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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**

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

INTRODUCTION

1. This complaint arises from Defendant's unlawful infringement of the following United States patents owned by Suess: U.S. Patent No. 9,978,413 ("'413 Patent"); U.S. Patent No. 9,928,864 ("'864 Patent"); U.S. Patent No. 11,133,031 ("'031 Patent"); and U.S. Patent No. 11,138,997 ("'997 Patent") (collectively the "Asserted Patents").

PARTIES

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

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

JURISDICTION AND VENUE

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

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

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

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

COUNT I

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

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

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

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

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

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

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

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

RUSS, AUGUST & KABAT

https://www.westerndigital.com/products/internal-drives/wd-red-pro-sata-hdd#WD8003FFBX

13. Based on information and belief, the Accused Products include: "an essentially non-magnetic substrate." For example, the Accused Products, including the Western Digital WD80EFX (8TB), 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
Western Digital Corporation, San Jose, CA 94062, USA
gerardo.bertero@wdc.com

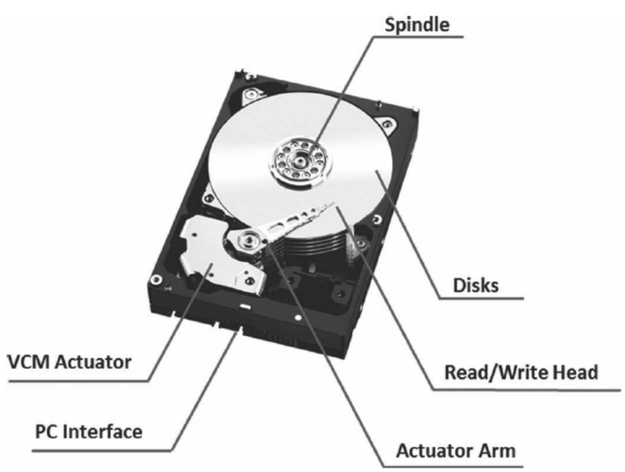

Figure 2.23 Typical hard disk drive.

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

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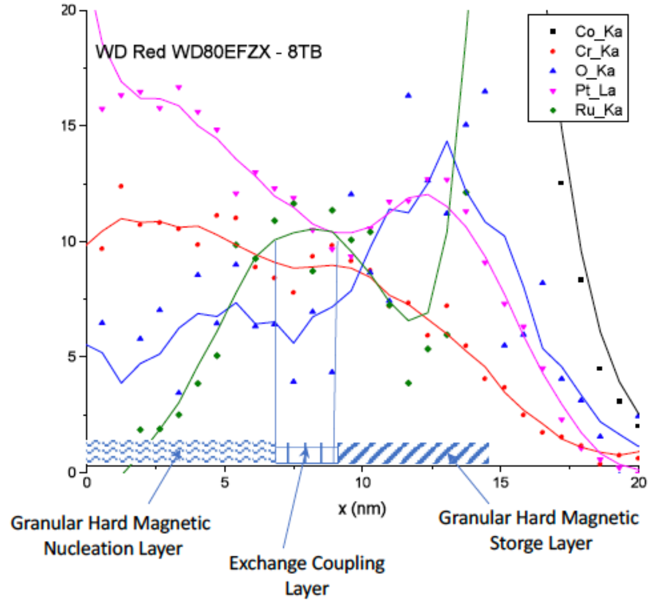
14. Based on information and belief, the Accused Products include: "a magnetic bilayer." For example, energy dispersive x-ray (EDX) chemical analysis of layers of the Western Digital WD80EFX (8TB) shows a magnetic bilayer.



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.

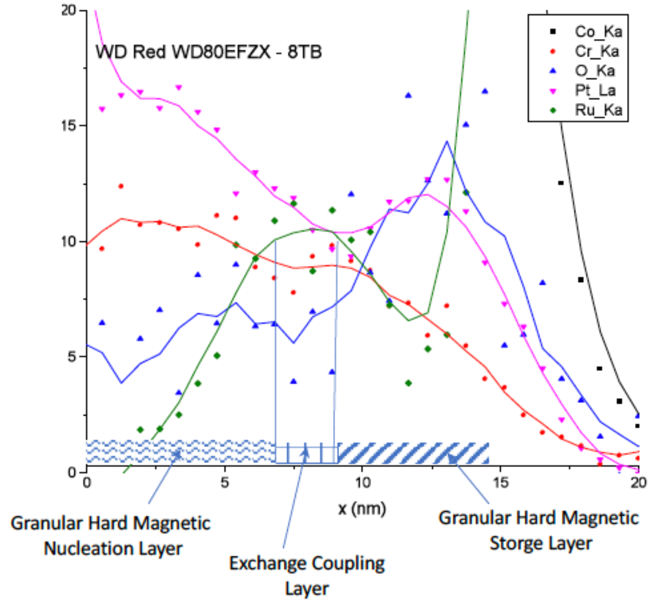
16. The granular oxide layer is a granular hard magnetic storage layer. The

formula from the '413 patent (at col. 6, line 54) provides an equation for the coercive field, $H_c = 2*K_{eff}/M_s$ (where H_c also is referred to as H_s). As shown in IEEE Transactions of Magnetics (July 2009)[1], at p. 2694 (excerpted below), a granular oxide layer has values of $M_s \sim 380$ emu/cm³ = 0.47T and $K_{eff} \sim 3.1x10^6$ erg/cm³ = 0.31e6 J/m³, and therefore has a coercive field $H_c = 2*K_{eff}/M_s = 1.6T$. Thus, the Western Digital WD80EFX (8TB) has a granular hard magnetic storage layer with perpendicular anisotropy having a coercive field of H_s without another magnetic layer.

> **Control of Exchange Coupling Between Granular Oxide and Highly Exchange Coupled Cap Layers and the Effect on Perpendicular Magnetic Switching and Recording Characteristics**
>
> Gunn Choe[1], Yoshihiro Ikeda[2], Kezhao Zhang[1], Kai Tang[1], and Mohammad Mirzamaani[1]
>
> [1]Hitachi Global Storage Technologies, Media Development, San Jose, CA 95193 USA
> [2]Hitachi Global Storage Technologies, San Jose Research Center, San Jose, CA 95135 USA
>
> recording layer in this study comprises a CoPtCrB continuous layer exchange coupled to a granular oxide CoPtCrSiO layer through ECL. The K_u values of granular oxide grain and cap layer are $\sim 3.1 \times 10^6$ erg/cm³ and $\sim 2.2 \times 10^6$ erg/cm³, respectively. 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-

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.



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

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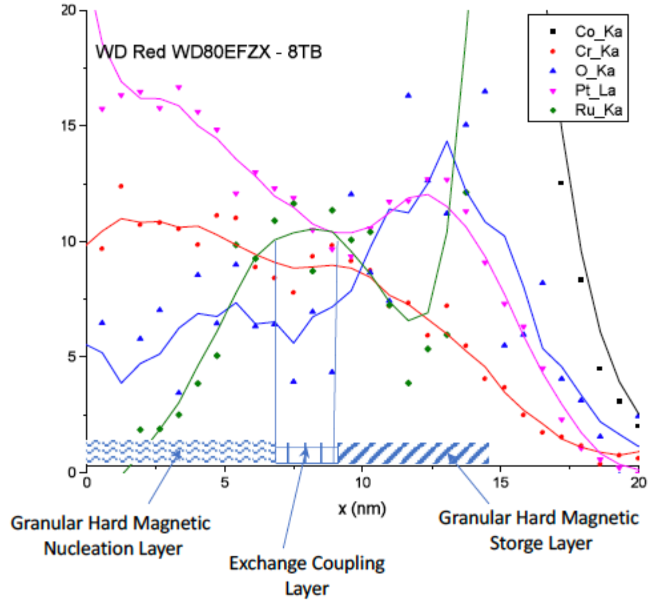
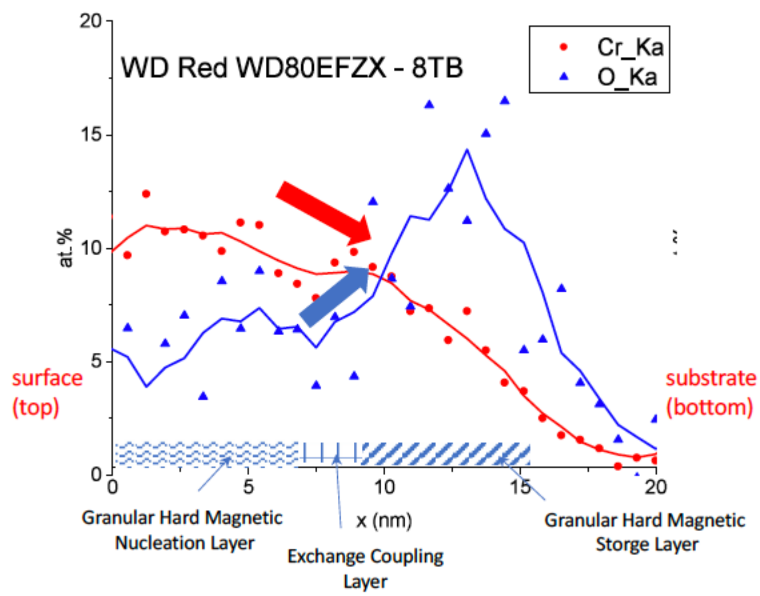
Oxygen Incorporation on Microstructure and Media Performance in CoCrPt-SiO_2 Perpendicular Recording Media, IEEE Transactions on Magnetics, Vol. 43, No. 2, February 2007.





