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UNITED STATES DISTRICT COURT
CENTRAL DISTRICT OF CALIFORNIA

MR TECHNOLOGIES, GMBH, Plaintiff, v. WESTERN DIGITAL TECHNOLOGIES, INC., Defendant.	Case No. 8:22-CV-01599-JVS-DFM
WESTERN DIGITAL TECHNOLOGIES, INC., Counterclaimant, v. MR TECHNOLOGIES, GMBH, Counterclaim- Defendant.	[redacted]

DECLARATION OF MARK RE IN SUPPORT OF MR TECH'S OPPOSITION TO WD'S MOTION FOR SUMMARY JUDGMENT OF INVALIDITY

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I. INTRODUCTION

1. I have been retained by Plaintiff, MR Technologies, GMBH, ("MR Tech") as an expert in this matter.

2. For this declaration, I have been asked to provide my opinions regarding the validity of claims 1, 2, 5, 10, 11, 12, 13, 14, 15, and 23 of the '864 patent ("'864 asserted claims"), and claims 1, 4, 5, 7, 9 of the '997 patent ("'864 asserted claims") (collectively, "asserted claims") and specifically to respond to Dr. Victora's expert report regarding invalidity ("Victora Report") as to the opinions I understand WD relies upon in its motion for summary judgment of invalidity.

3. I am being compensated at my standard hourly rate of $500 an hour, plus out-of-pocket expenses. My compensation does not depend on the outcome of this matter.

4. I may use exhibits or demonstratives to help illustrate my testimony at trial, including exhibits with tables, charts, graphs, or the like that summarize the content of voluminous documents. I may also show the jury examples of HDDs and/or their components such as the disks within an HDD.

5. I reserve the right to supplement this declaration based on additional information or discovery provided to me after the date of this declaration.

II. QUALIFICATIONS

6. I am an independent consultant with over 30 years of experience in the hard disk drive ("HDD") industry. Until January 2019, I was Chief Technology Officer at Seagate Technology PLC ("Seagate"). In this executive-level role, I was responsible for leading over 4,000 employees worldwide in areas such as corporate research and development ("R&D"), HDD product engineering, and component engineering. During my over 15 years at Seagate, I also spent time in other research and manufacturing roles including leading the Research Center in

Pittsburgh, leading R&D related to heads and media, and leading recording media from R&D to manufacturing.

7. Prior to joining Seagate in August 2003, I was Senior Vice President of R&D at Read-Rite Corporation ("Read-Rite"). In this role, I was responsible for over 1,000 employees in the U.S. and Asia in areas such as R&D, engineering, wafer fabrication, and quality. I helped establish Read-Rite as a technology leader with the following accomplishments: 1) a series of areal density world records, 2) industry-leading 20-gigabyte-per-disk products, 3) the development and manufacture of giant magnetoresistance heads, and 4) the deployment of automation to the assembly process. During my five years at Read-Rite, average annual patents issued increased from 5 to 50.

8. Prior to joining Read-Rite in August 1998, I was Director of Head Development at IBM Corporation ("IBM"). In this role, I oversaw a group of 200 people in areas related to head design and process development. During my 11 years at IBM, I also worked on magnetic imaging techniques, magnetic materials, air bearing technologies, mobile computing, and security-related technologies. I was named an IBM Distinguished Engineer, a technical/executive position.

9. In my career, I have been responsible for launching hundreds of products, with experience in all phases of the product cycle from R&D through manufacturing. I have experience working in large, global organizations and delivering low-cost, high-volume, and reliable technologies and products. Within the HDD business, I have experience with technologies related to head/media design and processing, mechanical technologies, application-specific integrated circuits ("ASICS"), security, and firmware algorithms. I have executed numerous corporate efficiency projects including transferring responsibilities across geographic borders. I have focused on developing intellectual property processes to consistently execute on roadmaps. I have

consulted with North American companies such as Plasma-Therm LLC and Rockport, and Japanese companies such as Hoya Corporation ("Hoya") and Tokyo Electron Ltd.

10. Over the course of my career, I have served in a number of capacities on boards. These boards include domestic and international research institutes, start-ups, and corporate entities. I hold a Bachelor of Science in Electrical Engineering from Northwestern University and a Doctor of Philosophy and Master of Science in Electrical and Computer Engineering from Carnegie Mellon University.

11. A copy of my current CV is attached as Exhibit A.

III. SUMMARY OF OPINIONS

12. My opinions and supporting analyses set forth in this report are based on my review of the patents-in-suit, their file histories, the Court's Claim Construction Order, the prior art references cited by Dr. Victora, deposition testimony, discovery responses, documents produced in the litigation, and other documents cited herein, as well as my education, training, and experience in designing and developing HDDs for over 30 years. I summarize my main conclusions below.

- The asserted claims are not obvious over *Li* alone or with *Victora* or *Berger*
- The asserted claims are not obvious over *Berger* alone or with *Hagedorn* or *Li*
- The asserted claims are not obvious over *Victora* alone with *Hagedorn* or *Li*
- The nonobviousness of the asserted claims is supported by substantial objective indicia of nonobviousness
- The asserted claims are not invalid for lack of written description or enablement regarding the "nucleation host" limitations

- The asserted claims are not invalid for indefiniteness regarding the "coercive field" limitations

13. I understand that I will have an opportunity to further address the Dr. Victora's opinions regarding invalidity in my rebuttal expert report.

IV. LEGAL STANDARDS

14. I am not an attorney and have no formal legal training. Counsel for MR Tech provided me with the legal standards below. In forming my opinions in this declaration, I applied these legal standards and the Court's constructions to the best of my knowledge and understanding.

A. Presumption of Validity

15. I understand that patents issued by the USPTO are presumed to be valid and that invalidity must be proven on a claim by claim basis by a heightened burden of proof called clear and convincing evidence.

B. Obviousness

16. I understand that a patent claim is invalid for obviousness if the claimed invention would have been obvious at the time of the invention to a person having ordinary skill in the art. I understand that the following factors are considered: (1) the scope and content of the prior art; (2) the differences between the art and the claims at issue; (3) the level of ordinary skill in the art at the time the invention of the asserted patent was made; and (4) objective evidence of non-obviousness. In order to determine whether claim elements are found in the prior art, I understand that it is necessary to compare the properly construed claim language of the patent with the teachings of the prior art.

17. I understand that in order to combine prior art references to show obviousness, a person of ordinary skill in the art, without knowledge of the claimed invention, or without the use of hindsight, must have been motivated to combine the prior art by some suggestion or teaching in

the prior art, the knowledge of one of skill in the art, or the nature of the problem to be solved. In addition, I understand that where a party argues a skilled artisan would have been motivated to combine references, it must show the artisan would have had a reasonable expectation of success in doing so. I also understand that it is appropriate to look to a variety of factors when evaluating reasons to combine references in an obviousness analysis, and that it is important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the alleged prior art elements in the manner claimed. I understand that a patent composed of several elements is not proved obvious merely by demonstrating that each element was independently known in the prior art.

18. I understand that in evaluating whether patent claims are invalid as obvious, objective indicia of non-obviousness must be considered. Such objective indicia can include commercial success, long-felt but unsolved needs, copying, praise, unexpected results, industry acceptance, failure of others, and skepticism by experts. I understand that there must be a sufficient nexus between the objective evidence of non-obviousness and the claimed invention.

19. Evidence of a long-felt but unresolved need can weigh in favor of non-obviousness because it is reasonable to infer that the need would not have persisted had the solution been obvious. Whether a long-felt need existed is analyzed as of the date of an articulated identified problem and evidence of efforts to solve that problem. It is appropriate to look to the filing date of the challenged invention to assess the presence of a long-felt and unmet need. There must be a nexus between the claimed invention and the long-felt but unsolved need. The long-felt need should be a need created by inadequacies in the technical knowledge, not one due to business-driven market forces unrelated to technical considerations. Long-felt need does not require that others tried and failed to meet that need.

20. I understand that commercial success, whether related to the patentee's practicing products or other infringing products, is relevant to obviousness because the law presumes an idea would successfully have been brought to market sooner, in response to market forces, had the idea been obvious. Thus, the law deems evidence of (1) commercial success, and (2) a nexus between an invention and the commercial success of a product embodying that invention, probative of whether an invention was nonobvious. Although sales figures coupled with market data provides stronger evidence of commercial success, sales figures alone can show commercial success. I understand that the patented invention need not be solely responsible for the commercial success. For commercial success to be relevant, the patentee must show a nexus between the success and the merits of the claimed invention. If the patentee shows that the success is tied to a specific product that embodies and is coextensive with the claimed invention, then the objective evidence is entitled to a rebuttable presumption of nexus. A limited exception to the presumption exists where the patented invention is only a component of the product to which the objective evidence is tied. When this presumption arises, the burden shifts to the other party to show that the success is due to other factors (such as unclaimed features, marketing, or preexisting market share). The presumed evidence cannot be rebutted with mere argument; evidence must be put forth.

21. I have been informed that it is impermissible to use the claimed invention itself as a blueprint for piecing together elements in the art. In other words, it is impermissible to use hindsight reconstruction to pick and choose among disclosures in the prior art to reconstruct the claimed invention.

C. Written Description and Enablement

22. I understand that lack of written description or enablement must be proven by clear and convincing evidence.

23. I understand that a patent claim is invalid for lack of written description if the specification does not "contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same." I also understand that the written description must include every feature or limitation of the claimed invention.

24. I further understand that the written description must convey clearly to those skilled in the art that, as of the priority date sought, the inventor was in possession of the invention claimed. The written description requirement does not require any particular form of disclosure, and support may be based on a combination of figures and disclosures throughout the specification. A description that merely renders the invention obvious does not satisfy the written description requirement. The level of detail required to satisfy the written description requirement depends on (i) the nature and scope of the claims and (ii) the complexity and predictability of the relevant technology. Factors to be taken under consideration include the existing knowledge in the particular field, the extent and content of the prior art, the maturity of the science or technology, and the predictability of the aspect at issue.

25. I understand that a claimed invention is not enabled under if the specification does not teach those of ordinary skill in the art how to make and use the invention as broadly as it is claimed, without undue experimentation. ordinary skill in the art how to make and use the invention as broadly as it is claimed, without undue experimentation. I understand that the assessment of undue experimentation is based on the level of skill in the art as of the priority date of the claimed invention.

26. I understand that, while the full scope of the claimed invention must be enabled, the specification "need not enable anything broader than the scope of the claims." Accordingly, it is my understanding that the question of specification enablement of a claim is whether the full scope of the claim is enabled, not whether the accused device is enabled.

