling layer is directly between the nucleation host and the storage layer.” The
 24 Accused Products, such as the Western Digital WD80EFX (8TB), have a coupling
 25 layer that is directly between the nucleation host and the storage layer, as shown by
 26 the energy dispersive x-ray (EDX) chemical analysis of layers of the Western Digital
 27 WD80EFX (8TB).
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Thus, the Western Digital WD80EFX (8TB) has a coupling layer that is directly between the nucleation host and the storage layer.

58. Based on information and belief, the Accused Products, including the Western Digital WD80EFX (8TB), include: “the coupling between the nucleation host and the hard magnetic storage layer is ferromagnetic.”

59. By making, using, offering for sale, selling and/or importing into the United States the Accused Products, Defendant has injured Plaintiff and is liable for infringement of the '031 Patent pursuant to 35 U.S.C. § 271.

60. As a result of Defendant’s infringement of the '031 Patent, Plaintiff is entitled to monetary damages in an amount adequate to compensate for Defendant’s infringement, but in no event less than a reasonable royalty for the use made of the invention by Defendant, together with interest and costs as fixed by the Court.

COUNT III

INFRINGEMENT OF U.S. PATENT NO. 9,928,864

61. Plaintiff realleges and incorporates by reference the foregoing paragraphs as if fully set forth herein.

62. MR Technologies is the owner and assignee of United States Patent No. 9,928,864 titled “Multilayer exchange spring recording media.” The '864 patent

1 was duly and legally issued by the United States Patent and Trademark Office on
2 March 27, 2018. MR Technologies is the owner and assignee, possessing all
3 substantial rights, to the '864 Patent. A true and correct copy of the '864 Patent is
4 attached as Exhibit 3.

5 63. Defendant makes, uses, offers for sale, sells, and/or imports into the
6 United States certain products and services that directly infringe, literally and/or
7 under the doctrine of equivalents, one or more claims of the '864 Patent, and
8 continue to do so. By way of illustrative example, these infringing products and
9 services include, without limitation, Defendant's magnetic hard disk drives,
10 including, for example, the Western Digital WD60EZZZ (6TB), and all versions
11 and variations thereof since the issuance of the '864 Patent ("Accused Products").

12 64. Defendant has also infringed, and continue to infringe, claims of the
13 '864 patent by offering to commercially distribute, commercially distributing,
14 making, and/or importing the Accused Products, which are used in practicing the
15 process, or using the systems, of the patent, and constitute a material part of the
16 invention. Defendant knows the components in the Accused Products to be
17 especially made or especially adapted for use in infringement of the patent, not a
18 staple article, and not a commodity of commerce suitable for substantial
19 noninfringing use. Accordingly, Defendant has been, and currently are,
20 contributorily infringing the '864 patent, in violation of 35 U.S.C. § 271(c).

21 65. The Accused Products satisfy all claim limitations of one or more
22 claims of the '864 Patent. One, non-limiting, example of the Accused
23 Instrumentalities' infringement is presented below. For example, based on
24 information and belief, the Accused Products include: "[a] magnetic recording
25 medium." For example, the Western Digital WD60EZZZ (6TB) has a magnetic
26 recording medium. [https://www.westerndigital.com/products/internal-drives/wd-
27 blue-desktop-sata-hdd#WD60EZZZ](https://www.westerndigital.com/products/internal-drives/wd-blue-desktop-sata-hdd#WD60EZZZ)

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66. Based on information and belief, the Accused Products include: “an essentially non-magnetic substrate.” For example, the Accused Products, including the Western Digital WD60EZZ (6TB), have a non-magnetic substrate, as demonstrated by a paper written by engineers at Western Digital, which describes a disk in an HDD product having a non-magnetic substrate, such as glass.

**Ultrahigh-Density
Magnetic Recording**
Storage Materials and Media Designs

Chapter 2

Hard Disk Drives: Fundamentals and Perspectives

Gerardo Bertero, Guoxiao Guo, Shafa Dahandeh,
and Anantha Krishnan
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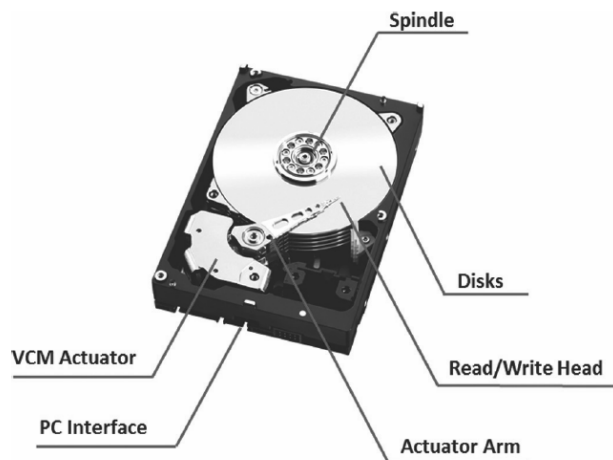


Figure 2.23 Typical hard disk drive.

2.4.1 HDD Servo Basic Components

As shown in Fig. 2.23 an HDD contains magnetic disks rotating about a spindle motor at a fixed rotating speed ranging from 4,200 to 15,000 rotations per minute (RPM). The disks are of aluminum or glass substrates coated with magnetic materials where the user data

67. Based on information and belief, the Accused Products further include: “an underlayer formed on the non-magnetic substrate.” For example, based on information and belief, the Western Digital WD60EZZ (6TB) has an underlayer formed on the non-magnetic substrate, as demonstrated by a paper that describes the underlayer (e.g., ruthenium (“Ru”) underlayer/seed layer) between the non-magnetic substrate and the magnetic multilayer structure.