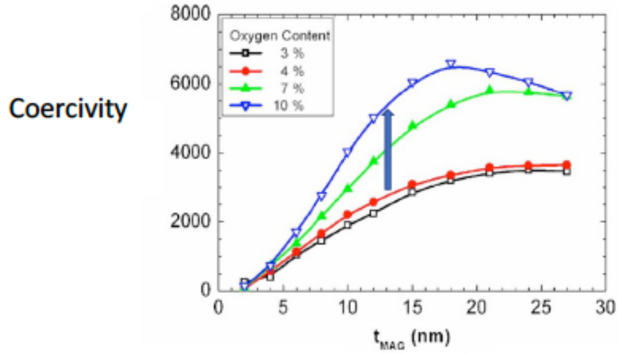


Fig. 1. Effect of CoCrPt–SiO_2 layer thickness (t_{MAG}) on coercivity (H_c) at various oxygen contents.

Jung, H.S., et. al., "Effect of Oxygen Incorporation on Microstructure and Media Performance in CoCrPt-SiO_2 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 ~ 380 emu/cm³ = 0.47T and K_{eff} ~ 3.1x10^6 erg/cm³ = 0.31e6 J/m³. Using the formula from the '413 patent (at col. 6, line 54) that coercive field, H_c = 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 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 Choe[1], Yoshihiro Ikeda[2], Kezhao Zhang[1], Kai Tang[1], and Mohammad Mirzamaani[1]

[1]Hitachi Global Storage Technologies, Media Development, San Jose, CA 95193 USA
[2]Hitachi 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(ox)=8%; the O concentration average for storage layer (9-14nm) in the 8TB disk: C(ox)=13%.

Using a linear fit for the change of coercive field as function of the O concentration 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.

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

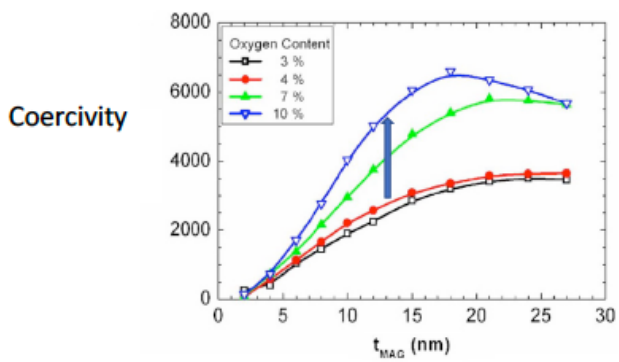
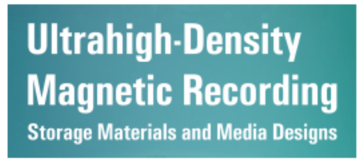


Fig. 1. Effect of CoCrPt–SiO$_2$ layer thickness (t_{MAG}) on coercivity (H_c) at various oxygen contents.

Jung, H.S., et. al., "Effect of Oxygen Incorporation on Microstructure and Media Performance in CoCrPt-SiO$_2$ Perpendicular Recording Media, IEEE Transactions on Magnetics, Vol. 43, No. 2, February 2007.

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

Chapter 2



Hard Disk Drives: Fundamentals and Perspectives

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

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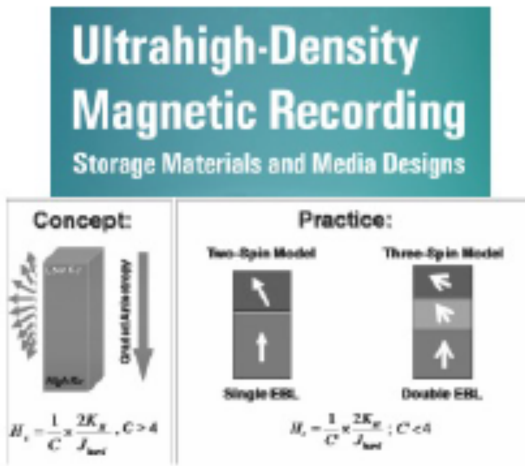


Figure 2.15 Exchange-spring and exchange-coupled composite (ECC) media structures. Incoherent rotation in the column of the grain is enabled by the use of exchange break layers (EBLs).

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 emu/cm³ results in 0.402 T, while M_s of 450 emu/cm³ 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–SiO_2 Perpendicular Recording Media

H. S. Jung[1], U. Kwon[2], M. Kuo[1], E. M. T. Velu[1], S. S. Malhotra[1], W. Jiang[1], and G. Bertero[1]

[1]Komag, Inc., San Jose, CA 95131 USA
[2]Materials Science and Engineering Department, Stanford University, Stanford, CA 94305 USA

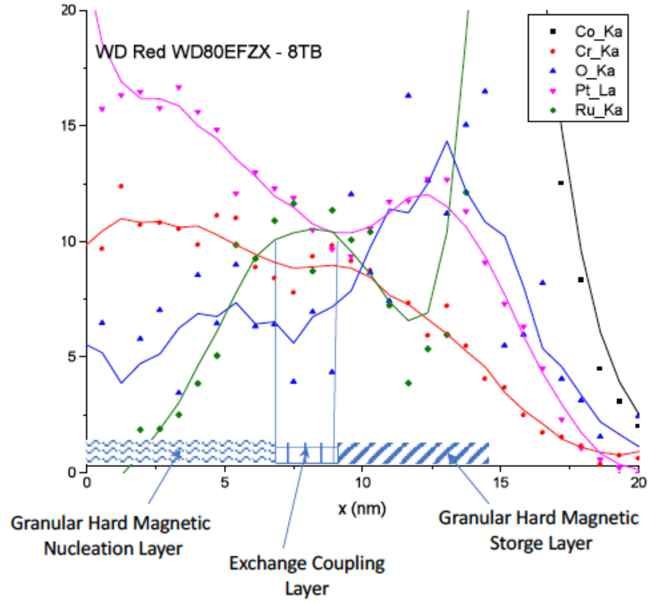
increases for $t_{MAG} <$ [illegible] nm even when OC = 10%. Even higher OC is necessary to achieve grain isolation in thinner layers.

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-SiO_2 Perpendicular Recording Media, IEEE Transactions on Magnetics, Vol. 43, No. 2, February 2007.

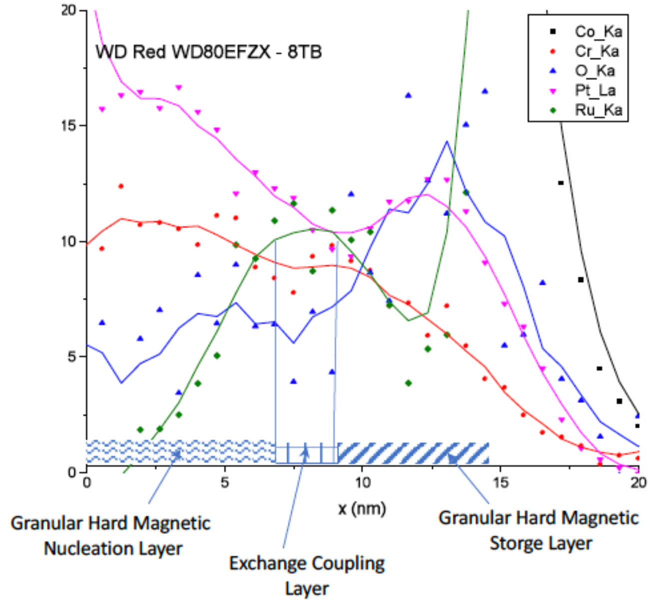
27. Based on information and belief, the Accused Products include: "the nucleation host and the hard magnetic storage layer are separated by a coupling layer between 0.1 nm and 3 nm thickness." The Accused Products, including the Western Digital WD80EFX (8TB), have a nucleation host and a hard magnetic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

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



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).



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

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

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

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

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

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

hdd#WD8003FFBX

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

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

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

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

Ultrahigh-Density Magnetic Recording
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Chapter 2

Hard Disk Drives: Fundamentals and Perspectives

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86 | *Hard Disk Drives*

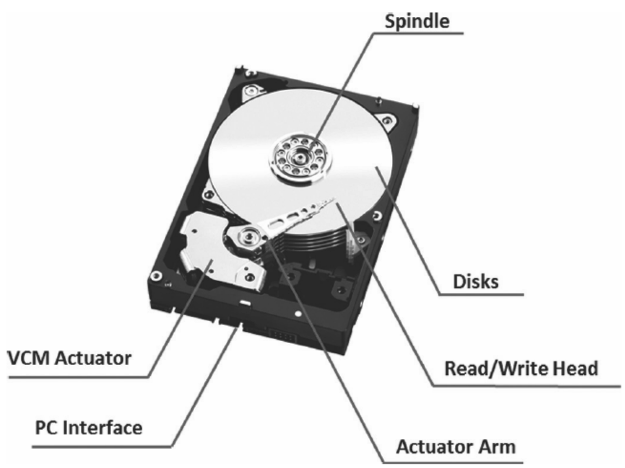

Figure 2.23 Typical hard disk drive.