V. CLAIM CONSTRUCTION

27. In forming my opinions, I applied the constructions adopted by the Court in its December 21, 2023 Order Regarding Claim Construction. For any terms that were not construed, I applied the plain meaning to a POSITA in light of the specification:

Claim Term	Court's Construction
"coercive field"	Plain meaning - a property of magnetic materials that provides a measure of the ability of a ferromagnetic material to withstand an external magnetic field without becoming demagnetized '864 Patent, Cls. 1, 2, 7; '997 Patent, Cls. 1, 3, 7
"exchange coupled magnetic multilayer structure"	a structure including a nucleation host that is exchange coupled to a hard magnetic storage layer "exchange coupled" means the magnetic moments in the nucleation host interact through exchange with the moments in the hard magnetic storage layer '864 Patent, Cl. 1; '997 Patent, Cls. 1, 7
"wherein: Hc(α=20°)<Hc(α=45°)"	Plain meaning - wherein the coercive field if angle alpha (between an external field and a normal of the recording medium) = 20 degrees, is less than the coercive field if alpha = 45 degrees '864 Patent, Cl. 7; '997 Patent, Cls. 3, 8
"coupling layer"	layer that alters the coupling between adjacent layers '864 Patent, Cls. 13, 15; '997 Patent, Cls. 5, 7
"the nucleation host is coupled to the hard magnetic storage layer by an exchange coupling layer"	the nucleation host is coupled to the hard magnetic storage layer by a layer that alters the exchange

	coupling between the nucleation host and the hard magnetic storage layer '864 Patent, Cl. 15
"an exchange coupling sufficiently strong to enable a formation of a domain wall across an interface of the hard magnetic storage layer and the nucleation host during reversal"	Plain meaning - the exchange coupling between the nucleation host and the hard magnetic storage layer is sufficiently strong to enable the formation of a domain wall that propagates through the nucleation host and reverses the hard magnetic storage layer during writing '864 Patent, Cl. 15
"nucleation host … comprises ferromagnetic layers with increasing anisotropy constant K from layer to layer"	nucleation host includes two or more ferromagnetic layers which have anisotropy constants K, and the values of the anisotropy constants K for the layers increase as the layers get closer to the hard magnetic storage layer, such that the nucleation host has an overall increase in anisotropy toward the hard magnetic storage layer '864 Patent, Cl. 1; '997 Patent, Cls. 1, 7
"ferromagnetic layers"	layers with a net magnetic moment Ms greater than zero in the absence of an applied magnetic field '864 Patent, Cls. 1, 4; '997 Patent, Cls. 1, 7
"nucleation host"	a structure that includes ferromagnetic layers that assist in switching the hard magnetic storage layer, and optional coupling layers '864 Patent, Cls. 1, 2, 4, 10, 11, 13, 14, 15; '997 Patent, Cls. 1, 4, 5, 6, 7, 9
"hard magnetic storage layer"	a magnetic layer that stores information in magnetically oriented bits '864 Patent, Cls. 1, 2, 4, 5, 13, 15, 15; '997 Patent, Cls. 1, 5, 6, 7
"underlayer"	one or more layers on which the hard magnetic storage layer is formed '864 Patent, Cl. 1; '997 Patent, Cls. 1, 7
"wherein Hm(α) is a field to reduce a normalized magnetization from a saturation to -0.5"	No construction required '864 Patent, Cl. 8

"a thin exchange coupling layer"	a layer that is sufficiently thin to alter but not prevent exchange coupling between adjacent ferromagnetic layers '997 Patent, Cl. 7
"domain wall"	The domain wall is the region over which magnetic moments of the material are changing from one direction to another in response to a magnetic field '864 Patent, Cl. 15
"the recording medium is usable for at least one of perpendicular recording or recording on patterned element"	"the recording medium is capable of being used as either perpendicular recording media or bit patterned media." '864 Patent, Cl. 23

VI. LEVEL OF ORDINARY SKILL IN THE ART

28. In my opinion, a person of ordinary skill in the relevant art of the patents-in-suit, around the time of their filing, had at least a bachelor's degree or equivalent in physics, material science, electrical engineering, chemistry or other similar discipline with coursework pertaining to magnetism or magnetic materials, and two years of experience in magnetic media systems. More education can supplement practical experience and vice versa. I refer to a person having this level of ordinary skill in the art as a "POSITA." For example, a POSITA would have education and/or experience sufficient to understand magnetic media systems design and related concepts.

29. I understand Dr. Bertero contends that a person of ordinary skill in the art had

- A Ph.D. in electrical engineering, physics, material science, or chemical engineering, with two years of practical experience;
- A Master's degree in electrical engineering, physics, material science, or chemical engineering, with four years of practical experience;
- A Bachelor's degree in electrical engineering, physics, material science, or chemical engineering, with six-eight years of practical experience.

30. Although Dr. Bertero's description (which Dr. Victora adopts for his analysis) requires a higher level of education and/or experience, the differences would not affect my opinions. In other words, my opinions are the same whether I apply the perspective of a POSITA under either my description or Dr. Bertero's.

31. I have deep familiarity with the skill and knowledge of a POSITA. In the June 2006 timeframe, my qualifications exceeded those of a POSITA under both my description and Dr. Bertero's. I also worked closely with and directed engineers who were at the level of ordinary skill in the art under both my description and Dr. Bertero's.

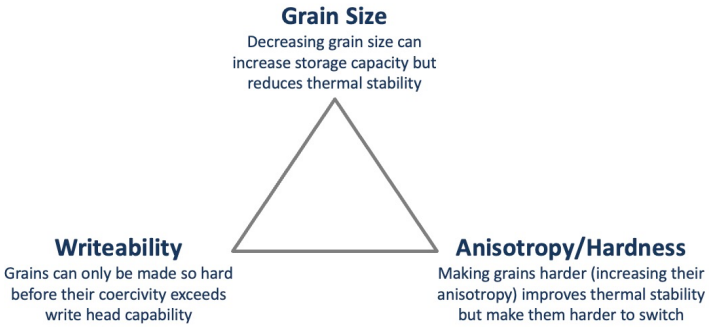
VII. BACKGROUND

A. Technology Background

32. Before the invention, the amount of data that could be stored in the storage layer-the areal density-had been restricted by what is known as the "superparamagnetic limit." In particular, a primary approach for increasing areal density was to use smaller magnetic grains in the storage layer which reduced the area (the size of each cluster of grains) representing single bit of data. But grain size could only be decreased to a certain extent before becoming thermally unstable. '864 patent at 1:11-25.

33. One way to make smaller grains thermally stable is to make them "harder"—i.e., increase their anisotropy. But the harder the grains, the higher the write field that must be applied to reverse their magnetization to record a bit. As a result, high anisotropy grains are thermally stable but "[could] not be written with existing recording heads." The superparamagnetic limit and this trilemma prevented PMR media makers from achieving greater areal density. *Id*.

Main way to increase storage capacity (number of bits disk can store) is to decrease grain size
But grains can only be made so small while still reliably storing data – this is called the "superparamagnetic limit"



B. Overview of the Patents-in-Suit

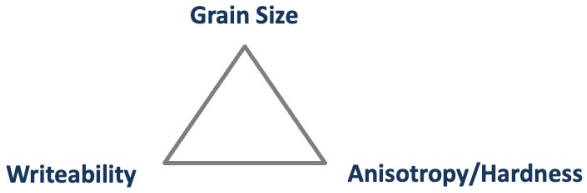
34. I prepared the Overview of the Asserted Patents section of MR Tech's November 3, 2023 Opening Claim Construction Brief, which I incorporate herein by reference. Because the patents-in-suit share a common specification, I primarily cite to the earlier-filed '864 patent for ease of reference.

35. The patents-in-suit describe the recording trilemma that I discussed above:

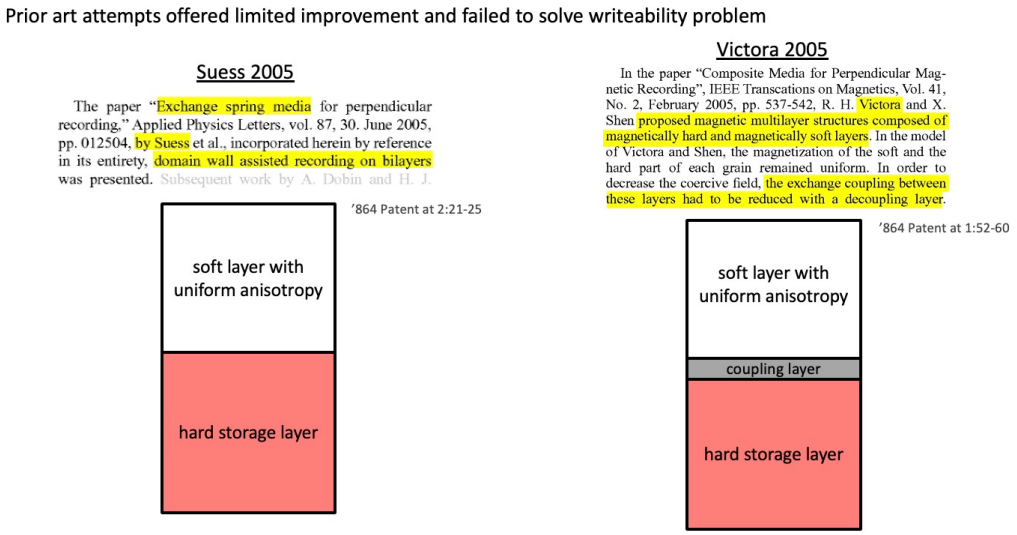
Description of Related Art

Modern magnetic recording media reaches ever higher recording densities. Further increase of the areal density is believed to be limited by the superparamagnetic limit. This limit represents that as the size of the magnetic grains in the media decrease, at some grain size the thermal fluctuations at room temperature $k_B T_{300}$ become capable of overcoming the energy barrier $\Delta E = KV$, which separates the two magnetization directions of an isolated grain with a volume V and an uniaxial anisotropy constant K. This superparamagnetic limit, or thermal instability, can be overcome by increasing the anisotropy K, according to the Stoner-Wohlfarth theory. However, such an increase also results in an unfavourable increase of the coercivity H_c. As a consequence, these grains are thermally stable but can not be written with existing recording heads.

'864 Patent at 1:10-25

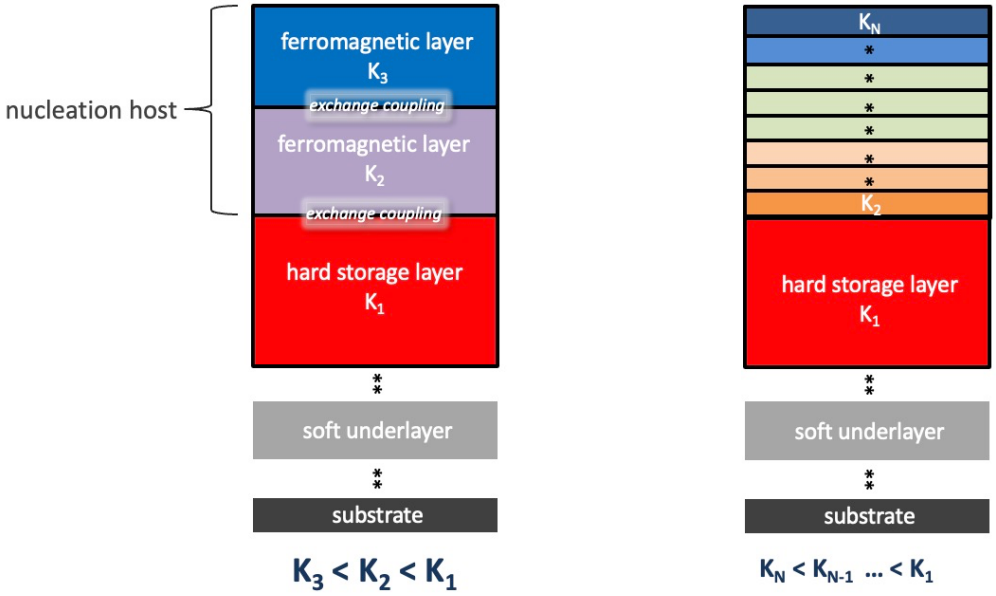


36. The patents-in-suit describe and claim novel recording PMR media that transcended the prior art attempts to improve writability and overcome the super paramagnetic limit. Two prior art attempts were proposed in 2005 by Dr. Dieter Suess, the inventor of the patents-in-suit, and Dr. Randall Victora. Both used a single homogenous soft layer with uniform anisotropy exchange coupled to a hard storage layer:



37. The patents-in-suit disclose that instead of a single layer with uniform anisotropy, a multi-layer nucleation host with increasing anisotropy toward the hard storage layer significantly reduces the write field required to switch the hard storage layer. In particular, the patents-in-suit teach the use of a multi-layer nucleation host on the hard storage layer. The nucleation host has two or more ferromagnetic layers with increasing anisotropy layer to layer toward the hard storage layer. Adjacent ferromagnetic layers of the nucleation host are exchange coupled with each other either "direct[ly] or via a thin coupling layer." The nucleation host is also exchange coupled to the hard storage layer, and that coupling can also be direct or via a thin coupling layer. And as with all PMR media, the hard storage layer is formed on an underlayer which is formed on a substrate.