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Chapter 3

Conventional Perpendicular Magnetic Recording Media

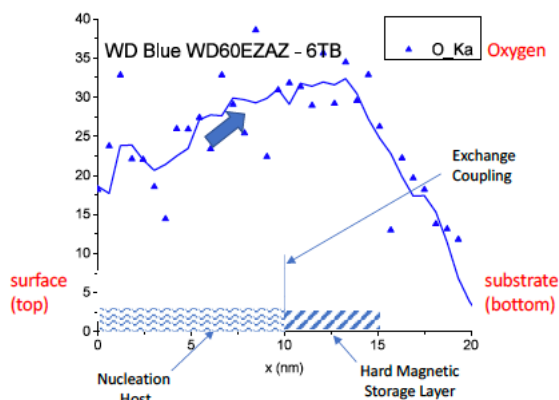
Hong-Sik Jung

Seagate Technology PLC, RMO, 47010 Kato Road, Fremont, CA 94538, USA
hong-sik.jung@seagate.com

136 | Conventional Perpendicular Magnetic Recording Media

key parameters to control both physical and chemical isolations among magnetic grains. Addition of SiO₂ to the CoPtCr alloy also provides a similar well-isolated fine-grain microstructure without disturbing the heteroepitaxial growth of CoPtCr grains on top of the Ru underlayer [21]. This significant improvement of H_n is achieved by improvement of c-axis orientation and a well-isolated

68. Based on information and belief, the Accused Products further include: “an exchange coupled magnetic multilayer structure.” For example, the Western Digital WD60EZZZ (6TB) has an exchange coupled magnetic multilayer structure. Energy dispersive x-ray (EDX) chemical analysis of layers of the WD60EZZZ (6TB) shows a nucleation layer in the 0-10nm region and a hard storage layer in the 10-15nm region, exchange coupled, as shown below.



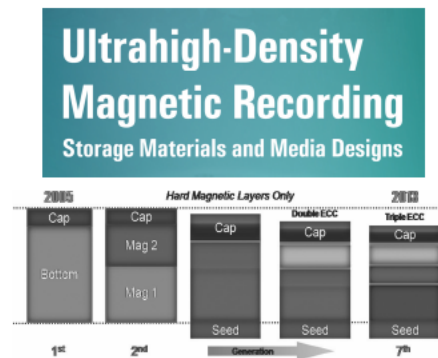
69. Further, it is known that ferromagnetic magnetic layers such as CoCrPt

1 (cobalt/chromium/platinum) are exchange coupled, as demonstrated by a paper
 2 written by engineers at Western Digital.

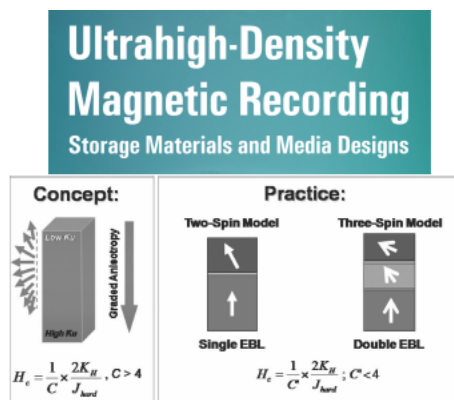
3 **Ultrahigh-Density**
 4 **Magnetic Recording**
 5 Chapter 2 Storage Materials and Media Designs

6 **Hard Disk Drives: Fundamentals and**
 7 **Perspectives**

8 Gerardo Bertero, Guoxiao Guo, Shafa Dahandeh,
 9 and Anantha Krishnan
 10 Western Digital Corporation, San Jose, CA 94062, USA
 gerardo.bertero@wdc.com



14 **Figure 2.16** Progression of PMR recording layer structure design as a function of drive generation. The ECC media design allows for a reduction
 15 in the total media thickness because it enables the use of high anisotropy
 16 layers without compromising switching performance.



20 **Figure 2.15** Exchange-spring and exchange-coupled composite (ECC)
 21 media structures. Incoherent rotation in the column of the grain is enabled
 22 by the use of exchange break layers (EBLs).

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 24
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 28 70. Based on information and belief, the Accused Products further include:

1 “an exchange coupled magnetic multilayer structure, including a hard magnetic
 2 storage layer, having a first coercive field $H_s > 0.5$ T, formed on the underlayer.” For
 3 example, the Western Digital WD60EZZ (6TB) has a hard magnetic storage layer,
 4 having a first coercive field $H_s > 0.5$ T, formed on the underlayer. Using the values
 5 from the IEEE Transactions of Magnetics (July 2009), at p. 2694 (reproduced
 6 below), $M_s \sim 380$ emu/cm³ = 0.47T and $K_{\text{eff}} \sim 3.1 \times 10^6$ erg/cm³ = 0.31e6 J/m³. Using
 7 the formula from the ‘864 patent (at col. 6, line 54), $H_c = 2 * K_{\text{eff}} / M_s = 1.6$ T (where
 8 H_c also is referred to as H_s), which is greater than 0.5 T.