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

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

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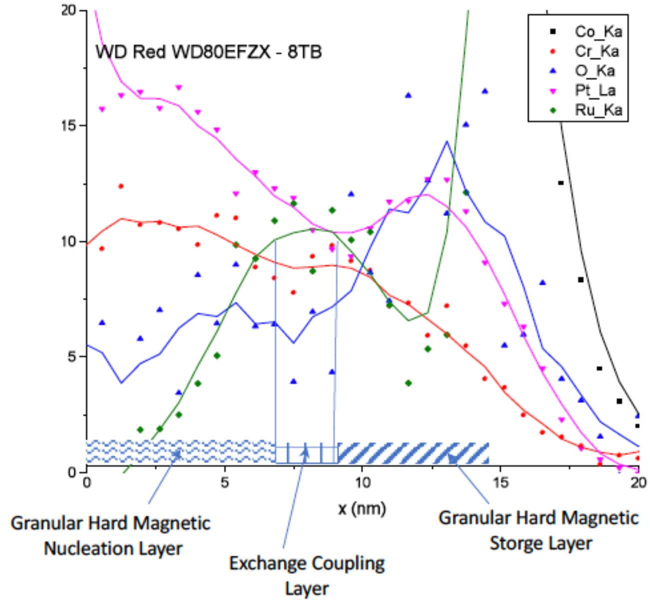


More specifically, the ruthenium ("Ru") peak at about 7-8 nm demonstrates two distinct layers, as Ru, either alone or with other materials, is widely used to provide exchange coupling between magnetic layers. Therefore, there is a "bilayer structure". The average oxygen ("O") concentration in the two 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, $H_c = 2*K_{eff}/M_s$ (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 $M_s \sim 380$ emu/cm³ = 0.47T and $K_{eff} \sim 3.1\text{x}10^6$ erg/cm³ =

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

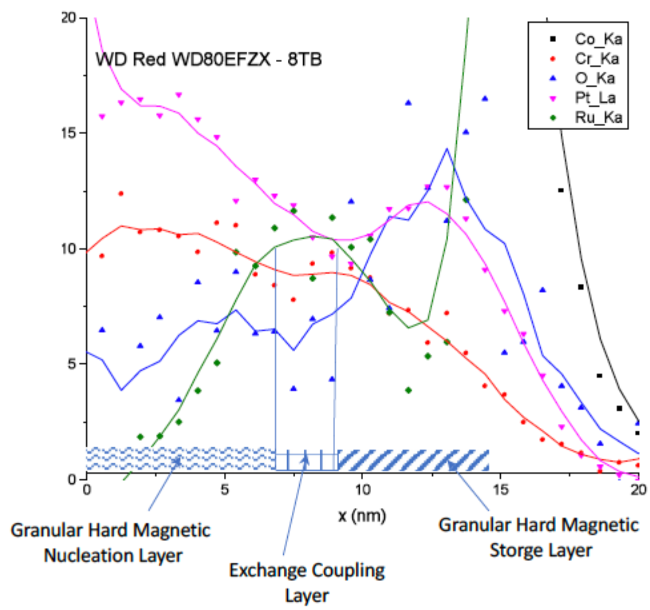
Control of Exchange Coupling Between Granular Oxide and Highly Exchange Coupled Cap Layers and the Effect on Perpendicular Magnetic Switching and Recording Characteristics

Gunn Choe[1], Yoshihiro Ikeda[2], Kezhao Zhang[1], Kai Tang[1], and Mohammad Mirzamaani[1]

[1]Hitachi Global Storage Technologies, Media Development, San Jose, CA 95193 USA
[2]Hitachi Global Storage Technologies, San Jose Research Center, San Jose, CA 95135 USA

recording layer in this study comprises a CoPtCrB continuous layer exchange coupled to a granular oxide CoPtCrSiO layer through ECL. The K_u values of granular oxide grain and cap layer are ~3.1×10^6 erg/cm³ and ~2.2×10^6 erg/cm³, respectively. 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-

45. 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:

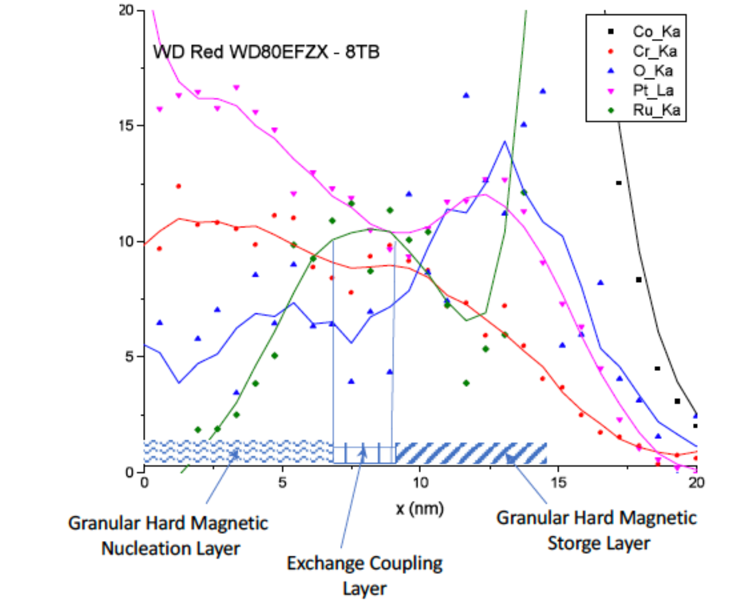


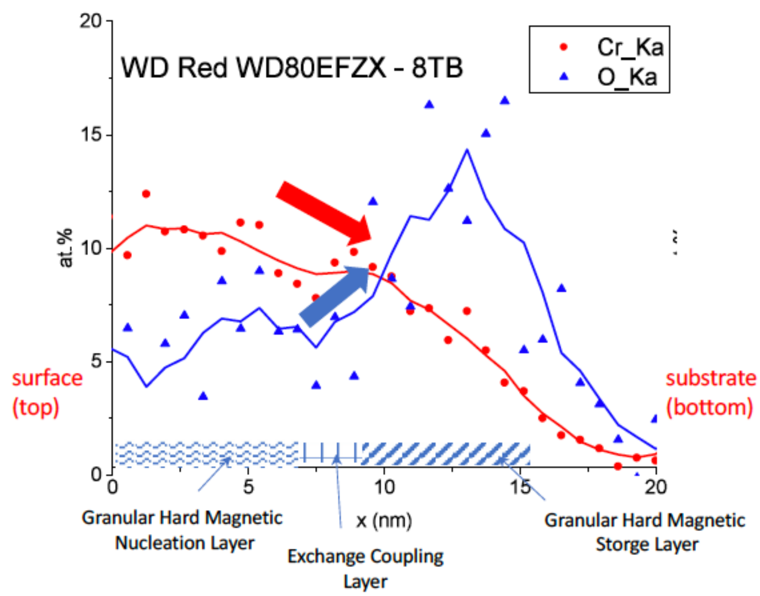
46. Thus, the Accused Products, including the Western Digital WD80EFX

(8TB), have a storage layer with a thickness of between 3 and 30 nm.

47. 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.

48. 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 Oxygen Incorporation on Microstructure and Media Performance in CoCrPt-SiO_2 Perpendicular Recording Media, IEEE Transactions on Magnetics, Vol. 43, No. 2, February 2007.





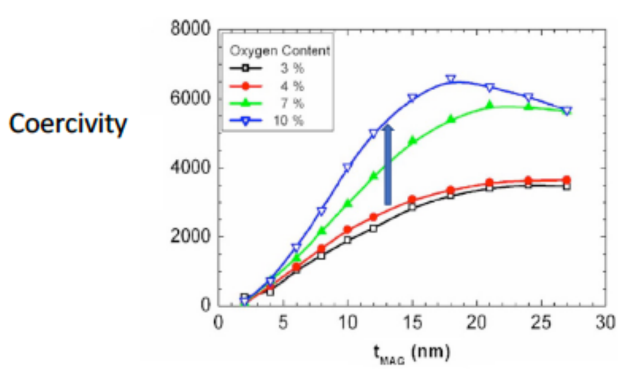


Fig. 1. Effect of CoCrPt–SiO_2 layer thickness (t_{MAG}) on coercivity (H_c) at various oxygen contents.

Jung, H.S., et. al., "Effect of Oxygen Incorporation on Microstructure and Media

Performance in CoCrPt-SiO_2 Perpendicular Recording Media, IEEE Transactions on Magnetics, Vol. 43, No. 2, February 2007.