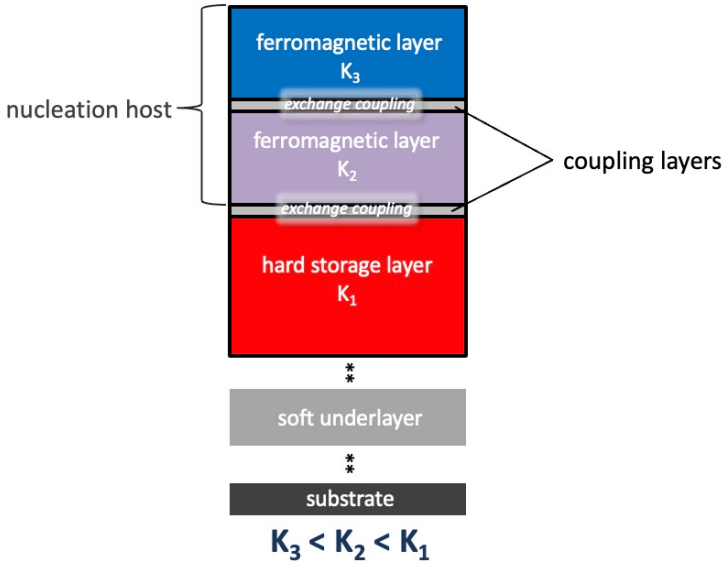
38. The patents-in-suit focus on the multilayer structure above the underlayer. One embodiment is referred to as a "trilayer" structure. In this embodiment, as shown on the left below, the nucleation host includes two ferromagnetic layers—the upper layer (blue) has a lower anisotropy than the lower layer (purple)—and is formed on a hard storage layer (red), which in turn is formed on an underlayer, with the substrate at the bottom. In other embodiments, as shown on the right below, the nucleation host includes more than two ferromagnetic layers with increasing anisotropy layer to layer toward the hard storage layer.



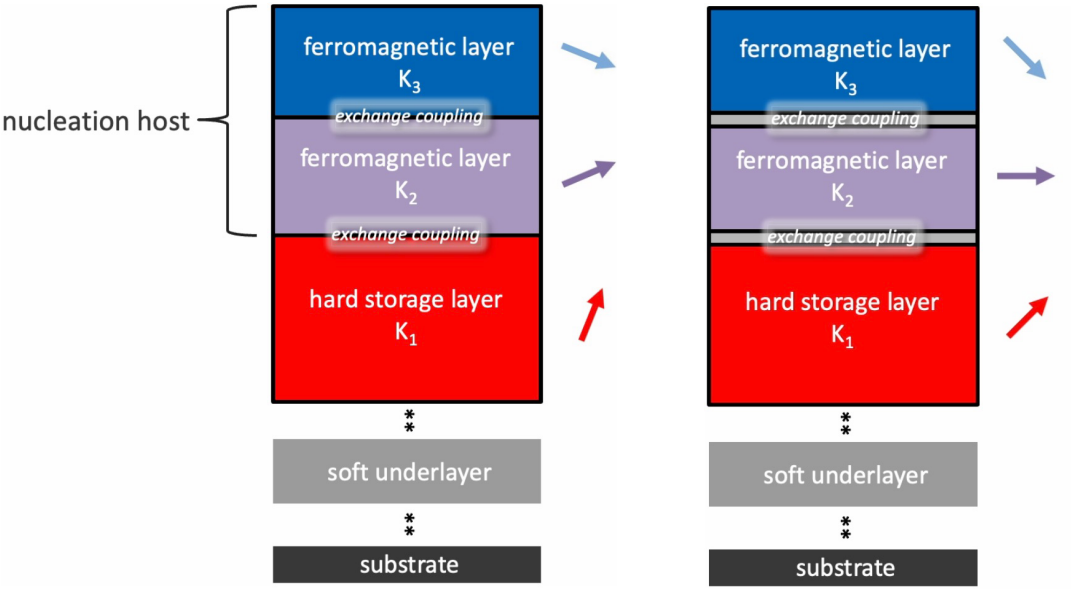
'864 patent at 2:63-3:3.

39. The exchange coupling between ferromagnetic layers of the nucleation host can be optimized using a coupling layer (grey). *See, e.g.*, 10/27/23 Bertero Tr. 39:22-40:2 ([redacted]"); '864 patent 1:58-60 ("In order to decrease the coercive field, the exchange coupling between these layers had to be reduced with a decoupling layer."), 2:63-3:1 ("The exchange coupling can be direct or via a thin coupling layer in order to achieve strong coupling."); Desai Tr. 83:4-9 ("[redacted]"), 109:14-18, 110:6-9, 110:10-14; Ikeda Tr. 31:16-32:13, 41:5-24, 42:11-20. The exchange coupling between the nucleation host and hard storage layer can also be optimized using a coupling layer (grey). *See id.* Abstract ("The strong exchange coupling can be through a coupling layer or direct."), 5:12-16 ("The exchange coupling between hard magnetic storage layer 24 and nucleation

host 21 can be sufficiently strong to enable the formation of a domain wall across the interface of these layers during reversal.").



40. As shown in the animations I prepared for the Tech Tutorial, screenshots of which are provided below, the exchange coupling between layers—whether direct (left) or via a coupling layer (right)—allows their magnetic moments to interact. The blue arrow represents the magnetic moments of the softer ferromagnetic layer (blue), the purple arrow represents the magnetic moments of the harder ferromagnetic layer (purple), and the red arrow represents the magnetic moments of the hard storage layer (red). When a write field is applied to the blue layer, its magnetic moments begin rotating. Through the exchange coupling with the purple layer, this causes the magnetic moments of the purple layer to rotate. And through the exchange coupling with the red storage layer, this in turn causes the magnetic moments of the red layer to rotate.

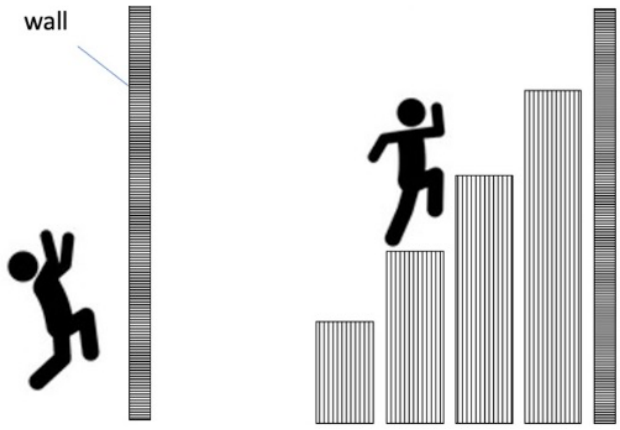


41. The ferromagnetic layers of the nucleation host significantly reduces the write field required to switch the hard storage layer. The idea is that the anisotropy will increase from the upper nucleation host layer to the lower nucleation host layer. The write field can reverse (flip) the magnetic moments in the upper host layer with lower anisotropy (even though the write field may not be strong enough to reverse the magnetic moments of the hard storage layer). Flipping the magnetic moments in the nucleation host helps to flip the magnetic moment in the hard storage layer. Flipping the magnetic moment of the material in the hard (and therefore thermally stable) storage layer writes a bit (0 or 1) to the hard storage layer. '864 patent, Abstract ("The nucleation host decreases the coercive field significantly while keeping the energy barrier of the hard layer almost unchanged. The coercive field of the total structure depends on one over number of layers in the nucleation host."), 2:58-3:3.

42. More specifically, the write field causes magnetic moments in the uppermost ferromagnetic layer of the nucleation host to rotate which in turn cause magnetic moments in the next ferromagnetic layer to rotate. This continues until rotating magnetic moments in the bottommost ferromagnetic layer of the nucleation host cause magnetic moments in the hard storage

layer to rotate and record a bit. *See id*.; MRT_WD00001845 (Bertero, Varvaro (Ed.) "Ultrahigh-Density Magnetic Recording; Storage Materials and Media Designs") at pgs. 74-75.

43. By analogy, the hard storage layer can be thought of as a wall and the nucleation host as stairs. The taller the wall, the greater the energy needed to jump over it. The invention enables the wall to be taller (the hard storage layer to be made harder and thus thermally stable despite smaller grain size) while reducing the energy needed to go over it. The invention went against the conventional wisdom of minimizing the distance between the hard storage layer and the write head and that adding softer layers of material between them would weaken and reduce the sharpness of the write field (which in turn reduces SNR). It was also counterintuitive that using multiple layers of increasing anisotropy toward the hard storage layer would decrease coercivity while at the same time maintain thermal stability. These unexpected results led to wide industry praise as discussed in Objective Indicia below.

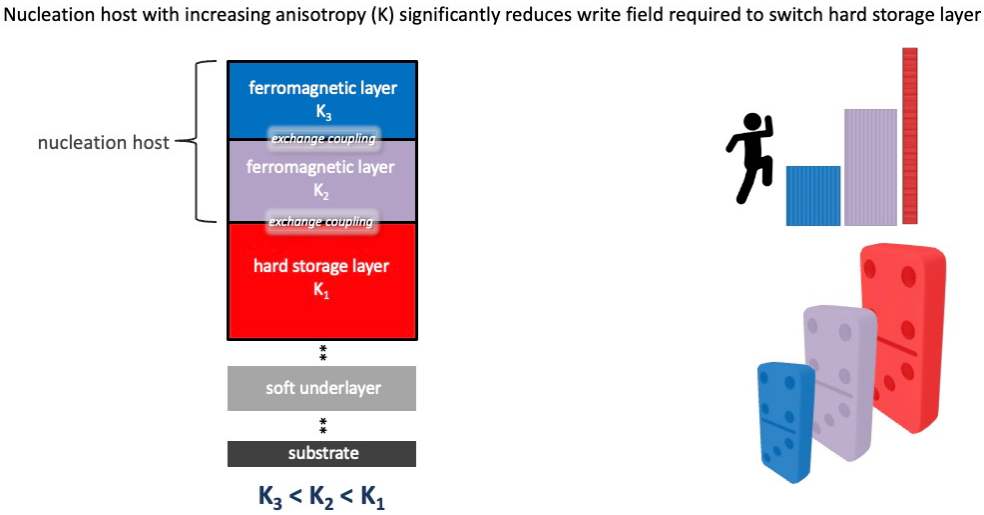


44. By another analogy, the hard storage layer can be thought of as a large domino and the nucleation host as a row of smaller dominos that generally increase in size toward the large domino. The invention enables the large domino to be larger (the hard storage layer to be made harder and thus more thermally stable despite smaller grain size) while reducing the energy needed to flip it. As shown in the animation I prepared for the Tech Tutorial, a screenshot of which is

provided below, the write head only needs enough energy to flip a small domino in order to flip the large domino.



45. These analogies are further illustrated below.



46. The invention thus provides "marked improvement against the superparamagnetic limit" by "overcom[ing] the writeability problem of extremely hard magnetic storage layers with high thermal stability." '864 patent Abstract.

VIII. THE ASSERTED CLAIMS ARE NOT INVALID IN VIEW OF THE ALLEGED PRIOR ART

A. Overview of the Asserted Prior Art

1. *Li*

47. *Li* (US 7,846,564) is a Seagate patent that was filed September 27, 2005. *Li* describes a recording layer formed of multiple sub-layers. In every embodiment, the hard storage layer is the top sub-layer which is closest to the write head and farthest from the substrate. The top sub-layer has the highest anisotropy field (Hk) and the underlying sub-layers have decreasing Hk. For example, in Fig. 3 below, the top sub-layer (M1) is the hard storage layer with the highest Hk and the underlying sub-layers (M2, M3, M4) have decreasing Hk values—$H_{k1} > H_{k2} > H_{k3} > H_{k4}$.