9 **Control of Exchange Coupling Between Granular Oxide and Highly**
 10 **Exchange Coupled Cap Layers and the Effect on Perpendicular**
 11 **Magnetic Switching and Recording Characteristics**

Gunn Choe¹, Yoshihiro Ikeda², Kezhao Zhang¹, Kai Tang¹, and Mohammad Mirzamaani¹

¹Hitachi Global Storage Technologies, Media Development, San Jose, CA 95193 USA

²Hitachi Global Storage Technologies, San Jose Research Center, San Jose, CA 95135 USA

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 13 recording layer in this study comprises a CoPtCrB continuous
 14 layer exchange coupled to a granular oxide CoPtCrSiO layer
 15 through ECL. The K_{ul} values of granular oxide grain and cap
 16 layer are $\sim 3.1 \times 10^6$ erg/cm³ and $\sim 2.2 \times 10^6$ erg/cm³, respec-
 17 tively. The average M_s value of oxide layer is 380 emu/cm³
 with average packing fraction ~ 0.73 (grain diameter ~ 8.4 nm,
 grain boundary width ~ 1 nm). Fig. 1 shows the cross-sectional
 transmission electron microscope (TEM) view of media struc-

18 71. Based on information and belief, the Accused Products further include:
 19 “an exchange coupled magnetic multilayer structure, including ... a nucleation host,
 20 having a second coercive field H_n without the hard magnetic storage layer, lower
 21 than the first coercive field, $H_n < H_s$.” For example, the Western Digital WD60EZZ
 22 (6TB) has a nucleation host having a second coercive field H_n without the hard
 23 magnetic storage layer, lower than the first coercive field, $H_n < H_s$. Energy dispersive
 24 x-ray (EDX) chemical analysis of layers of the WD60EZZ (6TB) determined the
 25 variation of the elemental concentration with depth. On information and belief, the
 26 variation of the coercive field with the elemental concentrations is well known.
 27 Combining these data established that the coercive field in the nucleation host H_n is
 28 less than the coercive field of the hard magnetic storage layer (H_s).

72. For example, the Jung paper reproduced below establishes that increasing the O leads to an increase in the anisotropy and thus the coercive field H_c .

IEEE TRANSACTIONS ON MAGNETICS, VOL. 43, NO. 2, FEBRUARY 2007

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Effect of Oxygen Incorporation on Microstructure and Media Performance in CoCrPt–SiO₂ Perpendicular Recording Media

H. S. Jung¹, U. Kwon², M. Kuo¹, E. M. T. Velu¹, S. S. Malhotra¹, W. Jiang¹, and G. Bertero¹

¹Komag, Inc., San Jose, CA 95131 USA

²Materials Science and Engineering Department, Stanford University, Stanford, CA 94305 USA

The effect of oxygen incorporation on microstructure and media performance in CoCrPt–SiO₂ films with various oxygen contents (OC) from 3 to 10 at% at different CoCrPt–SiO₂ film thicknesses (t_{MAG}) from 2 to 27 nm is investigated. Nonuniform microstructure with less grain isolation close to Ru and more grain isolation at the top region is clearly seen. Higher density of stacking faults is found at the top region. A higher OC is needed to reduce the thickness of the initial layer with less grain isolation. The increase in coercivity and saturation magnetization with increasing OC is due to the formation of lower Cr and higher Pt-containing core grains caused by the preferred oxidation of Cr. These excess Pt atoms mostly align along the c-axis direction. The magnetocrystalline anisotropy constant enhanced by the excess Pt improves thermal stability factor but it is sensitive to temperature. Crystallographic c-axis orientation and magnetic anisotropy dispersion deteriorate with increasing OC but are independent of t_{MAG} .

Jung, H.S., et. al., “Effect of Oxygen Incorporation on Microstructure and Media Performance in CoCrPt-SiO₂ Perpendicular Recording Media, IEEE Transactions on Magnetism, Vol. 43, No. 2, February 2007.

73. In addition, increasing the Oxygen (“O”) concentration indicates an increase in coercivity.

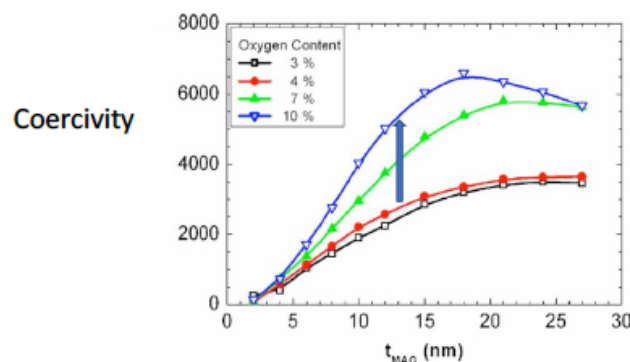


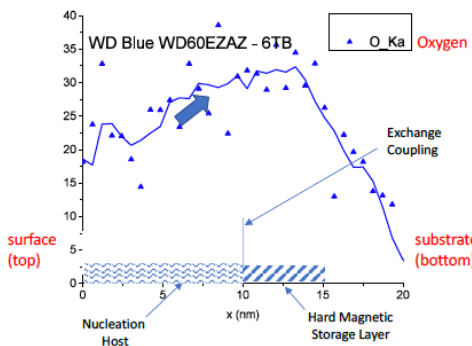
Fig. 1. Effect of CoCrPt–SiO₂ layer thickness (t_{MAG}) on coercivity (H_c) at various oxygen contents.

Jung, H.S., et. al., “Effect of Oxygen Incorporation on Microstructure and Media Performance in CoCrPt-SiO₂ Perpendicular Recording Media, IEEE Transactions

1 on Magnetism, Vol. 43, No. 2, February 2007.