49. 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), $M_s \sim 380$ emu/cm³ = 0.47T and $K_{eff} \sim 3.1x10^6$ erg/cm³ = 0.31e6 J/m³. Using the formula from the '413 patent (at col. 6, line 54) that coercive field, $H_c = 2*K_{eff}/M_s$, and inputting the values for M_s and K_{eff}, $H_c = 2*K_{eff}/M_s = 1.6T$ (where H_c 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 Choe[1], Yoshihiro Ikeda[2], Kezhao Zhang[1], Kai Tang[1], and Mohammad Mirzamaani[1]

[1]Hitachi Global Storage Technologies, Media Development, San Jose, CA 95193 USA
[2]Hitachi Global Storage Technologies, San Jose Research Center, San Jose, CA 95135 USA

recording layer in this study comprises a CoPtCrB continuous layer exchange coupled to a granular oxide CoPtCrSiO layer through ECL. The K_u values of granular oxide grain and cap layer are $\sim 3.1 \times 10^6$ erg/cm^3 and $\sim 2.2 \times 10^6$ erg/cm^3, respectively. The average M_s value of oxide layer is 380 emu/cm^3 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-

50. As shown, 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(ox)=8%; the O concentration average for storage layer (9-14nm) in the 8TB disk: C(ox)=13%. Using a linear fit for the change of coercive field as function of the O concentration 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

Oxygen content.

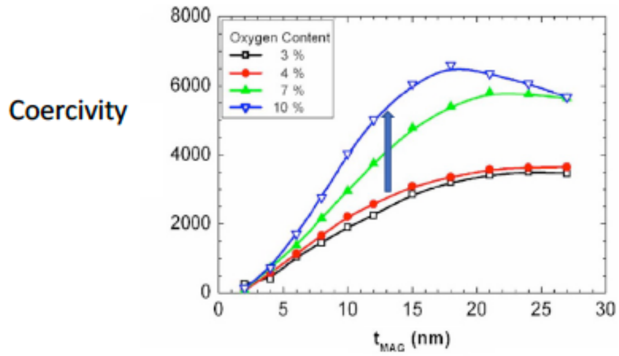
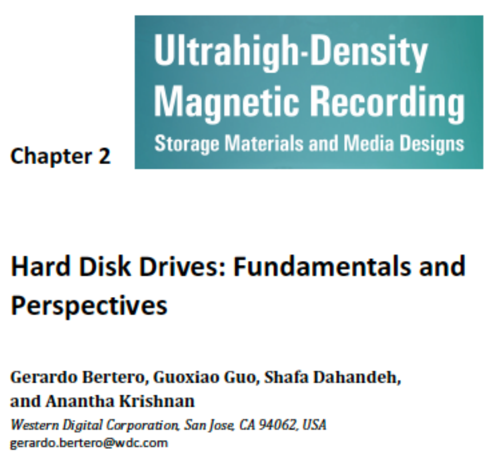


Fig. 1. Effect of CoCrPt–SiO_2 layer thickness (t_{MAG}) on coercivity (H_c) at various oxygen contents.

Jung, H.S., et. al., "Effect of Oxygen Incorporation on Microstructure and Media Performance in CoCrPt-SiO_2 Perpendicular Recording Media, IEEE Transactions on Magnetics, Vol. 43, No. 2, February 2007.

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


Chapter 2

Ultrahigh-Density Magnetic Recording

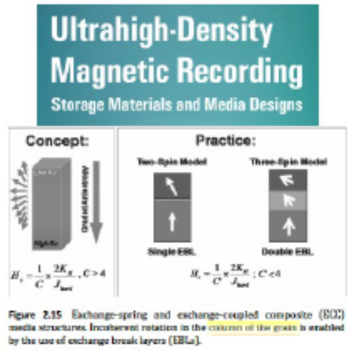
Storage Materials and Media Designs

Hard Disk Drives: Fundamentals and Perspectives

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

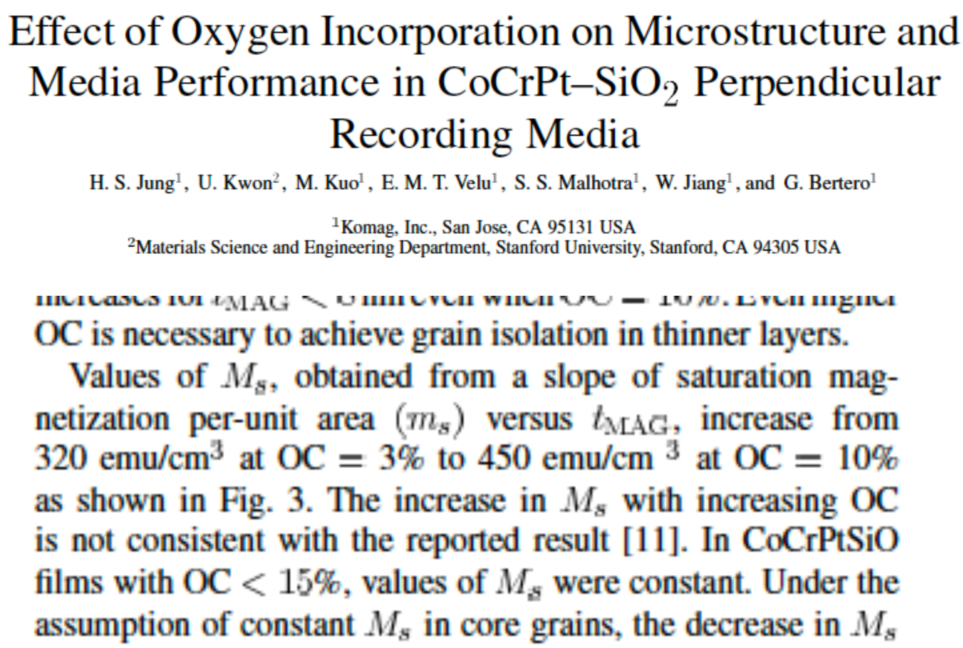
Western Digital Corporation, San Jose, CA 94062, USA

gerardo.bertero@wdc.com



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 emu/cm³ results in 0.402 T, while M_s of 450 emu/cm³ 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–SiO_2 Perpendicular Recording Media

H. S. Jung[1], U. Kwon[2], M. Kuo[1], E. M. T. Velu[1], S. S. Malhotra[1], W. Jiang[1], and G. Bertero[1]

[1]Komag, Inc., San Jose, CA 95131 USA
[2]Materials Science and Engineering Department, Stanford University, Stanford, CA 94305 USA

OC is necessary to achieve grain isolation in thinner layers.

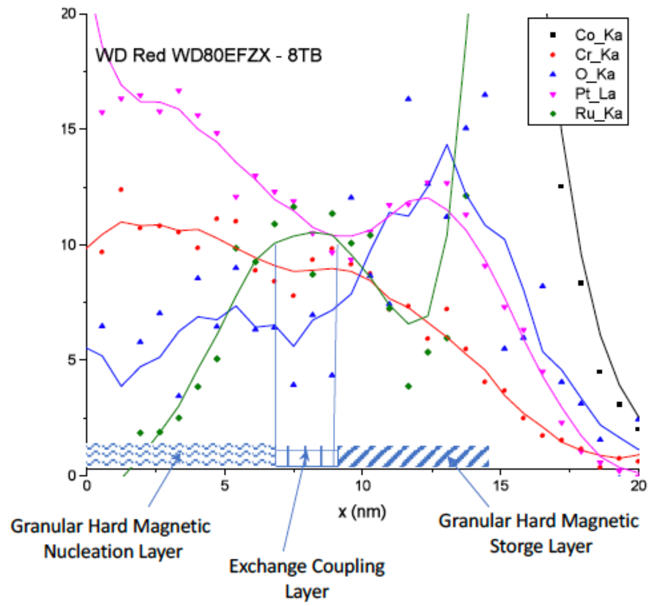
Values of M_s, obtained from a slope of saturation magnetization per-unit area (m_s) versus t_{MAG}, increase from 320 emu/cm^3 at OC = 3% to 450 emu/cm ^{3} at OC = 10% as shown in Fig. 3. The increase in M_s with increasing OC is not consistent with the reported result [11]. In CoCrPtSiO films with 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-SiO_2 Perpendicular Recording Media, IEEE Transactions on Magnetics, Vol. 43, No. 2, February 2007.