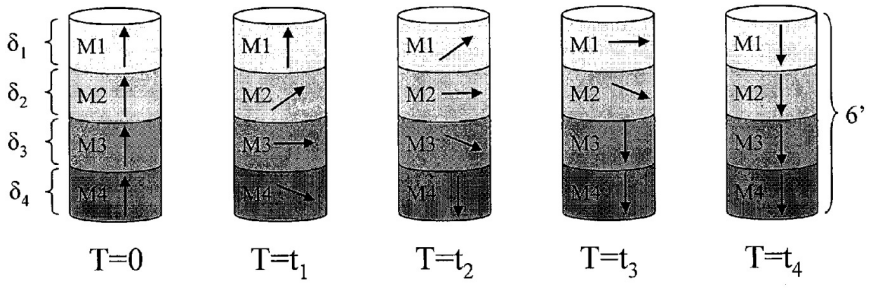


FIG. 3

48. The write head writes to the hard storage layer (M1) by generating a write field (or "head field"). The strength of the head field decreases away from the write head, toward the bottom sub-layer M4. *Li* refers to the decreasing strength of the head field down the stack as the head field gradient. Although the head field is weakest at the bottom sub-layer M4, it has an Hk that is low enough to enable the write field to flip its magnetization. The head field also exerts a torque on the overlying sub-layers M1, M2, and M3, but not enough to flip them. As a result, "[t]he magnetization reversal process is initiated at the bottom-most sub-layer M4 … and proceeds upwardly in sequence from sub-layer M4 to the overlying sub-layers M3 and M2" and ultimately

the hard storage layer M1. *Li* 9:45-55; *see also Li* 9:23-31 ("FIG. 3 shows the quasi-incoherent magnetization reversal process…of a magnetic grain according to the invention, comprised of 4 moderately exchange coupled, vertically stacked sub-layers layers M1, M2, M3, and M4…, and where the perpendicular magnetic anisotropy field Hk progressively decreases from sub-layer M1 to sub-layer M4").

49. Other embodiments have more or fewer underlying sub-layers but in every case, the hard storage layer (the sub-layer with the highest Hk) is at the top of the stack, nearest the write head, and the reversal process starts at the bottom sub-layer and proceeds upwardly. *See, e.g.*, 5:20-25, 5:36-6:22, 11:55-44; Figs. 3-5.

a) *Li* Teaches that the Highest Hk Sub-Layer (HSL) at the Top of the Stack and an Hk Gradient that Decreases Away from the Write Head Is Foundational to *Li*'s Proposed Media

50. Consistent with conventional wisdom at the time, *Li* emphasizes the importance of the hard storage layer being at the top so that it is nearest the write head. *See, e.g.*, US 7,550,210 ("[A] write head produces a larger magnetic field and larger field gradient near the surface of the [recording layer (RL)], while the field strength decreases further inside the RL."). *Li* explains that its proposed media with a thinner hard storage layer on top nearest the write head dramatically improves signal-to-noise ratio (SNR) and enables a corresponding increase in areal density. The HMS is given by the distance from the write head to the midpoint of the hard storage layer. *See Li* 11:6-24. This is because the soft underlayer below the hard storage layer provides a mirror image of the head field. *See, e.g.*, MRT_WD00001845 (Bertero, Varvaro (Ed.) "Ultrahigh-Density Magnetic Recording; Storage Materials and Media Designs") at pg. 58 ("PMR media also contain a magnetic soft underlayer (SUL) that provides an image to the field of the write head to enhance the writing field.").

51. For example, in the conventional media of Fig. 2 below, the recording layer 6 is formed of uniform magnetic grains with uniform Hk. Thus, the hard storage layer is the entire thickness (δ) of the grains. Assuming that the hard storage layer is a distance (d) of 6 nm below the write head and has a thickness (δ) of 20 nm, the HMS is 6 nm + (20 nm / 2) = 16 nm.

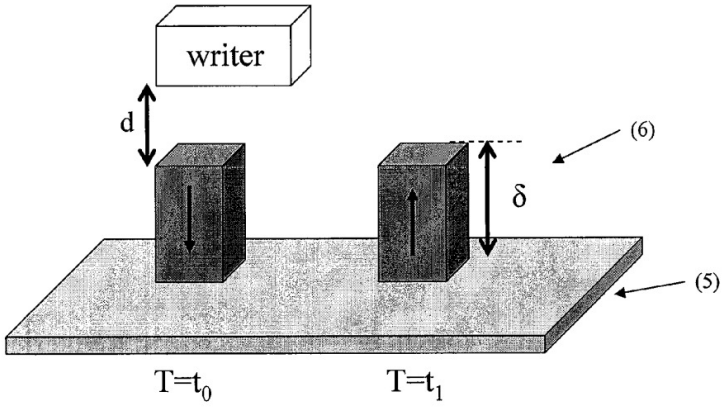
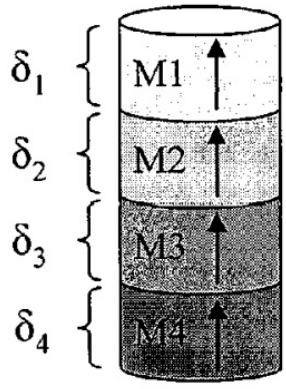


FIG. 2

Li 11:6-24, Fig. 2.

52. By contrast, in the media proposed by *Li* shown in Fig. 3 below, the hard storage layer is the top sub-layer of the grain. Assuming that the hard storage layer is a distance (d) of 6 nm below the write head and has a thickness (δ_1) of 5 nm, the HMS is only 8.5 nm—despite an overall grain thickness (the combined thickness of all four sub-layers) of 20 nm. This amounts to a nearly 50% decrease in HMS compared to the conventional media of Fig. 2.



Li Fig. 3, 11:6-24.

53. *Li* teaches that the "dramatic decrease in HMS afforded by the invention" dramatically improves SNR (meaning a higher percentage of the grains that should be flipped during a write process do get flipped) which in turn enables increase in areal density:

> As a consequence, ***the SNR's of the inventive anisotropy gradient grains and conventional, uniform grains will be dramatically different***. For example, it is conservatively estimated that use of a 3 sub-layer perpendicular magnetic recording layer with anisotropy gradient according to the invention would provide ***at least a 1-3 db increase in SNR (facilitating a corresponding increase in recording density) by virtue of the dramatic decrease in HMS afforded by the invention***.

Li 11:16-24; *see also* 13:4-10 ("[T]he present invention provides perpendicular magnetic recording media fabricated with a main recording layer comprised of columnar-shaped magnetic grains with ***specifically designed gradients*** of magnetic anisotropy, i.e., gradients ***of perpendicular magnetic anisotropy field (Hk)*** … which provide good writability and signal-to-noise ratio (SNR).").

54. *Li* further emphasizes the importance of the top sub-layer being the hard storage layer in its proposed media. *Li* teaches that this provides the smallest HMS, highest magnetic volume, and highest achievable writeability:

> Optimized media designs facilitated by the present invention afford the ***smallest actual effective head-media spacing (HMS)***, ***highest actual magnetic volume KμN***, and ***highest achievable writability at the effective volume KμV***.

Li 12:66-13:3.

55. Indeed, *Li* discloses that "the head field magnetic gradient should be less than the gradient of magnetic anisotropy of the various sub-layers constituting the magnetic grains … resulting in significant reduction of the effective head-media spacing (HMS), and thus providing a very substantial improvement in recording performance." *Li* 11:25-31. In other words, the rate at which the head field's strength decreases away from the write head should be less than the rate at which the Hk (the ability to resist flipping) decreases from the top sub-layer down. This is

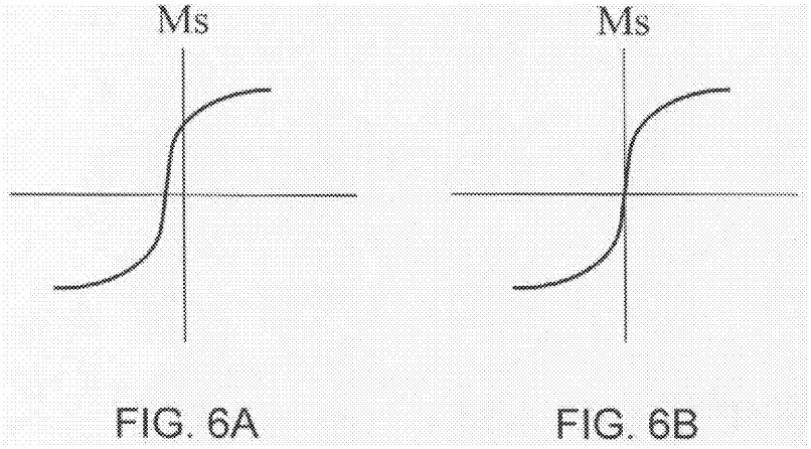
critical for *Li*'s proposed media because it ensures that "the magnetization reversal process is initiated at the bottom-most sub-layer" (e.g., the M4 sub-layer in Fig. 3). *Li* explains that this is fundamental to the operation of its proposed media and how it achieves an improvement over conventional, uniform grain media:

> Stated differently, when the magnetic grains are comprised of sub-layers with a anisotropy gradient, ***application of the external writing field from the head causes the sub-layer with the smallest perpendicular magnetic anisotropy field Hk, i.e., the lowermost sub-layer of the stack, to switch or reverse its magnetization direction***. This substantially simultaneously induces a quasi-incoherent rotation process in the overlying sub-layers of higher magnetic anisotropy. The magnetization reversal process in each grain is essentially an incoherent rotation process, i.e., a type of induced "quasi-buckling" or "curling" process, which is ***generated in the lowermost sub-layer*** with high magnetic moment and relatively lower intrinsic anisotropy, via tailored exchange interactions. By contrast, coherent magnetization reversal in conventional magnetic grains requires a larger switching field and poor media writability, resulting in difficulty in obtaining high density recording with good writability and thermal stability.

Li 9:57-10:6.

56. *Li* discloses additional benefits of the Hk gradient of its proposed media where the top sub-layer has the highest Hk and the underlaying sub-layers have decreasing Hk. *Li* teaches that it improves switching field distribution (SFD), meaning the grains have a more uniform response (the grains all flip in response to approximately the same external field strength threshold). *See Li* 11:42-50. This makes the write process more precise and reliable because it reduces the percentage of grains not flipping properly due to varying sensitivity to the magnetic field. This in turn reduces noise (increases SNR) which improves the ability to accurately read the data written to the hard storage layer. As *Li* explains, its proposed media provides "sharper and/or more symmetric at the written transition locations." *Li* 11:42-50. As shown in Figs. 6(A) (conventional media) and 6(B) (*Li*'s proposed media) below, the transition locations with *Li*'s

proposed media occur when Ms (saturation magnetization) is at or closer to zero and thus the grains flip at closer (sharper) magnetic field thresholds. *Li* 11:42-50.



57. A POSITA would thus have understood that—in accordance with conventional wisdom and the teachings of *Li*—the top down Hk gradient (Hk decreasing away from the write head) is foundational to achieving *Li*'s intended purpose of minimizing HMS, dramatically improving SNR, and maximizing writability. *See, e.g.*, *Li* 12:66-13:3 ("[T]he present invention afford[s] the smallest actual effective head-media spacing (HMS), highest actual magnetic volume KμN, and highest achievable writability at the effective volume KμV."). Indeed, *Li* discloses numerous alternative embodiments and in each, the top sub-layer has the highest Hk and is the hard storage layer. The claims of *Li* likewise uniformly describe that the highest Hk is at the top of the stack and progressively decreases away from the write head and toward the substrate. *See, e.g.*, *Li* claim 1 (Hk "progressively decreases from a sub-layer at said first end to a sub-layer at said second end of each of said magnetic grains" where the first end is "distal said substrate surface" and the second end is "proximal said substrate surface.").

b) Seagate Did Not Follow the Path Taught by *Li*; It Followed the Path Taught by Suess

58. At the time the *Li* patent was filed in 2005, I was Senior Vice President of Seagate's advanced media research and development team. I personally knew the *Li* inventors, Shaoping *Li*,

Kaizhong Gao, Lei Wang, Wenzhong Zhu, and Xiaobin Wang, because they were all part of my team. And having served as Senior Vice President of Recording Media Operations from 2009 to 2013 and as CTO from 2013 to 2018, I have personal knowledge that Seagate did not follow the path taught by *Li*. Instead, Seagate followed a different path—the counterintuitive path taught by Suess in the asserted patents which, as discussed above, defied conventional wisdom and achieved unexpected results.