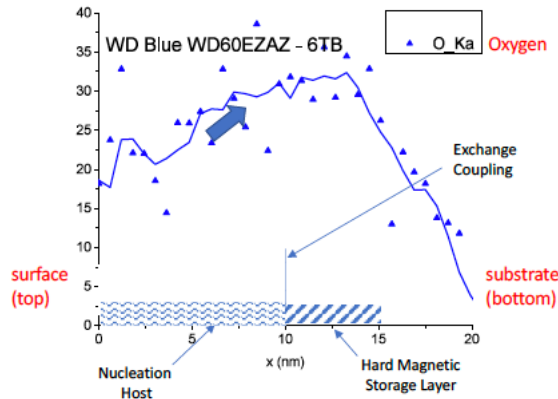
2 74. Further, the EDX chemical analysis of layers of the WD60EZZ (6TB)
 3 shows that the average O concentration is increasing from a lower level in the
 4 nucleation host (approx. 0-10nm) to a higher level in the hard storage layer (approx.
 5 10-15nm). This establishes that H_n , the coercive field of the nucleation host, is lower
 6 than H_s , the coercive field of the hard storage layer: $H_n < H_s$.

7 75. Based on information and belief, the Accused Products further include:
 8 “said nucleation host is formed on the hard magnetic storage layer such that the hard
 9 magnetic storage layer is between the nucleation host and the non-magnetic
 10 substrate.” For example, the Western Digital WD60EZZ (6TB) has a nucleation
 11 host that is formed on the hard magnetic storage layer such that the hard magnetic
 12 storage layer is between the nucleation host and the non-magnetic substrate. Energy
 13 dispersive x-ray (EDX) chemical analysis of layers of the Western Digital
 14 WD60EZZ (6TB) shows that the nucleation host is located at approximately 0-10
 15 nm, while the hard magnetic storage layer is located at approximately 10-15 nm.
 16 These layers are formed on a non-magnetic substrate. Thus, the hard magnetic
 17 storage layer is located between the nucleation host and the non-magnetic substrate.



24 76. Based on information and belief, the Accused Products further include:
 25 “said nucleation host ... is exchange coupled to the hard magnetic storage layer.”
 26 For example, the Western Digital WD60EZZ (6TB) has a nucleation host that is
 27 exchange coupled to the hard magnetic storage layer. There is an exchange coupling
 28 between the nucleation host and the storage layer.

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77. In addition, the nucleation host is exchanged coupled to the hard magnetic layer, as demonstrated by a paper written by engineers at Western Digital.

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Hard Disk Drives: Fundamentals and Perspectives

Gerardo Bertero, Guoxiao Guo, Shafa Dahandeh,
and Anantha Krishnan
Western Digital Corporation, San Jose, CA 94062, USA
gerardo.bertero@wdc.com

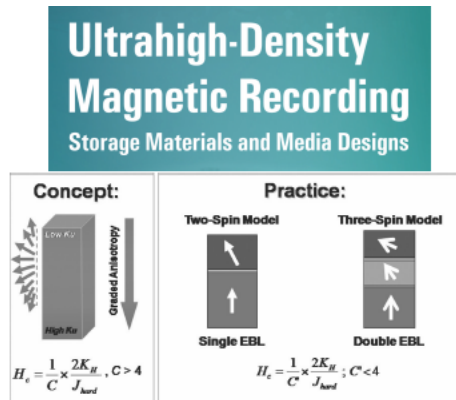
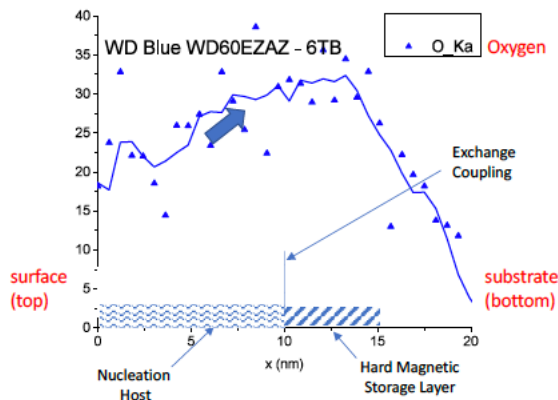


Figure 2.15 Exchange-spring and exchange-coupled composite (ECC) media structures. Incoherent rotation in the column of the grain is enabled by the use of exchange break layers (EBLs).

78. Based on information and belief, the Accused Products further include: “said nucleation host ... comprises ferromagnetic layers with increasing anisotropy

1 constant K from layer to layer.” For example, the Western Digital WD60EZZZ
 2 (6TB) has a nucleation host that comprises ferromagnetic layers with increasing
 3 anisotropy constant K from layer to layer. Energy dispersive x-ray (EDX) chemical
 4 analysis of layers of the Western Digital WD60EZZZ (6TB) shows the O
 5 concentration increasing from layer to layer within the nucleation host, (approx. 0-
 6 10 nm).



79. As also described above by the Jung paper, increasing oxygen (“O”) concentration demonstrates an increase in the anisotropy constant with increasing x depth. Thus, the nucleation host comprises several “ferromagnetic layers with increasing anisotropy constant K from layer to layer”.

80. In addition, as shown below, Western Digital itself described its own media as having “graded anisotropy” and shows a nucleation host comprising layers with increasing anisotropy. As shown in the EDX analysis above, the anisotropy constant K is increasing with each atomic layer in the nucleation host.