RUSS, AUGUST & KABAT

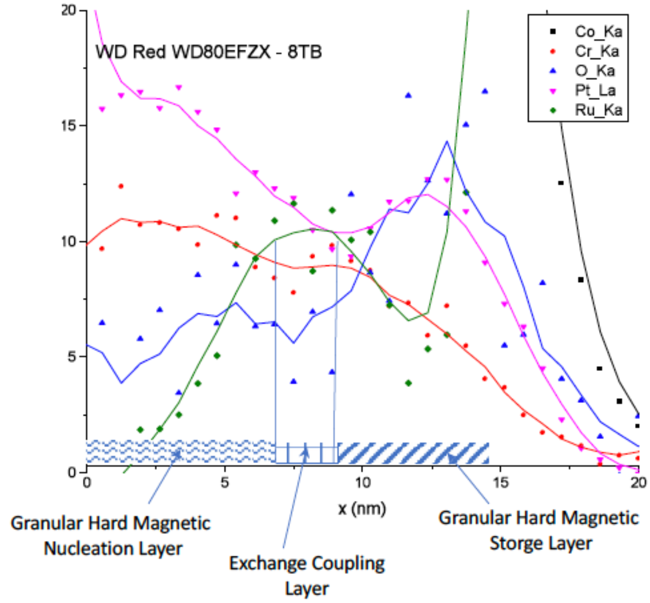
55. Based on information and belief, the Accused Products include: "the nucleation host and the hard magnetic storage layer are separated by a coupling layer between 0.1 nm and 3 nm thickness." The Accused Products, including the Western Digital WD80EFX (8TB), have a nucleation host and a hard magnetic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

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



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.

57. 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).



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

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

63. Defendant makes, uses, offers for sale, sells, and/or imports into the United States certain products and services that directly infringe, literally and/or under the doctrine of equivalents, one or more claims of the ’864 Patent, and continue to do so. By way of illustrative example, these infringing products and services include, without limitation, Defendant’s magnetic hard disk drives, including, for example, the Western Digital WD60EZAZ (6TB), and all versions and variations thereof since the issuance of the ’864 Patent (“Accused Products”).

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

65. The Accused Products satisfy all claim limitations of one or more claims of the ’864 Patent. One, non-limiting, example of the Accused Instrumentalities’ infringement is presented below. For example, based on information and belief, the Accused Products include: “[a] magnetic recording medium.” For example, the Western Digital WD60EZAZ (6TB) has a magnetic recording medium. https://www.westerndigital.com/products/internal-drives/wd-blue-desktop-sata-hdd#WD60EZAZ

66. Based on information and belief, the Accused Products include: "an essentially non-magnetic substrate." For example, the Accused Products, including the Western Digital WD60EZAZ (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.


Chapter 2

Ultrahigh-Density Magnetic Recording
Storage Materials and Media Designs

Hard Disk Drives: Fundamentals and Perspectives

Gerardo Bertero, Guoxiao Guo, Shafa Dahandeh, and Anantha Krishnan
Western Digital Corporation, San Jose, CA 94062, USA
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86 | *Hard Disk Drives*

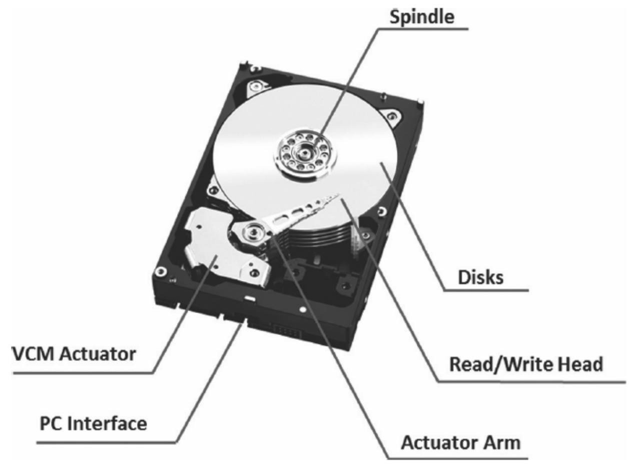

Figure 2.23 Typical hard disk drive.

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

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 WD60EZAZ (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
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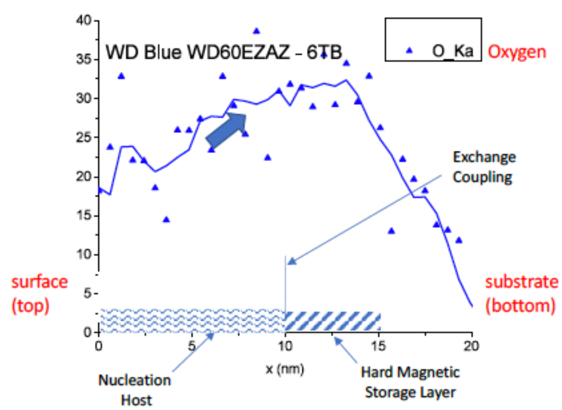
136 | *Conventional Perpendicular Magnetic Recording Media*

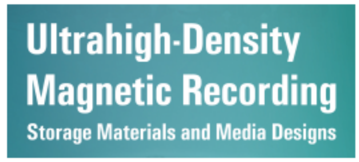
key parameters to control both physical and chemical isolations among magnetic grains. Addition of SiO_2 to the CoPtCr alloy also provides a similar well-isolated fine-grain microstructure without disturbing the heteroepitaxial growth of CoPtCr grains on top of the Ru underlayer [21]. This significant 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 WD60EZAZ (6TB) has an exchange coupled magnetic multilayer structure. Energy dispersive x-ray (EDX) chemical analysis of layers of the WD60EZAZ (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

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



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

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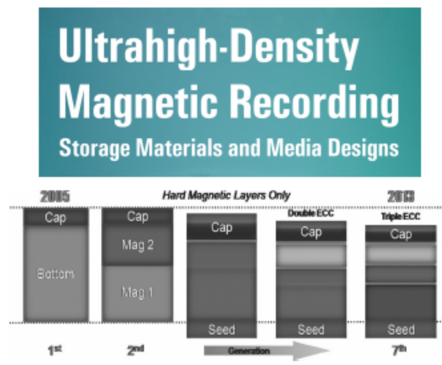


Figure 2.16 Progression of PMR recording layer structure design as a function of drive generation. The ECC media design allows for a reduction in the total media thickness because it enables the use of high anisotropy layers without compromising switching performance.

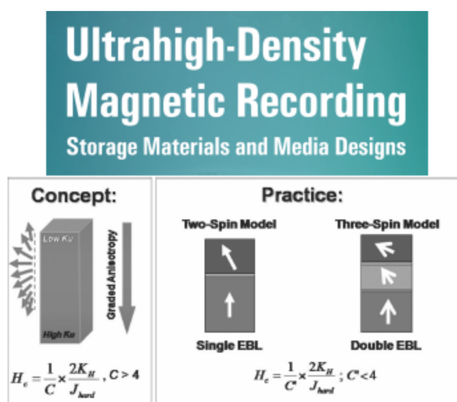


Figure 2.15 Exchange-spring and exchange-coupled composite (ECC) media structures. Incoherent rotation in the column of the grain is enabled by the use of exchange break layers (EBLs).

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

"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." For example, the Western Digital WD60EZAZ (6TB) has a hard magnetic storage layer, having a first coercive field H_s>0.5 T, formed on the underlayer. Using the values from the IEEE Transactions of Magnetics (July 2009), at p. 2694 (reproduced below), $M_s \sim 380$ emu/cm³ = 0.47T and $K_{eff} \sim 3.1x10^6$ erg/cm³ = 0.31e6 J/m³. Using the formula from the '864 patent (at col. 6, line 54), $H_c = 2*K_{ef}f/M_s = 1.6T$ (where H_c also is referred to as H_s), which is greater than 0.5 T.

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

Gunn Choe[1], Yoshihiro Ikeda[2], Kezhao Zhang[1], Kai Tang[1], and Mohammad Mirzamaani[1]

[1]Hitachi Global Storage Technologies, Media Development, San Jose, CA 95193 USA
[2]Hitachi Global Storage Technologies, San Jose Research Center, San Jose, CA 95135 USA

recording layer in this study comprises a CoPtCrB continuous layer exchange coupled to a granular oxide CoPtCrSiO layer through ECL. The K_u values of granular oxide grain and cap layer are $\sim 3.1 \times 10^6$ erg/cm^3 and $\sim 2.2 \times 10^6$ erg/cm^3, respectively. The average M_s value of oxide layer is 380 emu/cm^3 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-

71. Based on information and belief, the Accused Products further include: "an exchange coupled magnetic multilayer structure, including … 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." For example, the Western Digital WD60EZAZ (6TB) has 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. Energy dispersive x-ray (EDX) chemical analysis of layers of the WD60EZAZ (6TB) determined the variation of the elemental concentration with depth. On information and belief, the variation of the coercive field with the elemental concentrations is well known. Combining these data established that the coercive field in the nucleation host H_n is 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 615

Effect of Oxygen Incorporation on Microstructure and Media Performance in CoCrPt–SiO_2 Perpendicular Recording Media

H. S. Jung[1], U. Kwon[2], M. Kuo[1], E. M. T. Velu[1], S. S. Malhotra[1], W. Jiang[1], and G. Bertero[1]

[1]Komag, Inc., San Jose, CA 95131 USA
[2]Materials Science and Engineering Department, Stanford University, Stanford, CA 94305 USA

The effect of oxygen incorporation on microstructure and media performance in CoCrPt–SiO_2 films with various oxygen contents (OC) from 3 to 10 at% at different CoCrPt–SiO_2 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-SiO_2 Perpendicular Recording Media, IEEE Transactions on Magnetics, Vol. 43, No. 2, February 2007.