2. *Victora*

59. Dr. Victora states that *Victora* "refers to three references reflecting the same body of work" which he identifies as *Victora-1*, *Victora-2*, and *Victora-3*. VR 90. *Victora-2* and *Victora-3* are discussed in the asserted patents. '864 patent 1:52-2:6. *Victora-1* provides additional simulation modeling on the same media concept of *Victora-2* and *Victora-3*. *Victora* is cited among the References Cited on the face of the patents. Thus, I understand that the patent office considered *Victora* and found that it did not render the claimed invention obvious. The patent office found that the closest prior art was a 2005 presentation by Dr. Suess which, like *Victora*, disclosed a single soft layer on a single hard layer. The patent office concluded that "the prior art of record does not teach or suggest … a nucleation host comprising multiple ferromagnetic layers with increasing anisotropy constant K from layer to layer." '997 FH NOA; '864 FH NOA.

60. All three *Victora* references are directed to bilayer recording media that behaves like tilted media (I explain what tilted media is and how it works below). *Victora*'s bilayer media consists of a single hard layer having high anisotropy formed on a single soft layer having very low anisotropy, such that the media emulates tilted media. The hard layer is exchange coupled to the underlying soft layer via a coupling layer. None of the *Victora* references discloses or suggests using multiple softer layers let alone softer layers having anisotropy constants that increase toward the hard layer. All three disclose that it is the use of a single soft layer with very low anisotropy

that enables *Victora*'s proposed media to emulate tilted media. Indeed, *Victora* teaches that its "exchange coupled composite media … ***allows for two*** layers of granular media"—a single hard layer and a single soft layer with an anisotropy low enough that it effectively tilts the angle of the write field to emulate tilted media. *Victora-1* at p. 2832, *see also Victora-2* at p.537-538, *Victora-3* at p. 1.

a) Tilted Media Background

61. *Berger* explains the concept of tilted media. Referring to Fig. 2 below, in conventional perpendicular media, "the magnetization 206, or magnetic easy axis 206, of the magnetic recording layer 110 is oriented nearly parallel to the magnetic field 116." *Berger* 2:22-25.

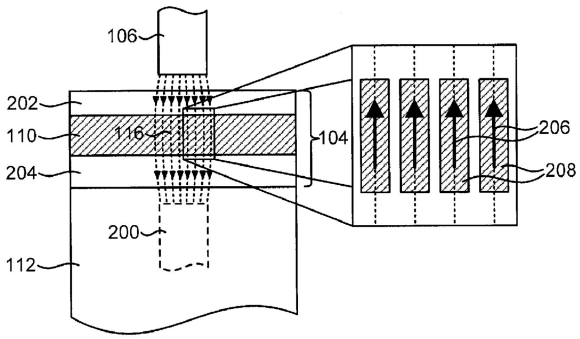


Fig. 2

Berger Fig. 2. As a result, "relatively high reversal fields are necessary to reverse the magnetization 206 of the grains 208 of the magnetic recording layer 100 because little or no torque is exerted onto the grain magnetization 206 by the magnetic write field 116." *Berger* 2:25-29; *see also Victora-1* at 537 ("[P]erpendicular magnetic recording incurs a significant disadvantage in writability owing to the close alignment of the [easy axis] and the recording field.").

62. Tilted media was proposed to address this problem. In tilted media, the magnetic grains of the hard storage layer are tilted away from the perpendicular (up-down) axis so that the

magnetic easy axis is at an angle rather than parallel to the write field. *Berger* 2:22-46. This allows the write field to exert more torque on the magnetization (magnetic moments) of the grains, making it easier to flip their magnetization and write to the hard storage layer. As *Victora* explains, "media with easy axis tilted at 45° (this is the optimal case)" can reduce the coercive field of the grains by half which in turn reduces the write field required to flip the grains by half. *Victora-1* at 537; *Victora-3* at p. 1 ("The easy axis of tilted media is adjusted from out-of-plane direction to 45° and its switching field is decreased to 0.5 Hk as compared to Hk in the perpendicular case.").

63. The problem with tilted media was it could not be reliably fabricated. In particular, existing fabrication techniques could not control the tilt angle of the grains. *Berger* 2:36-38 ("methods for producing high-quality recording media with a uniformly tilted easy axis do not exist."), *Victora-2* at 537 ("[I]n spite of the advantages of tilted media, its difficulty in fabrication prevents it from wide usage in real applications."); *Victora-3* at 1 ("[I]n spite of the advantages of tilted media, there is no practical method to fabricate such media.").

b) *Victora*'s Tilted Media Equivalent Uses a Single Hard Layer on a Single Soft Layer Having Very Low Anisotropy

64. *Victora* proposes perpendicular recording media that emulates tilted media but is easier to fabricate. In *Victora*'s tilted media equivalent (referred to as "dynamic tilted media" or "exchange coupled composite (ECC) media"), the "grains each consist[] of two parts: a magnetically hard part with perpendicular anisotropy and ***a magnetically soft part where the anisotropy can point in any direction provided it is small***." *Victora-1* at 2828. This enables *Victora*'s proposed bilayer media to achieve a reduction in the coercive field similar to tilted media. *See Victora-2* at 537; *Victora-1* at 2828; *Victora-3* at 1.

65. As shown in the schematic on the left of *Victora-2*'s Fig. 1 below, *Victora* attempted to achieve a tilted media equivalent using a hard layer with high perpendicular

anisotropy (K_2) exchange coupled to a hard layer with high longitudinal anisotropy (K_1). This media failed to behave like tilted media and only achieved a maximum thermal barrier to switching field ratio of 1.2 (whereas tilted media achieves a ratio of 2).

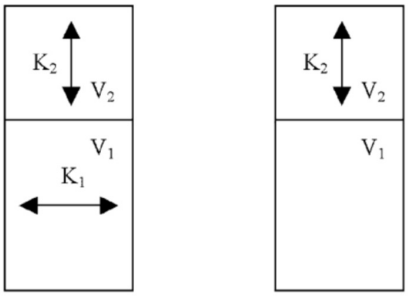


Fig. 1. Grain schematic diagram.

66. *Victora* found that if the ratio of K_2 to K_1 is infinity (i.e., K_1 has zero anisotropy), the media can achieve a thermal barrier to switching field ratio of "very close to two." *Victora-2* at 539. This led *Victora* to the grain structure on the right, consisting of a single hard layer with high anisotropy K_1 on top and a single soft layer with zero anisotropy on the bottom. *Victora-2* at 538 ("This result leads to our change of grain structure from containing two hard magnetic regions to one hard magnetic region (on top) together with ***one soft magnetic region*** (on bottom) as shown in the right part of Fig. 1."). *Victora* provides simulations demonstrating the tilted media behavior of this media where K_2 = 20 Mergs/cc and K_1 = 0. *Victora* explains that because it has zero anisotropy, the magnetization of the soft layer can "rotate and, thus, change the angle of the exchange field applied to the hard region."

67. *Victora* teaches that although it may not be possible to fabricate a soft layer having zero anisotropy, the soft layer should have less than 1/10 the anisotropy of the hard layer. *Victora-2* at 539 ("[I]n physically realizable materials, the anisotropy of the soft region K_1 may not be zero."). This allows the soft layer to tilt the write field to achieve tilted media behavior. *Victora-2*

at 539-541. *Victora* concludes, "in real applications, ***we just need to control the anisotropy of the soft region to be less than 1/10 of that of the hard region***." *Victora-2* at 539.

68. The use of a single soft layer with less than 1/10 the anisotropy of the overlying hard layer also achieves an equivalent increase in SNR to tilted media. Conventional media has high sensitivity to deviations in easy axis orientation. If the grains are not uniformly aligned to the perpendicular axis, even deviations of 1° significantly increases noise (the percentage of grains that do not flip). *Victora*'s tilted media equivalent greatly reduces this sensitivity. As *Victora* explains, "45° tilted media … has a very high tolerance for easy axis deviation." "Our composite media also exhibits this good property." *Victora-2* at 539.

69. A POSITA implementing *Victora* thus understood that the use of a single soft layer with very low anisotropy enables the tilted media behavior that achieves the benefits taught by *Victora*, including a near 50% reduction in the required write field and significantly higher SNR. As explained in *Victora-1*, the culmination of the *Victora* work, "Exchange coupled composite media … allows for ***two*** layers of granular media." *Victora-1* at 2832. A POSITA understood that adding an intervening layer with higher anisotropy than the very low anisotropy soft layer would defeat *Victora*'s core objective of emulating tilted media.

c) *Victora* Teaches that the Hard Layer Should Be Formed on Top of the Soft Layer

70. Although *Victora-2* mentions the possibility of putting the soft layer on top of the hard layer as a topic for potential research, it does not disclose that doing so would be beneficial. Moreover, *Victora-3* teaches that after developing a prototype of *Victora*'s tilted media equivalent where "the hard layer was put on the bottom and the soft layer on top," *Victora* concluded that "it is a better idea to reverse the position of these two layers." *Victora-3* at 1. And given that this

was consistent with the conventional wisdom of putting the hard layer nearest the write head, this would have further discouraged a POSITA from putting the soft layer on top.

3. *Berger*

71. *Berger* issued from a parent application filed September 21, 2005 which has the same specification. The parent application issued as U.S. 7,687,157 (*Berger-157*). The asserted '997 patent cites *Berger-157*. Thus, I understand that the patent office considered the teachings of *Berger* (which are the same as *Berger-157*) and found that it did not render the claimed invention obvious. The patent office found that the closest prior art was a 2005 presentation by Dr. Suess which, like *Berger*, disclosed a single soft layer on a single hard layer. The patent office concluded that "the prior art of record does not teach or suggest … a nucleation host comprising multiple ferromagnetic layers with increasing anisotropy constant K from layer to layer." '997 FH NOA.

72. This is consistent with a POSITA's understanding that *Berger*, like *Victora* (which was also cited and considered by the patent office), is directed to bilayer media that uses a single soft layer exchange coupled to a single hard layer, such that it behaves like tilted media. In every embodiment of *Berger*, there is only a single soft layer exchange coupled to a single hard layer. There is no teaching or suggestion of using multiple soft layers let alone having anisotropy constants that increase toward the hard layer. And as with *Victora*, a POSITA would have understood that adding an intervening layer with higher anisotropy than the soft layer would defeat *Berger*'s core objective of emulating tilted media.

73. As *Berger* explains, the core objective of its media is to emulate and achieve the benefits of tilted media:

> increased. For these reasons, there have been proposals to produce magnetic media comprising magnetic grains having a magnetic easy axis that is tilted, or non-parallel, with respect to the surface normal. However, at the present time, apparatus and methods for producing high-quality recording media with a uniformly tilted easy axis do not exist.
>
> Accordingly, what are needed are apparatus and methods for improving the writeability of perpendicular magnetic recording media. Further needed are apparatus and methods for producing perpendicular magnetic recording media that behaves like media with a tilted easy axis, while still being fully compatible with currently used processes and structures for producing perpendicular recording media. Such apparatus and methods are disclosed herein.

Berger at 2:33-46. Another *Berger* reference, U.S. 7,550,210 (*Berger-210*), similarly describes *Berger* and *Victora* as tilted media equivalents:

> While there is no known fabrication process to make high-quality recording media with a tilted easy axis, there have been proposals to achieve a magnetic behavior that emulates tilted media using a media structure compatible with conventional media fabrication techniques. In one technique, the perpendicular recording medium is a composite medium of ***two*** ferromagnetically exchange-coupled magnetic layers with substantially different anisotropy fields (Hk). … This behavior, sometimes called the "exchange-spring" behavior, and various types of composite media are described by [*Victora-2*] and [*Victora-3*]. Pending application Ser. No. 11/231,516, filed Sep. 21, 2005 [the parent application to *Berger*] … describes a perpendicular magnetic recording medium with an exchange-spring structure.

Berger-210 at 2:20-45.