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Ultrahigh-Density Magnetic Recording

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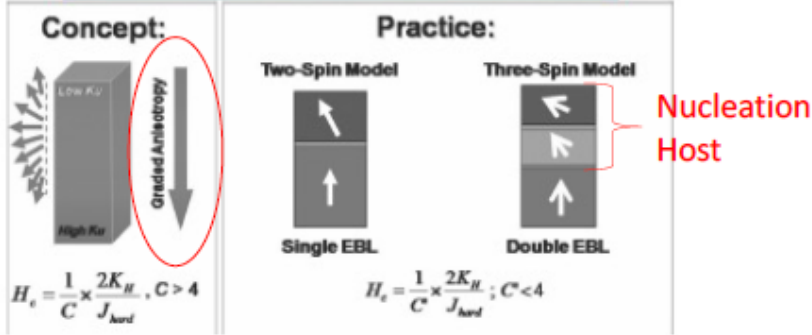


Figure 2.15 Exchange-spring and exchange-coupled composite (ECC) media structures. Incoherent rotation in the column of the grain is enabled by the use of exchange break layers (EBLs).

81. By making, using, offering for sale, selling and/or importing into the United States the Accused Products, Defendant has injured Plaintiff and is liable for infringement of the '864 Patent pursuant to 35 U.S.C. § 271.

82. As a result of Defendant's infringement of the '864 Patent, Plaintiff is entitled to monetary damages in an amount adequate to compensate for Defendant's infringement, but in no event less than a reasonable royalty for the use made of the invention by Defendant, together with interest and costs as fixed by the Court.

COUNT IV

INFRINGEMENT OF U.S. PATENT NO. 11,138,997

83. Plaintiff realleges and incorporates by reference the foregoing paragraphs as if fully set forth herein.

84. MR Technologies is the owner and assignee of United States Patent No. 11,138,997 titled "Multilayer exchange spring recording media." The '997 patent was duly and legally issued by the United States Patent and Trademark Office on October 5, 2021. MR Technologies is the owner and assignee, possessing all substantial rights, to the '997 Patent. A true and correct copy of the '997 Patent is

1 attached as Exhibit 4.

2 85. Defendant makes, uses, offers for sale, sells, and/or imports into the
3 United States certain products and services that directly infringe, literally and/or
4 under the doctrine of equivalents, one or more claims of the '997 Patent, and
5 continue to do so. By way of illustrative example, these infringing products and
6 services include, without limitation, Defendant's magnetic hard disk drives,
7 including, for example, the Western Digital WD60EZZZ (6TB), and all versions
8 and variations thereof since the issuance of the '997 Patent ("Accused Products").

9 86. Defendant has also infringed, and continue to infringe, claims of the
10 '997 patent by offering to commercially distribute, commercially distributing,
11 making, and/or importing the Accused Products, which are used in practicing the
12 process, or using the systems, of the patent, and constitute a material part of the
13 invention. Defendant knows the components in the Accused Products to be
14 especially made or especially adapted for use in infringement of the patent, not a
15 staple article, and not a commodity of commerce suitable for substantial
16 noninfringing use. Accordingly, Defendant has been, and currently are,
17 contributorily infringing the '997 patent, in violation of 35 U.S.C. § 271(c).

18 87. The Accused Products satisfy all claim limitations of one or more
19 claims of the '997 Patent. One, non-limiting, example of the Accused
20 Instrumentalities' infringement is presented below. For example, based on
21 information and belief, the Accused Products include: "[a] magnetic recording
22 system." For example, the Western Digital WD60EZZZ (6TB) has a magnetic
23 recording system. [https://www.westerndigital.com/products/internal-drives/wd-
24 blue-desktop-sata-hdd#WD60EZZZ](https://www.westerndigital.com/products/internal-drives/wd-blue-desktop-sata-hdd#WD60EZZZ)

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88. Based on information and belief, the Accused Products include: “a disk, including a magnetic recording medium.” For example, the Western Digital WD60EZZ (6TB) includes a disk, including a magnetic recording medium. <https://www.westerndigital.com/products/internal-drives/wd-blue-desktop-sata-hdd#WD60EZZ>

89. Based on information and belief, the Accused Products include: “a writing head.” For example, the Western Digital WD60EZZ (6TB) includes a writing head. <https://www.westerndigital.com/products/internal-drives/wd-blue-desktop-sata-hdd#WD60EZZ>

90. Based on information and belief, the Accused Products include” “an essentially non-magnetic substrate.” For example, the Accused Products, including the Western Digital WD60EZZ (6TB), have a non-magnetic substrate, as demonstrated by a paper written by engineers at Western Digital, which describes a

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disk in an HDD product having a non-magnetic substrate, such as glass.

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86 | Hard Disk Drives

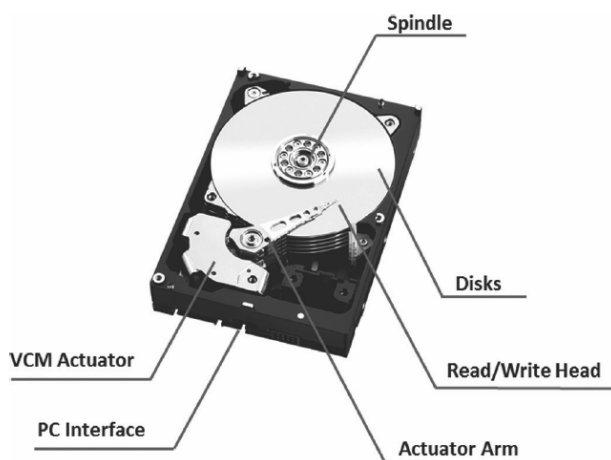


Figure 2.23 Typical hard disk drive.