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

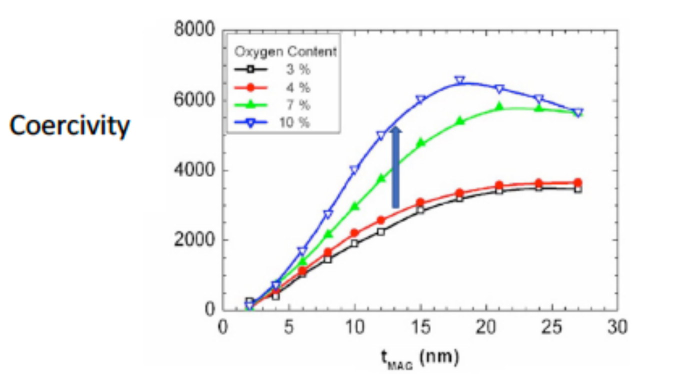
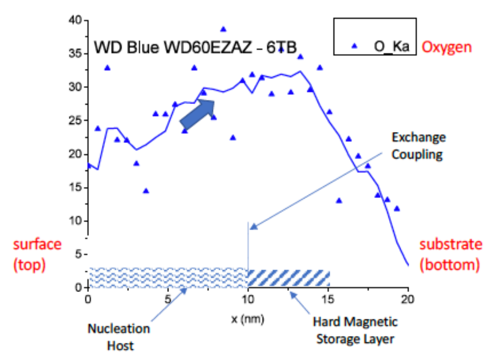


Fig. 1. Effect of CoCrPt–SiO_2 layer thickness (t_{MAG}) on coercivity (H_c) at various oxygen contents.

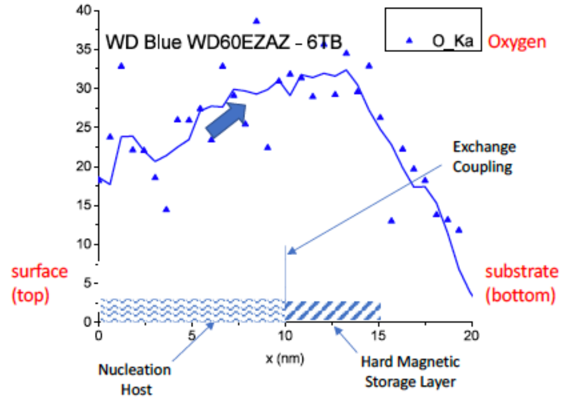
Jung, H.S., et. al., "Effect of Oxygen Incorporation on Microstructure and Media Performance in CoCrPt-SiO_2 Perpendicular Recording Media, IEEE Transactions on Magnetics, Vol. 43, No. 2, February 2007.

74. Further, the EDX chemical analysis of layers of the WD60EZAZ (6TB) shows that the average O concentration is increasing from a lower level in the nucleation host (approx. 0-10nm) to a higher level in the hard storage layer (approx. 10-15nm). This establishes that H_n, the coercive field of the nucleation host, is lower than H_s, the coercive field of the hard storage layer: $H_n<H_s$.

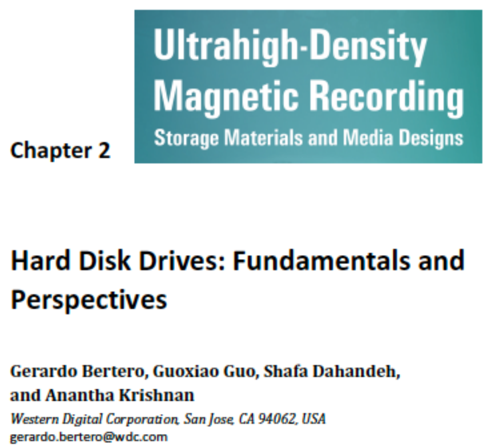
75. Based on information and belief, the Accused Products further include: "said nucleation host is formed on the hard magnetic storage layer such that the hard magnetic storage layer is between the nucleation host and the non-magnetic substrate." For example, the Western Digital WD60EZAZ (6TB) has a 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.



76. 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 WD60EZAZ (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.



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.


Ultrahigh-Density Magnetic Recording
Storage Materials and Media Designs

Chapter 2

Hard Disk Drives: Fundamentals and Perspectives

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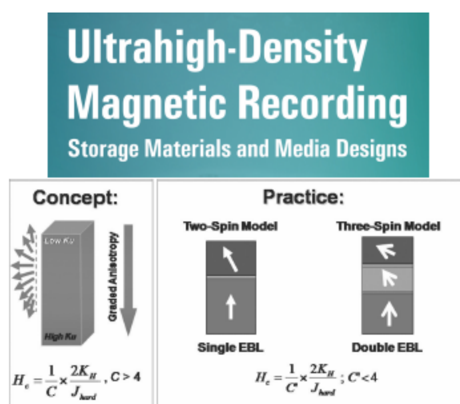
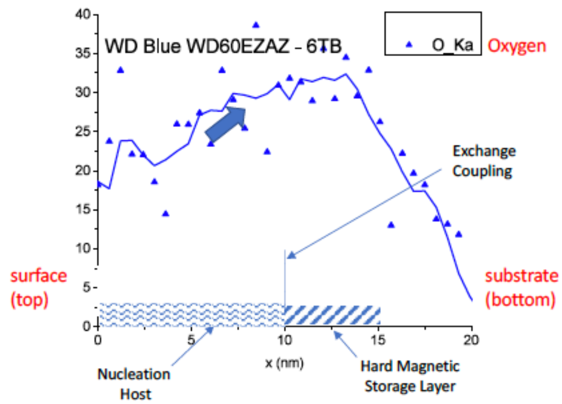


Figure 2.15 Exchange-spring and exchange-coupled composite (ECC) media structures. Incoherent rotation in the column of the grain is enabled by the use of exchange break layers (EBLs).

78. 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 WD60EZAZ (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 WD60EZAZ (6TB) shows the O concentration increasing from layer to layer within the nucleation host, (approx. 0-10 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.

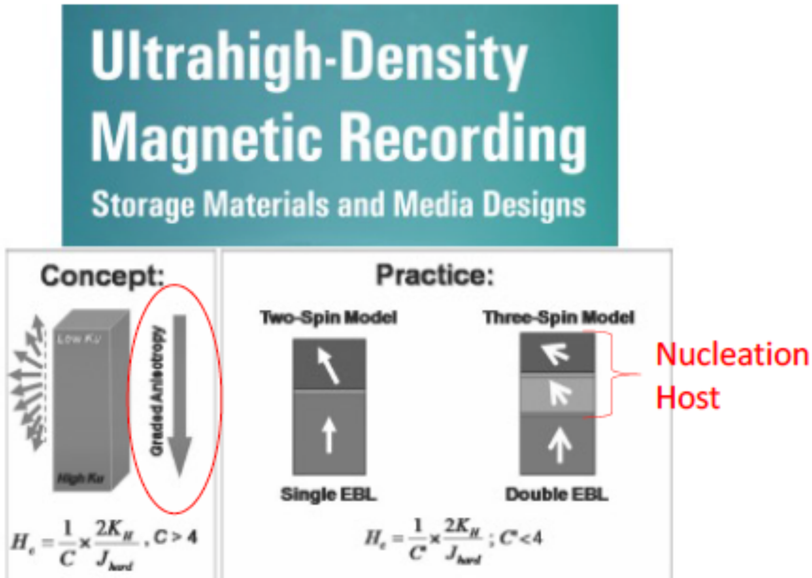


Figure 2.15 Exchange-spring and exchange-coupled composite (ECC) media structures. Incoherent rotation in the column of the grain is enabled by the use of exchange break layers (EBLs).

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

attached as Exhibit 4.

85. Defendant makes, uses, offers for sale, sells, and/or imports into the United States certain products and services that directly infringe, literally and/or under the doctrine of equivalents, one or more claims of the ’997 Patent, and continue to do so. By way of illustrative example, these infringing products and services include, without limitation, Defendant’s magnetic hard disk drives, including, for example, the Western Digital WD60EZAZ (6TB), and all versions and variations thereof since the issuance of the ’997 Patent (“Accused Products”).