74. Referring to Fig. 4 below, *Berger* teaches that when a write field is applied to its tilted media equivalent the soft layer effectively tilts the head field so that the media behaves like tilted media. *Berger* 6:50-53 ("[T]he magnetization 400 b of the softer exchange-spring layer 304 may begin to reverse, thereby exerting a torque onto the magnetically harder magnetic recording layer 302."). As a result, the "the exchange-spring media 300 exhibits a magnetization reversal behavior which is ***similar to a magnetic recording layer having a tilted magnetic easy axis***, while

still being fully compatible with conventional perpendicular media deposition and fabrication processes and structures." *Berger* 6:61-64.

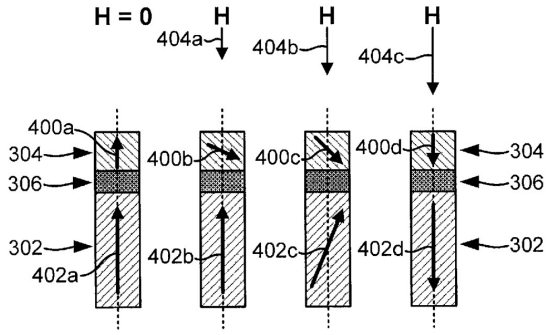


Fig. 4

75. And like *Victora*, *Berger* teaches that its tilted media equivalent improves SNR. *Berger* 8:49-55 ("The higher signal-to-noise ratios and bit error rates for the exchange spring structure 301 as illustrated by FIGS. 7A, 7B, and 8 illustrate that the unique materials and thicknesses used for the exchange spring layer 304 and the coupling layer 306, as recited in the claims, do improve the signal-to-noise ratio and bit error rate of … the magnetic recording layer 302, by itself.").

76. A POSITA implementing *Berger* thus understood that the use of a single soft layer enables the tilted media behavior that achieves the benefits taught by *Berger*, including a significant reduction in the required write field and higher SNR.

4. *Hagedorn*

77. Dr. Victora states that *Hagedorn* "refers to two references, *Hagedorn-1* and *-2*, that have a priority date of 1969 and 1970" that "describe the same work by F. B. Hagedorn and are properly considered as a single reference." Victora Report ¶ 89. *Hagedorn-1* is cited and discussed in the asserted patents. Thus, I understand that the patent office considered *Hagedorn* and found that it did not render the claimed invention obvious. The patent office found that the closest prior

art was a 2005 presentation by Dr. Suess which, like *Victora*, disclosed a single soft layer on a single hard layer. The patent office concluded that "the prior art of record does not teach or suggest … a nucleation host comprising multiple ferromagnetic layers with increasing anisotropy constant K from layer to layer." '997 FH NOA; '864 FH NOA.

78. *Hagedorn* is directed to "evaluation of coupled films as nondestructive readout (NDRO) memory elements." *Hagedorn-1* at 166. Thin-film NDRO memory (I provide a background discussion of thin-film NDRO memory below) is very different from HDD media. Although HDD media existed at the time, *Hagedorn* does not disclose or suggest that its exchange-coupled films could be used for HDD media. *Hagedorn* does not disclose a magnetic recording system, a write head, a substrate or an underlayer. Nor does *Hagedorn* disclose a nucleation host with ferromagnetic layers having increasing anisotropy constants toward an underlying hard storage layer. Rather, the proposed thin-film NDRO memory elements consisted of only two exchange coupled layers.

a) Thin Film NDRO Memory Elements

79. NDRO memory was developed to allow stored data to be read without erasing or altering the stored information (i.e., nondestructively), which was a common drawback of early memory technologies. Early random access memory elements were small magnetic rings through which wires were threaded to write and read information. Each ring stored a bit of information which could be read by determining the direction of the magnetic field in the ring. The read process for core memories involved a destructive process to read the data, meaning the memory had to be switched to read.

80. Thin-film NDRO memory was developed to remove this destructive read process and to reduce the size of the memory elements. To fabricate thin-film NDRO memory, a magnetic

layer several micrometers thick (which at the time was considered a thin-film) was patterned to create individual memory elements, each storing a bit of information.

81. An example of a thin-film NDRO memory element is shown in Fig. 1 (plan view) and Fig. 2 (cross-section) below. The memory element 12 can be magnetized either of two directions. Word lines above (18a) and below (18b) apply a field to the memory element to reverse its magnetization and write a bit of data to the memory element. Sense lines above (16a) and below (16b) are used to sense the magnetization to read the bit of data stored in the memory element.

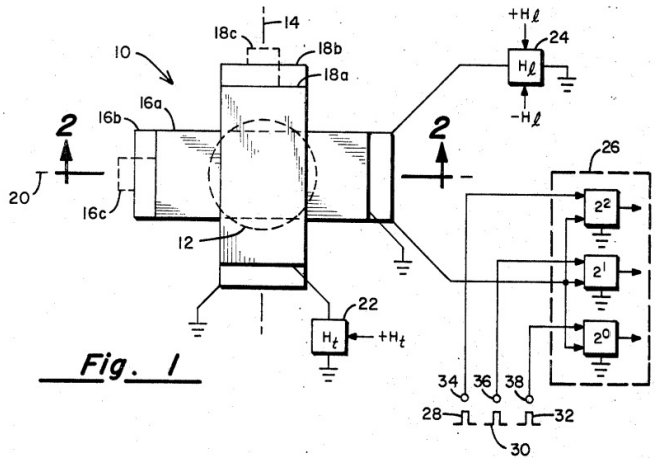


Fig. 1

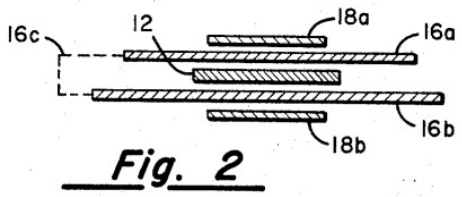


Fig. 2

b) *Hagedorn's* Disclosure Regarding Arbitrarily Low Coercivity Related to Thick Slabs Not Thin-Films

82. *Hagedorn* does not disclose or suggest the use of multiple ferromagnetic layers having increasing anisotropy toward a hard storage layer to reduce coercivity. *Hagedorn* discloses that "a combination of many slabs could yield an arbitrarily low coercive force." *Hagedorn-2* at 2498. Each slab must be "thick enough so that each interface becomes independent of other boundaries." *Id.* And "if all slabs are the same thickness the "effective anisotropy field can be made arbitrarily small." *Id.* Even then, "[f]rom a practical point of view, a linear decrease in anisotropy has been shown to leave a substantial discrepancy between the calculated and experimental coercive forces for reasonable defect sizes." *Id.* And so *Hagedorn* concludes that

anisotropy variations over even larger distances "appear to be required … to achieve coercive forces of the magnitude which are observed" in the model analyzed in *Hagedorn*. *Id.*

83. *Hagedorn* does not suggest that such a multi-slab structure would be useful for any practical application. To the contrary, *Hagedorn* teaches the use of a bilayer structure (with only two layers) for thin-film NDRO memory.

84. And given that *Hagedorn* was published decades earlier and describes fundamentally different memory technology, a POSITA developing PMR media at the time of the claimed invention would not have even looked to *Hagedorn*. Indeed, I searched the Google patents database and the only mention of *Hagedorn* in any patent or application relating to HDD media that I could find was in Dr. Suess's patents and patent applications. And notably, none of the prior art references in Dr. Victora's asserted combinations mentions *Hagedorn*.

B. The Asserted Claims Were Not Obvious Over *Li* Alone or Combined with *Victora* or *Berger*

85. There is no dispute that *Li* does not disclose 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" as the asserted claims require. *See* Victora Report ¶¶ 625-629. As discussed in my overview of *Li* above, in every embodiment of *Li*, the hard storage layer (the highest Hk sub-layer) is at the top and the nucleation host (the lower Hk sub-layers and any coupling layers between them) is under the hard storage layer. In other words, in all embodiments, it is the nucleation host that is between the hard storage layer and the substrate—the exact opposite of the asserted claims.

86. Dr. Victora attempts to overcome this core deficiency by arguing that a POSITA would have modified *Li* to (1) move the highest Hk sub-layer (HSL) to the bottom of the stack and (2) reverse the order of the lower Hk sub-layers so that their Hk values increase downward, toward

the HSL. But Dr. Victora does not explain why a POSITA would have been motivated to do this. He does not identify any problem a POSITA would have been trying to solve, any benefit that his modification would achieve, or any other design incentives that would have led a POSITA to pursue this modification. As explained below, neither a POSITA's knowledge nor *Victora* nor *Berger* would have motivated a POSITA to modify *Li* as Dr. Victora proposes. To the contrary, *Li* teaches away from Dr. Victora's modification and is directed to a fundamentally different design objective than *Victora* or *Berger*.

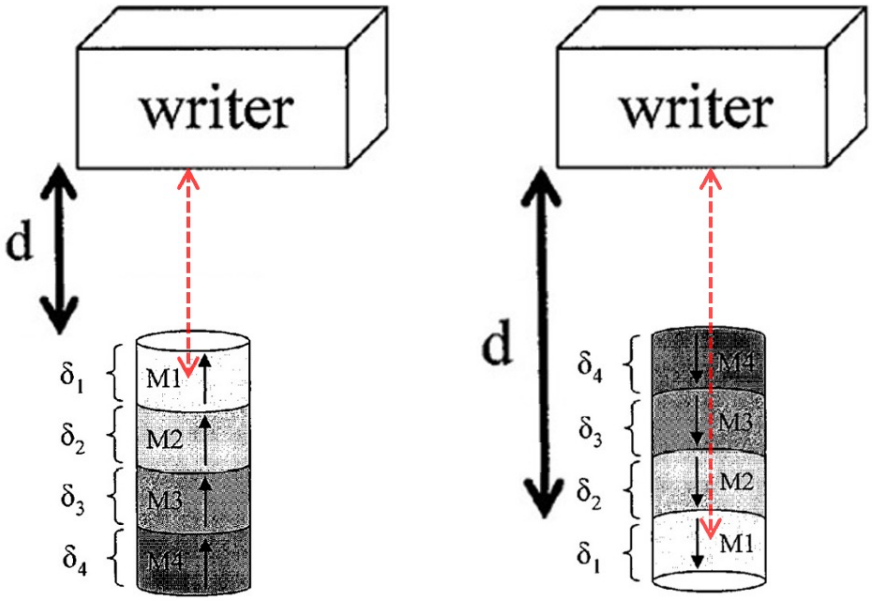
1. A POSITA Would Not Have Modified *Li* Based on the POSITA's Knowledge to Arrive at the Claimed Invention

87. Dr. Victora argues that "[a] POSITA would have known and found it obvious to place the hard layer on the bottom as early researchers fabricating PMR media (Wang and *Berger*) actually did. Suess-2004 also disclosed a hard layer on the bottom near the substrate." Victora Report ¶ 631. But this does not explain ***why*** a POSITA—contrary to all the disclosures in *Li* to put the highest Hk sub-layer (HSL) at the top in order to minimize HMS—would choose to move the HSL to the bottom, farthest from the write head, effectively maximizing HMS. And the mere fact that others had proposed bilayer media with a soft layer on a hard layer would not have motivated a POSITA to pursue Dr. Victora's modification. Doing so contradicts *Li*'s principle objective of minimizing the space between the write head and the hard storage layer (HMS) and his teaching that the Hk gradient must be greater than the write field gradient. If anything, a POSITA understood that *Li* deliberately chose a different path with different objectives.

88. A POSITA would have expected that Dr. Victora's proposed deviation from the teachings of *Li* would offer no benefit or improvement and would instead be detrimental to *Li*'s intended purpose of minimizing HMS. *Li* repeatedly emphasizes the importance of putting the hard storage layer on top to minimize HMS and achieve "the ***smallest actual effective head-media***

spacing (HMS), ***highest actual magnetic volume KμN***, and ***highest achievable writability at the effective volume KμV***." *Li* 12:67-13:3; *see also* Overview of *Li* above. A POSITA would thus have been dissuaded from moving the HSL away from the write head much less to the bottom of the stack because doing so would maximize rather than minimize HMS.