2.4.1 HDD Servo Basic Components

As shown in Fig. 2.23 an HDD contains magnetic disks rotating about a spindle motor at a fixed rotating speed ranging from 4,200 to 15,000 rotations per minute (RPM). The disks are of aluminum or glass **substrates** coated with magnetic materials where the user data

91. Based on information and belief, the Accused Products further include: “an underlayer formed on the non-magnetic substrate.” For example, based on information and belief, the Western Digital WD60EZZ (6TB) has an underlayer formed on the non-magnetic substrate, as demonstrated by a paper that describes the underlayer (e.g. ruthenium (“Ru”) underlayer/seed layer) between the non-magnetic

substrate and the magnetic multilayer structure.

Chapter 3

Conventional Perpendicular Magnetic Recording Media

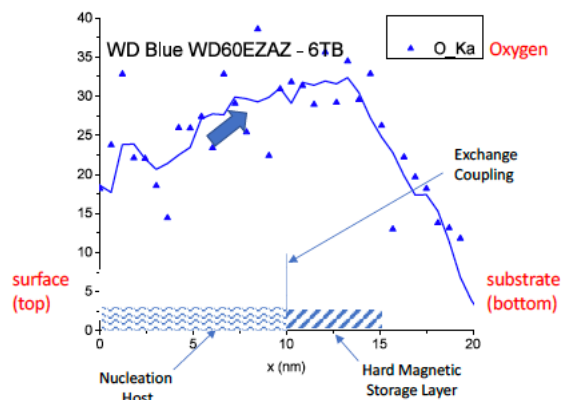
Hong-Sik Jung

Seagate Technology PLC, RMO, 47010 Kato Road, Fremont, CA 94538, USA
 hong-sik.jung@seagate.com

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key parameters to control both physical and chemical isolations among magnetic grains. Addition of SiO₂ to the CoPtCr alloy also provides a similar well-isolated fine-grain microstructure without disturbing the heteroepitaxial growth of CoPtCr grains on top of the Ru underlayer [21]. This significant improvement of H_n is achieved by improvement of c-axis orientation and a well-isolated

92. Based on information and belief, the Accused Products further include: “an exchange coupled magnetic multilayer structure.” For example, the Western Digital WD60EZZZ (6TB) has an exchange coupled magnetic multilayer structure. Energy dispersive x-ray (EDX) chemical analysis of layers of the WD60EZZZ (6TB) shows a nucleation layer in the 0-10nm region and a hard storage layer in the 10-15nm region, exchange coupled, as shown below.



1 93. Further, it is known that ferromagnetic magnetic layers such as CoCrPt
 2 (cobalt/chromium/platinum) are exchange coupled, as demonstrated by a paper
 3 written by engineers at Western Digital.

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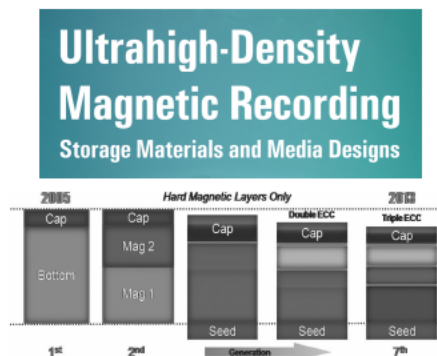


Figure 2.16 Progression of PMR recording layer structure design as a function of drive generation. The ECC media design allows for a reduction in the total media thickness because it enables the use of high anisotropy layers without compromising switching performance.

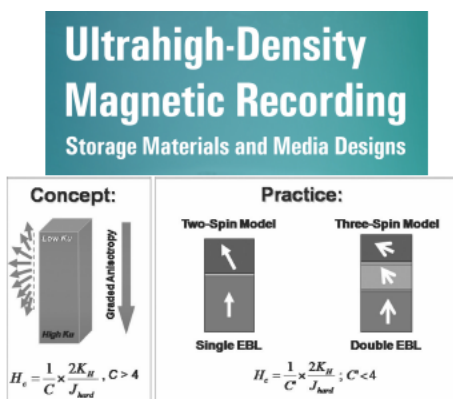


Figure 2.15 Exchange-spring and exchange-coupled composite (ECC) media structures. Incoherent rotation in the column of the grain is enabled by the use of exchange break layers (EBLs).

1 less than the coercive field of the hard magnetic storage layer (H_s).

2 96. For example, the Jung paper reproduced below establishes that
3 increasing the O leads to an increase in the anisotropy and thus the coercive field H_c .

4 Effect of Oxygen Incorporation on Microstructure and 5 Media Performance in CoCrPt–SiO₂ Perpendicular 6 Recording Media 7 8

9 H. S. Jung¹, U. Kwon², M. Kuo¹, E. M. T. Velu¹, S. S. Malhotra¹, W. Jiang¹, and G. Bertero¹

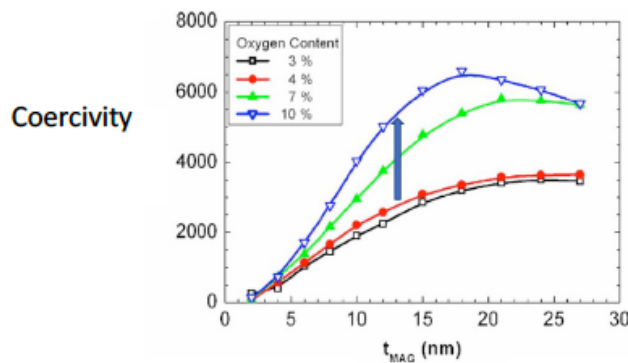
¹Komag, Inc., San Jose, CA 95131 USA

²Materials Science and Engineering Department, Stanford University, Stanford, CA 94305 USA