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

87. The Accused Products satisfy all claim limitations of one or more claims of the ’997 Patent. One, non-limiting, example of the Accused Instrumentalities’ infringement is presented below. For example, based on information and belief, the Accused Products include: “[a] magnetic recording system.” For example, the Western Digital WD60EZAZ (6TB) has a magnetic recording system. https://www.westerndigital.com/products/internal-drives/wd-blue-desktop-sata-hdd#WD60EZAZ

88. Based on information and belief, the Accused Products include: "a disk, including a magnetic recording medium." For example, the Western Digital WD60EZAZ (6TB) includes a disk, including a magnetic recording medium. https://www.westerndigital.com/products/internal-drives/wd-blue-desktop-sata-hdd#WD60EZAZ

89. Based on information and belief, the Accused Products include: "a writing head." For example, the Western Digital WD60EZAZ (6TB) includes a writing head. https://www.westerndigital.com/products/internal-drives/wd-blue-desktop-sata-hdd#WD60EZAZ

90. Based on information and belief, the Accused Products include" "an essentially non-magnetic substrate." For example, the Accused Products, including the Western Digital WD60EZAZ (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
Western Digital Corporation, San Jose, CA 94062, USA
gerardo.bertero@wdc.com

86 | *Hard Disk Drives*

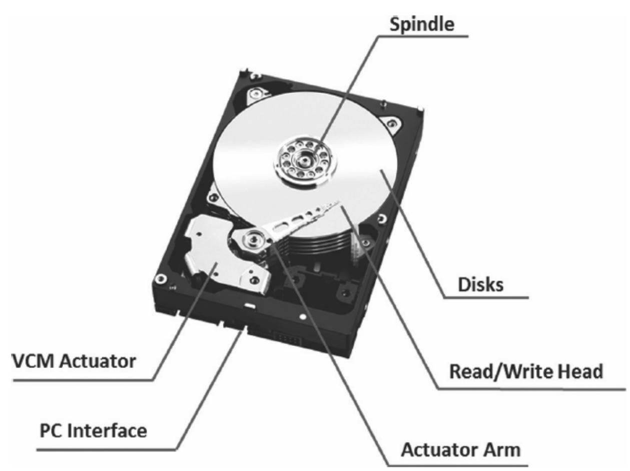


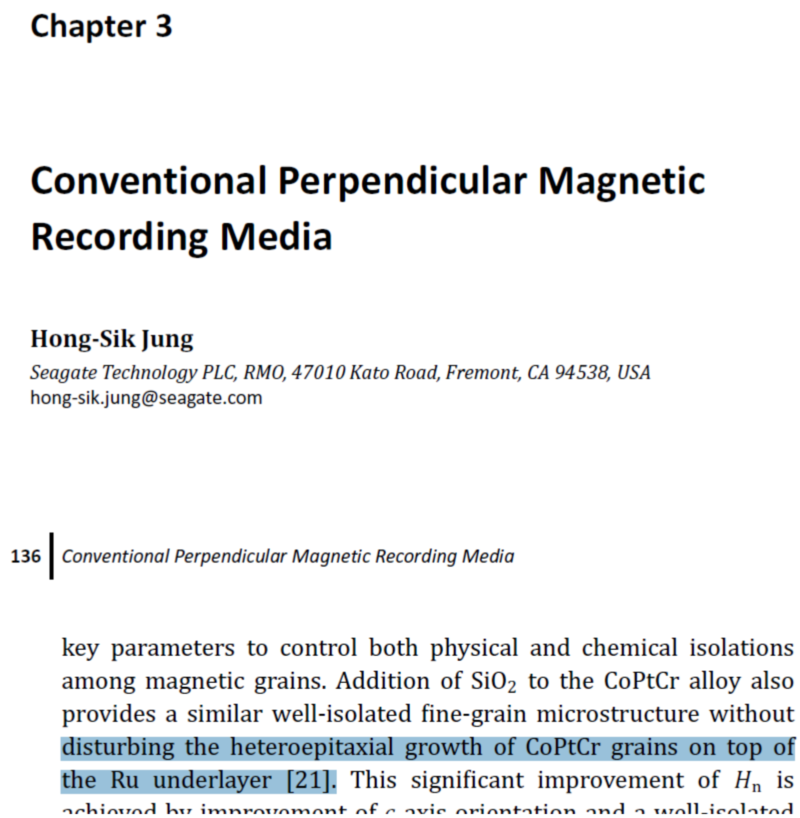
Figure 2.23 Typical hard disk drive.

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 WD60EZAZ (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.



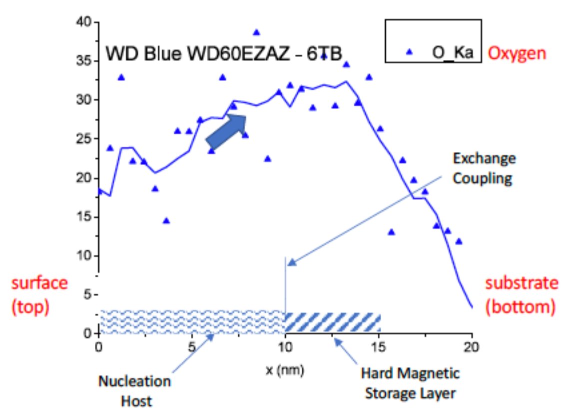
Chapter 3

Conventional Perpendicular Magnetic Recording Media

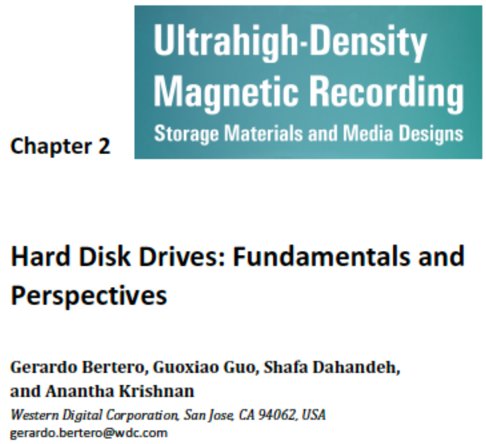
Hong-Sik Jung
Seagate Technology PLC, RMO, 47010 Kato Road, Fremont, CA 94538, USA
hong-sik.jung@seagate.com

key parameters to control both physical and chemical isolations among magnetic grains. Addition of SiO_2 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 WD60EZAZ (6TB) has an exchange coupled magnetic multilayer structure. Energy dispersive x-ray (EDX) chemical analysis of layers of the WD60EZAZ (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.



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


Ultrahigh-Density Magnetic Recording
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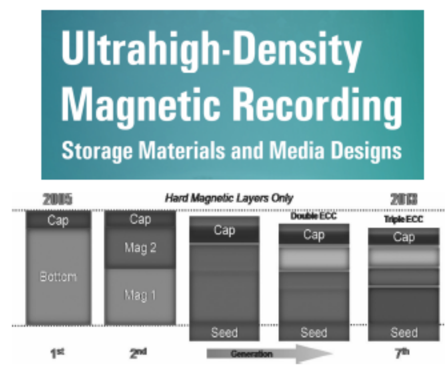


Figure 2.16 Progression of PMR recording layer structure design as a function of drive generation. The ECC media design allows for a reduction in the total media thickness because it enables the use of high anisotropy layers without compromising switching performance.

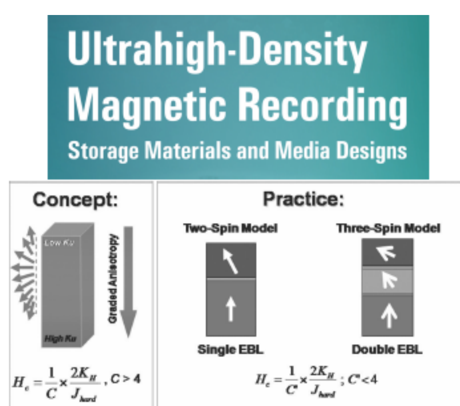


Figure 2.15 Exchange-spring and exchange-coupled composite (ECC) media structures. Incoherent rotation in the column of the grain is enabled by the use of exchange break layers (EBLs).

RUSS, AUGUST & KABAT

94. Based on information and belief, the Accused Products further include: "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." For example, the Western Digital WD60EZAZ (6TB) has a hard magnetic storage layer, having a first coercive field H_s>0.5 T, formed on the underlayer. Using the values from the IEEE Transactions of Magnetics (July 2009), at p. 2694 (reproduced below), M_s ~ 380 emu/cm^3 = 0.47T and K_{eff} ~ 3.1x10^6 erg/cm^3 = 0.31e6 J/m^3. Using the formula from the '864 patent (at col. 6, line 54), H_c = 2*K_{ef}f/M_s = 1.6T (where H_c also is referred to as H_s), which is greater than 0.5 T.

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

Gunn Choe[1], Yoshihiro Ikeda[2], Kezhao Zhang[1], Kai Tang[1], and Mohammad Mirzamaani[1]

[1]Hitachi Global Storage Technologies, Media Development, San Jose, CA 95193 USA
[2]Hitachi Global Storage Technologies, San Jose Research Center, San Jose, CA 95135 USA

recording layer in this study comprises a CoPtCrB continuous layer exchange coupled to a granular oxide CoPtCrSiO layer through ECL. The K_u values of granular oxide grain and cap layer are ~3.1 × 10^6 erg/cm^3 and ~2.2 × 10^6 erg/cm^3, respectively. The average M_s value of oxide layer is 380 emu/cm^3 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-

95. Based on information and belief, the Accused Products further include: "an exchange coupled magnetic multilayer structure, including … 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." For example, the Western Digital WD60EZAZ (6TB) has 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. Energy dispersive x-ray (EDX) chemical analysis of layers of the WD60EZAZ (6TB) determined the variation of the elemental concentration with depth. On information and belief, the variation of the coercive field with the elemental concentrations is well known. Combining these data established that the coercive field in the nucleation host H_n is

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

96. 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 615

Effect of Oxygen Incorporation on Microstructure and Media Performance in CoCrPt–SiO_2 Perpendicular Recording Media

H. S. Jung[1], U. Kwon[2], M. Kuo[1], E. M. T. Velu[1], S. S. Malhotra[1], W. Jiang[1], and G. Bertero[1]

[1]Komag, Inc., San Jose, CA 95131 USA
[2]Materials Science and Engineering Department, Stanford University, Stanford, CA 94305 USA

The effect of oxygen incorporation on microstructure and media performance in CoCrPt–SiO_2 films with various oxygen contents (OC) from 3 to 10 at% at different CoCrPt–SiO_2 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-SiO_2 Perpendicular Recording Media, IEEE Transactions on Magnetics, Vol. 43, No. 2, February 2007.