89. For example, if the Fig. 3 stack (below left) were turned upside down (below right) as Dr. Victora says a POSITA would have done, the distance (d) to the HSL (M1) would increase by the combined thickness of the three overlying sub-layers M2, M3, M4, causing a corresponding increase in the HMS (red):



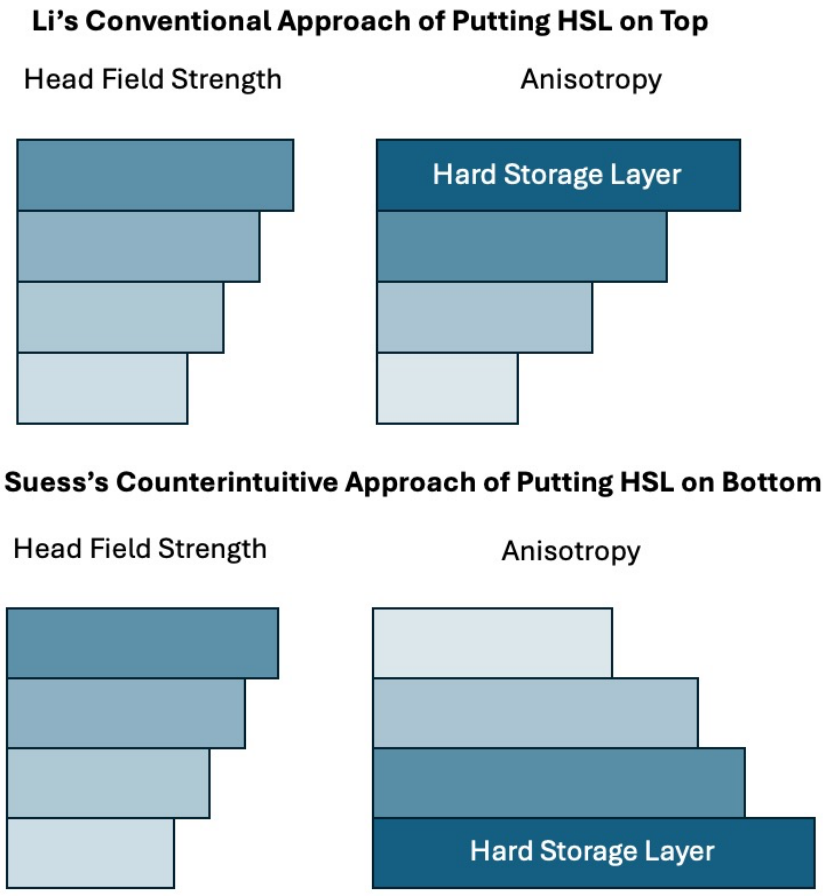
Thus, assuming the distance to the top of the stack is 6 nm, and each sub-layer is 5 nm thick, the distance (d) to the hard storage layer would increase from 6 nm to 21 nm and the HMS would increase from 8.5 nm to 23 nm. This means the HMS of Dr. Victora's modified version of *Li* would not only be more than 2.5 times greater than *Li*'s proposed media, it would also be greater than the conventional media of Fig. 2. *See* Overview of *Li* above.

90. As a result, a POSITA understood that Dr. Victora's modification would defy the foundational principles of *Li*'s designs and that such a fundamental departure from *Li*'s core

concepts would fail to achieve the benefits taught by *Li* or offer any improvement. As *Li* explains, it is the "dramatic decrease in HMS afforded by the invention" that enables the significant improvements in SNR and writability achieved by *Li*'s designs. *See, e.g.*, *Li* at 11:19-24 ("[A] perpendicular magnetic recording layer with anisotropy gradient according to the invention would provide at least a 1-3 db increase in SNR (facilitating a corresponding increase in recording density) ***by virtue of the dramatic decrease in HMS afforded by the invention***."), 11:25-31 (explaining that the core concept of using a top down Hk gradient provides "a very substantial improvement in recording performance."), 11:31-38 ("***anisotropy gradient*** perpendicular media fabricated ***according to the invention*** … lead[s] to a reduction of the media switching distribution and an increase in the media nucleation field."), 11:38-50 ("[T]he resultant magnetization becomes sharper and/or more symmetric at the written transition locations" and thus improves SNR), Fig. 6(B); *see also* Overview of *Li* above.

91. Modifying *Li* as *Victora* suggests would also be contrary to the express teaching of *Li* that the Hk gradient should be greater than the write field gradient, so that the write field is greater than the lowest layer so that switching goes from the bottom up. As discussed above in my overview of *Li*, *Li* applied the conventional thinking that the Hk of the layers should follow the gradient of the write field, decreasing as one get further away from the write head. Modifying *Li* to put the hard storage layer on bottom, besides increasing the HMS significantly, would mean reversing the gradient, so that as the write field gets weaker, the Hk of the layers gets stronger. As illustrated in the figures below, that was completely counter to the conventional thinking, and Dr. Victora does not provide any evidence in *Li* or any other reference that indicates a POSITA would expect success by reversing the gradient, so that the Hk of the layers increased as the write field gradient decreased. There is no recognition in either *Li* or in a POSITA's general knowledge

that the hard layer could switch when placed so far from the write field and where the write field is too low to switch the hard layer. Thus, one of skill understood that switching could not go from bottom up, as *Li* teaches, if the order were reversed.



92. In addition, the conventional wisdom of minimizing the distance between the write head and the hard storage layer would have further discouraged a POSITA from pursuing Dr. Victora's modification. A POSITA would have expected that putting the hard storage layer at the bottom of the stack where the write field is weakest would reduce writability and degrade SNR. In *Li*'s designs, the hard storage layer is at the top where the write field is strongest and more concentrated. Consequently, the write field exerts the strongest torque on the magnetization of the hard storage layer. Although the write field is not strong enough to flip the hard storage layer on its own, a POSITA understood that the torque it exerts improves writability and enables recorded

magnetic transitions to be sharper and more defined, thereby improving SNR, and allowing for increases in areal density. A POSITA also would have expected that putting the lowest Hk sub-layer on top would further degrade SNR. Because softer layers were thought to have more intergranular exchange, a POSITA would have expected the softer layers to reduce head field sharpness, resulting in grains adjacent to the ones being written being more susceptible to being flipped inadvertently.

2. A POSITA Would Not Have Been Motivated to Combine *Li* with *Victora* or *Berger*

93. I understand WD asserts that *Li* combined with *Victora-3* renders the asserted claims obvious. Dr. Victora's report, however, does not appear to contain any opinion regarding a combination of *Li* with *Victora*. He does not identify anything in *Victora-3* that a POSITA purportedly would have implemented in *Li*. Nor does he explain why a POSITA would have looked to *Victora-3* when implementing *Li* or how the two would be combined to arrive at the claimed invention. He merely states that "[a] POSITA would have known and found it obvious to place the hard layer on the bottom as … Wang … actually did." But this appears to be no different than Dr. Victora's opinion that a POSITA would have modified *Li* based on the POSITA's knowledge. I address that opinion in the section above which I incorporate herein by reference. Moreover, as discussed in the Overview of *Victora* above and further discussed below regarding the *Victora*-based combinations, *Victora* is directed to a fundamentally different design objectives than *Li* and so a POSITA would not have combined *Li* with *Victora*. *Victora* was aimed at simulating the tilted media result, which required only two layers, one of which was soft. A POSITA would recognize that one could fully realize the benefit of tilted media with one soft layer, and would therefore not be motivated to add additional layers. *Li*, on the other hand, was aimed at improving Signal to

Noise Ratio (SNR) by reducing the effective distance from the write head to the hard storage layer (HMS). Dr. Victora does not identify any failing or deficiency in *Li* that *Victora* would address.

94. Regarding *Berger*, Dr. Victora asserts that "*Li*, in combination with *Berger*, further discloses that the storage layer is between the nucleation host and the substrate." He does not, however, explain how *Berger* discloses anything beyond the concept of putting a hard layer below a soft layer. Nor does he explain why a POSITA would have even looked to *Berger* when implementing *Li* or how the two would be combined to arrive at the claimed invention. Indeed, Dr. Victora only cites "*Berger* at Fig. 3 and related description" which merely disclose the same basic concept. Dr. Victora's *Li* with *Berger* combination thus appears to be substantively the same as his proposed modification of *Li* based on a POSITA's knowledge and/or *Victora*. I address those opinions in the sections above which I incorporate herein by reference. Moreover, as discussed in the Overview of *Berger* above and further discussed below regarding the *Berger*-based combinations, *Berger* is directed to a fundamentally different design objectives than *Li* and so a POSITA would not have combined *Li* with *Berger*.

C. The Asserted Claims Are Not Obvious Over *Berger* Alone or Combined with *Hagedorn* or *Li*

95. There is no dispute that *Berger* does not disclose a nucleation host that comprises ferromagnetic layers with increasing anisotropy constant K from layer to layer toward the hard storage layer as the asserted claims require. *See* Victora Report ¶¶ 219-224. As discussed in my overview of *Berger* above, in every embodiment of *Berger*, there is only a single soft layer on the hard storage layer. A POSITA understood that this is critical to *Berger*'s objective of emulating tilted media. *Berger* 6:59-64 ("Advantageously, the exchange-spring media 300 exhibits a magnetization reversal behavior which is similar to a magnetic recording layer having a tilted magnetic easy axis, while still being fully compatible with conventional perpendicular media

deposition and fabrication processes and structures."). A POSITA understood that adding an additional layer with different anisotropy than the soft layer would defeat *Berger*'s core objective and would not have expected any benefit or improvement over *Berger*'s tilted media equivalent.

96. Dr. Victora asserts that a POSITA would have combined *Berger* with *Hagedorn* because the '864 patent purportedly "acknowledges that *Hagedorn* is directly applicable to lowering the coercive field as taught in *Berger*." I understand, however, that it is improper to rely on the teachings of the asserted patents to provide a motivation to combine references. And as explained below, neither a POSITA's knowledge nor *Hagedorn* or *Li* would have motivated a POSITA to modify *Berger* as Dr. Victora proposes. Indeed, as I mention above, neither *Berger* nor any other prior art reference that Dr. Victora cites even mentions *Hagedorn*. This is telling, given that *Hagedorn* is, as Dr. Victora notes, a very famous and highly cited paper.

1. A POSITA Would Not Have Been Motivated to Combine *Berger* with *Hagedorn*

97. Dr. Victora asserts that "[a] POSITA would have known to combine *Berger* with *Hagedorn's* theory, in other words, to modify *Berger* to utilize a multilayer exchange spring structure according to *Hagedorn's* disclosure which renders layers with increasing anisotropy obvious to further *Berger*'s objective of lowering the coercive field." I disagree for the reasons above and as further discussed below.

98. A POSITA implementing *Berger* would not have even looked to *Hagedorn*. As discussed in the overview of *Hagedorn* above, the NDRO memory described by *Hagedorn* is a fundamentally different technology than the claimed invention. A POSITA developing PMR media in 2006 would not have looked to a decades old reference from before PMR media had even been invented.

99. Dr. Victora cites no evidence that anyone other than Dr. Suess recognized that *Hagedorn's* disclosure that "a combination of many slabs could yield an arbitrarily low coercive force" could be applicable to exchange-spring media. Dr. Victora cites a paper by Dobin and Richter to assert that a POSITA would have connected *Hagedorn* with PMR media. But I understand the Dobin paper is not prior art because it was published in August 2006. Further, the Dobin paper does not refer to the above disclosure in *Hagedorn*. It refers to a bilayer structure with a single soft layer exchange coupled to a single hard layer. *See Dobin* at 1; *Hagedorn-2* at 2498 (explaining that such a bilayer structure can have 1/5 the coercivity of the hard layer if the coercivity of the soft layer is 1/5 that of the hard layer).

100. The Dobin paper only supports my opinion that the claimed invention was not obvious. It does not even mention the possibility of using multiple soft layers and instead discloses that "the ultimate potential of the [bilayer] composite exchange spring media is realized when the interfacial domain wall fits inside soft and hard layers." *Dobin* at 1. This also demonstrates that Dr. Victora relied on hindsight, using the asserted patents as a roadmap for connecting *Berger* with *Hagedorn*, which I understand is improper.