11 The effect of oxygen incorporation on microstructure and media performance in CoCrPt–SiO₂ films with various oxygen contents (OC) from 3 to 10 at% at different CoCrPt–SiO₂ film thicknesses (t_{MAG}) from 2 to 27 nm is investigated. Nonuniform microstructure with less grain isolation close to Ru and more grain isolation at the top region is clearly seen. Higher density of stacking faults is found at the top region. A higher OC is needed to reduce the thickness of the initial layer with less grain isolation. The increase in coercivity and saturation magnetization with increasing OC is due to the formation of lower Cr and higher Pt-containing core grains caused by the preferred oxidation of Cr. These excess Pt atoms mostly align along the c-axis direction. The magnetocrystalline anisotropy constant enhanced by the excess Pt improves thermal stability factor but it is sensitive to temperature. Crystallographic c-axis orientation and magnetic anisotropy dispersion deteriorate with increasing OC but are independent of t_{MAG} .

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15 *Jung, H.S., et. al.*, “Effect of Oxygen Incorporation on Microstructure and Media
16 Performance in CoCrPt–SiO₂ Perpendicular Recording Media, IEEE Transactions
17 on Magnetism, Vol. 43, No. 2, February 2007.

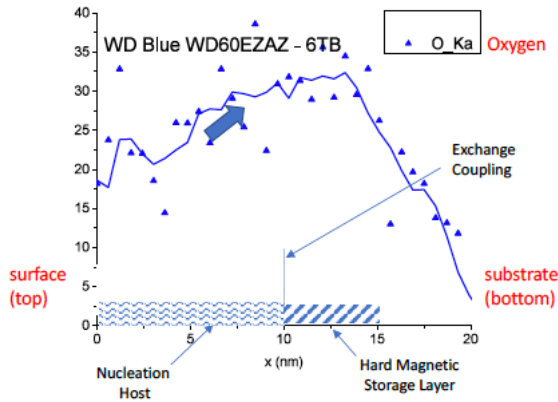
18 97. In addition, increasing the Oxygen (“O”) concentration indicates an
19 increase in coercivity.



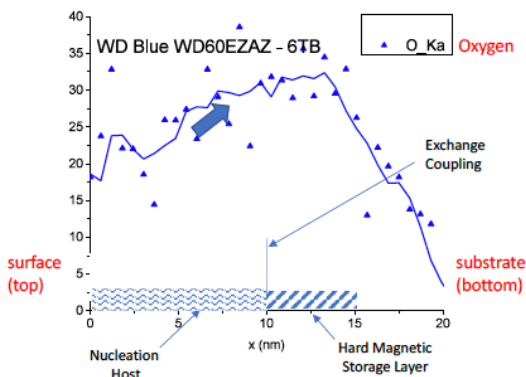
26 Fig. 1. Effect of CoCrPt–SiO₂ layer thickness (t_{MAG}) on coercivity (H_c) at
27 various oxygen contents.

28 98. Further, the EDX chemical analysis of layers of the WD60EZA (6TB)

1 shows that the average O concentration is increasing from a lower level in the
 2 nucleation host (approx. 0-10nm) to a higher level in the hard storage layer (approx.
 3 10-15nm). This establishes that H_n , the coercive field of the nucleation host, is lower
 4 than H_s , the coercive field of the hard storage layer: $H_n < H_s$.

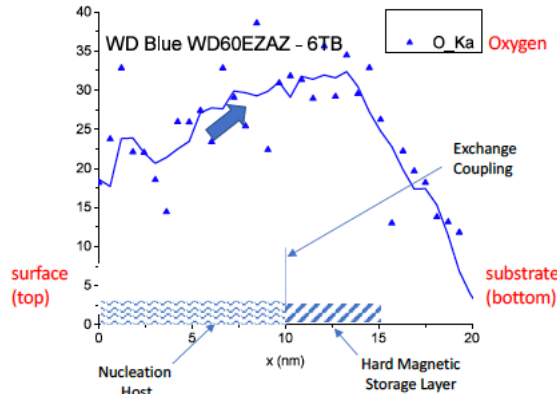


99. Based on information and belief, the Accused Products further include:
 “said nucleation host is formed on the hard magnetic storage layer such that the hard
 magnetic storage layer is between the nucleation host and the non-magnetic
 substrate.” For example, the Western Digital WD60EZAZ (6TB) has a nucleation
 host that 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. Energy
 dispersive x-ray (EDX) chemical analysis of layers of the Western Digital
 WD60EZAZ (6TB) shows that the nucleation host is located at approximately 0-10
 nm, while the hard magnetic storage layer is located at approximately 10-15 nm.
 These layers are formed on a non-magnetic substrate. Thus, the hard magnetic
 storage layer is located between the nucleation host and the non-magnetic substrate.



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100. Based on information and belief, the Accused Products further include: “said nucleation host ... is exchange coupled to the hard magnetic storage layer.” For example, the Western Digital WD60EZZA (6TB) has a nucleation host that is exchange coupled to the hard magnetic storage layer. There is an exchange coupling between the nucleation host and the storage layer.



101. In addition, the nucleation host is exchange coupled to the hard magnetic layer, as demonstrated by a paper written by engineers at Western Digital.