97. In addition, increasing the Oxygen ("O") concentration indicates an increase in coercivity.

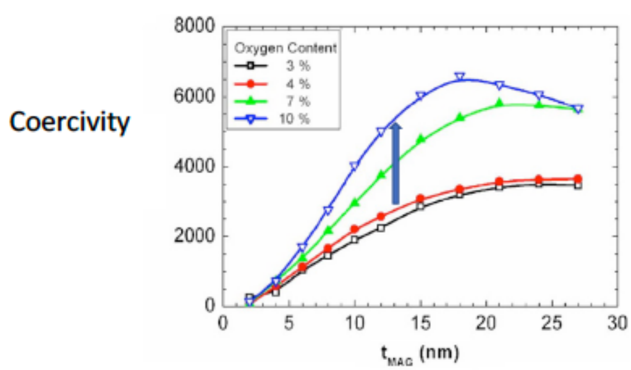
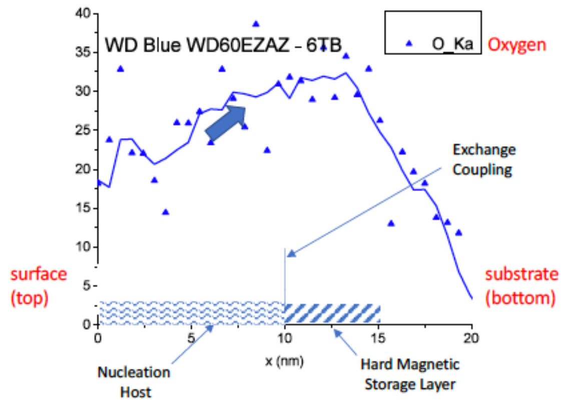


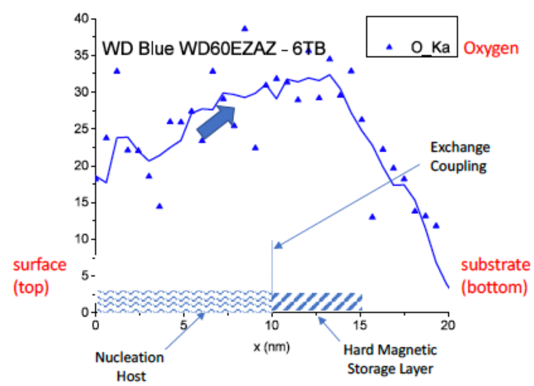
Fig. 1. Effect of CoCrPt–SiO_2 layer thickness (t_{MAG}) on coercivity (H_c) at various oxygen contents.

98. Further, the EDX chemical analysis of layers of the WD60EZAZ (6TB)

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

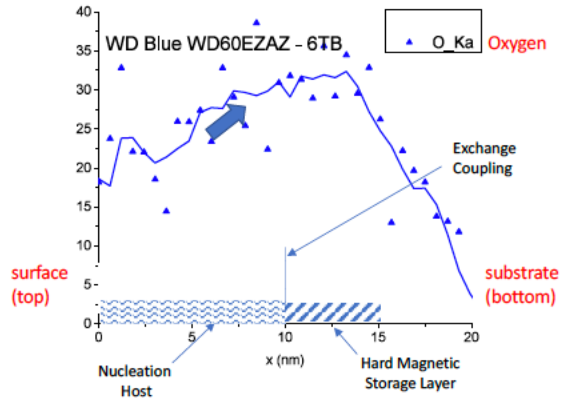


99. Based on information and belief, the Accused Products further include: "said nucleation host is formed on the hard magnetic storage layer such that the hard magnetic storage layer is between the nucleation host and the non-magnetic substrate." For example, the Western Digital WD60EZAZ (6TB) has a 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.

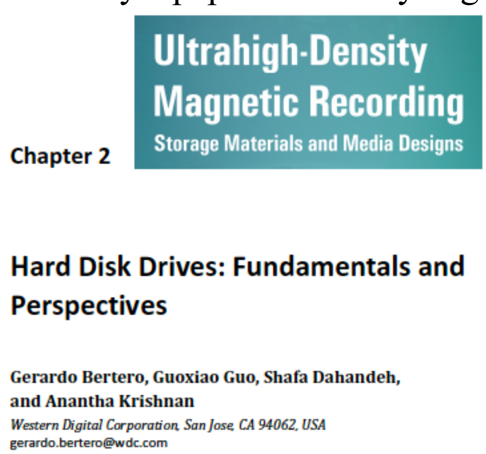


RUSS, AUGUST & KABAT

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 WD60EZAZ (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 exchanged coupled to the hard magnetic layer, as demonstrated by a paper written by engineers at Western Digital.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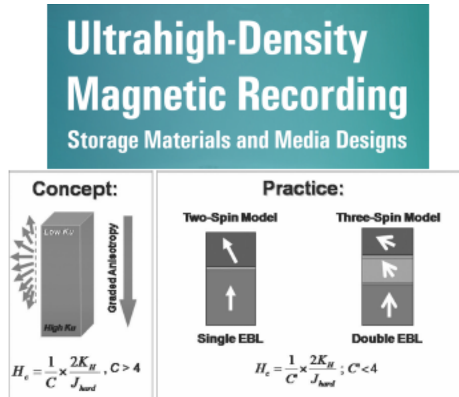
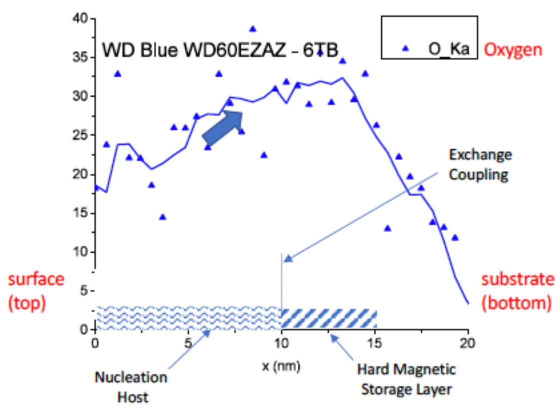


Figure 2.15 Exchange-spring and exchange-coupled composite (ECC) media structures. Incoherent rotation in the column of the grain is enabled by the use of exchange break layers (EBLs).

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 WD60EZAZ (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 WD60EZAZ (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

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.

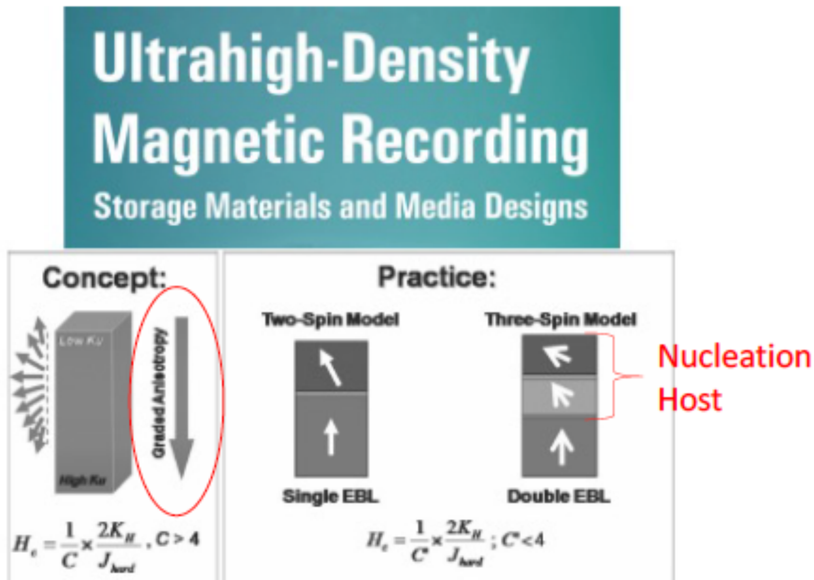


Figure 2.15 Exchange-spring and exchange-coupled composite (ECC) media structures. Incoherent rotation in the column of the grain is enabled by the use of exchange break layers (EBLs).

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

106. As a result of Defendant's infringement of the '997 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.

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;

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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MR Technologies, GMBH