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Ultrahigh-Density Magnetic Recording

Storage Materials and Media Designs

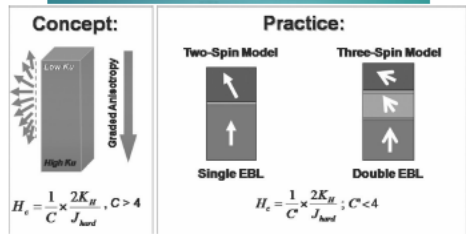
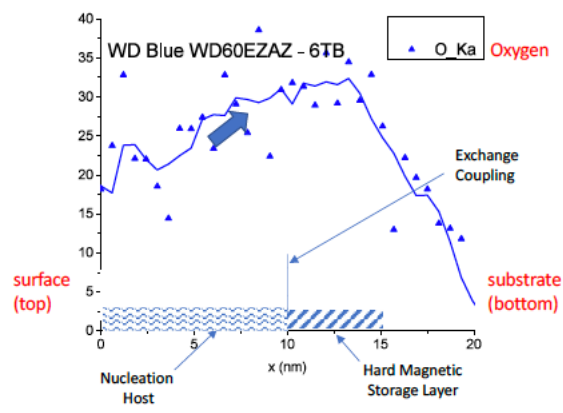


Figure 2.15 Exchange-spring and exchange-coupled composite (ECC) media structures. Incoherent rotation in the column of the grain is enabled by the use of exchange break layers (EBLs).

102. Based on information and belief, the Accused Products further include: “said nucleation host ... comprises ferromagnetic layers with increasing anisotropy constant K from layer to layer.” For example, the Western Digital WD60EZZZ (6TB) has a nucleation host that comprises ferromagnetic layers with increasing anisotropy constant K from layer to layer. Energy dispersive x-ray (EDX) chemical analysis of layers of the Western Digital WD60EZZZ (6TB) shows the O concentration increasing from layer to layer within the nucleation host, (approx. 0-10 nm).



103. As also described above by the Jung paper, increasing oxygen (“O”) concentration demonstrates an increase in the anisotropy constant with increasing x depth. Thus, the nucleation host comprises several “ferromagnetic layers with increasing anisotropy constant K from layer to layer”.

104. In addition, as shown below, Western Digital itself described its own

1 media as having “graded anisotropy” and shows a nucleation host comprising layers
 2 with increasing anisotropy. As shown in the EDX analysis above, the anisotropy
 3 constant K is increasing with each atomic layer in the nucleation host.

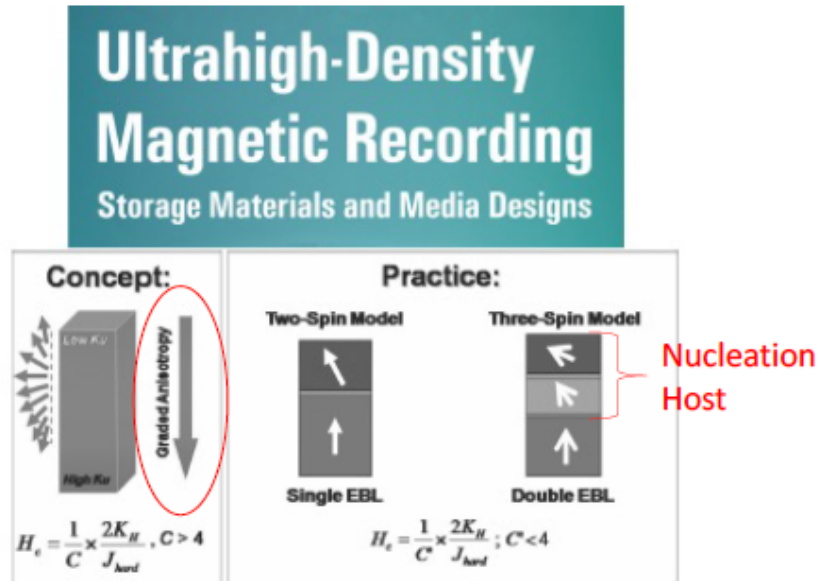


Figure 2.15 Exchange-spring and exchange-coupled composite (ECC) media structures. Incoherent rotation in the column of the grain is enabled by the use of exchange break layers (EBLs).

105. By making, using, offering for sale, selling and/or importing into the
 106. United States the Accused Products, Defendant has injured Plaintiff and is liable for
 107. infringement of the '997 Patent pursuant to 35 U.S.C. § 271.

108. As a result of Defendant’s infringement of the '997 Patent, Plaintiff is
 109. entitled to monetary damages in an amount adequate to compensate for Defendant’s
 110. infringement, but in no event less than a reasonable royalty for the use made of the
 111. invention by Defendant, together with interest and costs as fixed by the Court.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff respectfully request that this Court enter:

- a. A judgment in favor of Plaintiff that Defendant has infringed, either literally and/or under the doctrine of equivalents, the '413 Patent, the '031 Patent, the '864 Patent, and the '997 Patent;

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b. A judgment and order requiring Defendant to pay Plaintiff its damages, costs, expenses, and pre-judgment and post-judgment interest for Defendant’s infringement of the ’413 Patent, the ’031 Patent, the ’864 Patent, and the ’997 Patent;

c. A judgment and order requiring Defendant to provide an accounting and to pay supplemental damages to Plaintiff, including without limitation, pre-judgment and post-judgment interest;

d. A judgment and order finding that this is an exceptional case within the meaning of 35 U.S.C. § 285 and awarding to Plaintiff its reasonable attorneys’ fees against Defendant; and

e. Any and all other relief as the Court may deem appropriate and just under the circumstances.

DEMAND FOR JURY TRIAL

Plaintiff, under Rule 38 of the Federal Rules of Civil Procedure, requests a trial by jury of any issues so triable by right.

DATED: August 26, 2022

Respectfully submitted,

/s/Marc A. Fenster

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***Attorneys for Plaintiff
 MR Technologies, GMBH***