101. Even if a POSITA had looked to *Hagedorn* and appreciated that its disclosure that combining many slabs could yield arbitrarily low coercive force might be applicable to PMR media, the POSITA still would not have been motivated to combine *Berger* with *Hagedorn* to arrive at the claimed invention. As I explain below, a POSITA would not have expected any benefit in modifying Berger let alone enough to outweigh the significant cost and complexity of adding layers of new materials.

102. A POSITA would have expected that adding an additional layer would degrade writability. The conventional wisdom was to minimize the distance between the write head and

the hard storage layer because the head field weakens as the distance increases. *See e.g.*, *Berger-210* at 3:3-6 ("[A] write head produces a larger magnetic field and larger field gradient near the surface of the [recording layer (RL)], while the field strength decreases further inside the RL."); *Victora-3* at 1 ("[I]t is a better idea to reverse the position of these two layers"—i.e., put the hard layer on top). Adding a layer would not only increase the distance but would increase the amount of ferromagnetic material between the write head and the hard storage layer, further weakening and reducing the sharpness of the head field.

103. Dr. Victora asserts that adding a layer would decrease the coercive field. But before the claimed invention, a POSITA would not have expected that adding a layer would decrease the coercive field beyond what was achieved by the bilayer media proposed by *Berger*. Even if a POSITA would have expected an additional decrease in the coercive field, the POSITA would have expected a corresponding decrease in thermal stability. The conventional thinking was that decreasing the coercive field (making it easier to write) would also decrease thermal stability (making it easier to for thermal fluctuations to cause data loss). A POSITA would not have expected the counterintuitive discovery of the asserted patents that coercivity could be reduced using the claimed multilayer nucleation host while maintaining thermal stability. Indeed, a POSITA understood that *Berger* reduces the required write field while maintaining thermal stability because it is specifically designed to behave like tilted media. A POSITA would have expected that deviating from *Berger*'s tilted media equivalent by adding additional layers to reduce the overall coercivity of the stack (which again, would not have been expected) would proportionally reduce the thermal stability, defeating the purpose of modifying *Berger* in this manner.

104. Even if a POSITA would have been motivated to add another soft layer to *Berger*, the POSITA would have put the hard storage layer at the top where the write field is strongest and sharpest, as evidenced by *Li*. *See, e.g.*, *Li* 12:66-13:3 (disclosing that, consistent with conventional wisdom, putting the hard storage layer nearest the write head "afford[s] the smallest actual effective head-media spacing (HMS), highest actual magnetic volume KμN, and highest achievable writability at the effective volume KμV."). Dr. Victora does not explain why a POSITA would have kept the hard storage layer on the bottom contrary to conventional wisdom.

105. The known negative effects of adding another soft layer to *Berger* would have further deterred a POSITA from pursuing Dr. Victora's combination. As *Berger* explains, in conventional exchange spring structures, "the magnetically softer exchange spring layer often worsens the signal-to-noise ratio and bit error rate of the underlying magnetic recording layer." *Berger* 8:55-59. The POSITA's understanding prior to the claimed invention was that, due to its lower coercivity, a soft layer increases intergranular coupling. This increases noise because the magnetization of a grain can influence the magnetization of neighboring grains. *Berger* 5:39-43 ("[I]t is preferable that the inter-granular exchange coupling of the exchange spring layer 304 be sufficiently low to minimize or reduce negative effects, such as lower signal-to-noise ratio or the like."). In addition, a soft layer can cause the write field to spread and reduce its sharpness, which also increases noise because the write field can inadvertently flip grains near the target grains.

106. *Berger* attempts to reduce these effects and discloses that by optimizing the exchange coupling between the soft layer and the hard layer, "negative effects caused by the exchange-spring layer's 304 higher inter-granular exchange coupling, such as lower signal-to-noise ratios or the like, may be at least partially isolated from the magnetic recording layer 302." *Berger* 5:37-44. A POSITA would have expected that the negative effects of adding yet another

soft layer on top of the hard layer would outweigh any potential benefit (and even if motivated to add another soft layer to *Berger*, a POSITA would followed the conventional approach of putting the hard storage layer on top as taught by *Li* for the reasons discussed above).

2. A POSITA Would Not Have Been Motivated to Combine *Berger* with *Li*

107. A POSITA would not have modified *Berger* in view of *Li*. As discussed in the overview of *Berger* above, *Berger* teaches bilayer media that consists of a single soft layer exchange coupled to a single hard layer such that the media emulates tilted media. A POSITA would not have added an additional soft layer to *Berger*'s tilted media equivalent for the reasons discussed above. *See* Sections VIII.B.2. and VIII.C.1.

108. In addition, *Berger* and *Li* are directed to competing objectives. The objective of *Berger* is to achieve the perpendicular media equivalent of tilted media. The objective of *Li* is to minimize HMS. As discussed above, a POSITA understood that adding another soft layer to *Berger* would defeat *Berger*'s objective and putting the hard storage layer on the bottom would defeat *Li*'s objective.

109. Even if a POSITA would have been motivated to somehow combine these references, the POSITA would have put the hard storage layer at the top where the write field is strongest and sharpest. *See, e.g.*, *Li 12:66-13:3 (disclosing that, consistent with conventional wisdom,* putting the hard storage layer nearest the write head "afford[s] the smallest actual effective head-media spacing (HMS), highest actual magnetic volume KμN, and highest achievable writability at the effective volume KμV."); *Victora-3* at 1 ("[I]t is a better idea to reverse the position of these two layers"—i.e., put the hard layer on top). Dr. Victora does not explain why a POSITA would have kept the hard storage layer on the bottom contrary to conventional wisdom.

D. The Asserted Claims Are Not Obvious Over *Victora* Combined with *Hagedorn* or *Li*

110. There is no dispute that *Victora* does not disclose a nucleation host that comprises ferromagnetic layers with increasing anisotropy constant K from layer to layer toward the hard storage layer as the asserted claims require. *See* Victora Report ¶¶ 222-223, 483-484. As discussed in my overview of *Victora* above, in all three *Victora* references, there is only a single soft layer on the hard storage layer. As with *Berger*'s tilted media equivalent, a POSITA understood that this is critical to *Victora*'s objective of emulating tilted media. A POSITA understood that adding an additional layer with different anisotropy than the soft layer would defeat *Victora*'s core objective and would not have expected any benefit or improvement over *Victora*'s tilted media equivalent.

111. Dr. Victora asserts that a POSITA would have combined *Victora* with *Hagedorn* because both references were purportedly "known and widely cited in the art, as for example in the Asserted Patents." *See* Victora Report ¶¶ 483-484. For his combination with *Li*, Dr. Victora merely asserts that the claimed invention was obvious "in light of the combination of *Victora* together with … *Li*." But Dr. Victora does not explain ***why*** a POSITA would have been motivated to combine these references to arrive at the claimed invention. *See* Victora Report ¶¶ 483-484. He does not identify any problem a POSITA would have been trying to solve, any benefit that his combination would achieve, or any other design incentives that would have led a POSITA to pursue this combination. And I understand that it is improper to rely on the teachings of the asserted patents to provide such motivation.

112. Further, as explained below, neither a POSITA's knowledge nor *Hagedorn* or *Li* would have motivated a POSITA to modify *Victora* as Dr. Victora proposes.

1. A POSITA Would Not Have Been Motivated to Combine *Victora* with *Hagedorn*

113. A POSITA implementing *Victora* would not have even looked to *Hagedorn*. As discussed in the overview of *Hagedorn* above, the NDRO memory described by *Hagedorn* is a fundamentally different technology than the claimed invention. A POSITA developing PMR media in 2006 would not have looked to a decades old reference from before PMR media had even been invented.

114. Dr. Victora cites no evidence that anyone other than Dr. Suess recognized that *Hagedorn's* disclosure that "a combination of many slabs could yield an arbitrarily low coercive force" could be applicable to exchange-spring media. Dr. Victora cites a paper by Dobin and Richter to assert that a POSITA would have connected *Hagedorn* with PMR media. But I understand the Dobin paper is not prior art because it was published in August 2006. Further, the Dobin paper does not refer to the above disclosure in *Hagedorn*. It refers to a bilayer structure with a single soft layer exchange coupled to a single hard layer. *See Dobin at 1; Hagedorn-2 at 2498* (explaining that such a bilayer structure can have 1/5 the coercivity of the hard layer if the coercivity of the soft layer is 1/5 that of the hard layer).

115. The Dobin paper only supports my opinion that the claimed invention was not obvious. It does not even mention the possibility of using multiple soft layers and instead discloses that "the ultimate potential of the composite exchange spring media is realized when the interfacial domain wall fits inside soft and hard layers." *Dobin* at 1. This also demonstrates that Dr. Victora relied on hindsight, using the asserted patents as a roadmap for connecting *Berger* with *Hagedorn*.

116. Even if a POSITA had looked to *Hagedorn* and appreciated that its disclosure that combining many slabs could yield arbitrarily low coercive force might be applicable to PMR media, the POSITA still would not have been motivated to combine *Victora* with *Hagedorn* to

arrive at the claimed invention. A POSITA would not have added an additional soft layer to *Victora*'s tilted media equivalent for the same reasons discussed above regarding *Berger*. *See* Sections VIII.C.1 and 2 above. Indeed, Dr. Victora offers no opinion that any disclosure unique to *Victora* would have motivated a POSITA to pursue his proposed combination.

2. A POSITA Would Not Have Been Motivated to Combine *Victora* with *Li*

117. A POSITA would not have modified *Victora* in view of *Li*. As discussed in the overview of *Victora* above, *Victora* teaches bilayer media that consists of a single hard layer having high anisotropy formed on a single soft layer having very low anisotropy such that the media emulates tilted media. Further, *Victora* discloses that the hard layer should be on top of the soft layer. Thus, even with *Li*, the combination would not disclose "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" as the asserted claims require.

118. In addition, *Victora* and *Li* are directed to competing objectives. The objective of *Victora* is to achieve the perpendicular media equivalent of tilted media. The objective of *Li* is to minimize HMS. As discussed above, a POSITA understood that adding another soft layer to *Victora* would defeat *Victora*'s objective and putting the hard storage layer on the bottom would defeat *Li*'s objective.

119. Even if a POSITA would have been motivated to somehow combine these references, the POSITA would have put the hard storage layer at the top where the write field is strongest and sharpest. *See, e.g.*, *Li* 12:66-13:3 (disclosing that, consistent with conventional wisdom, putting the hard storage layer nearest the write head "afford[s] the smallest actual effective head-media spacing (HMS), highest actual magnetic volume KμN, and highest achievable writability at the effective volume KμV."); *Victora-3* at 1 ("[I]t is a better idea to reverse

the position of these two layers"—i.e., put the hard layer on top). Dr. Victora does not explain why a POSITA would have kept the hard storage layer on the bottom contrary to conventional wisdom.

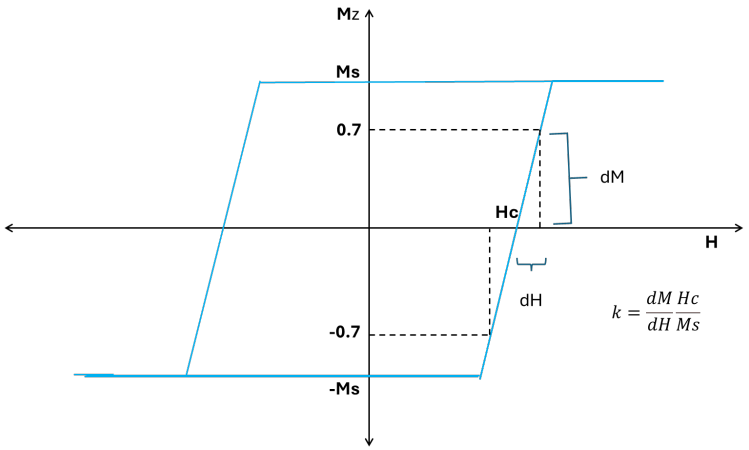
120. A POSITA would not have added an additional soft layer to *Victora*'s tilted media equivalent for the additional reasons discussed above regarding *Berger*. *See* Sections VIII.C.1 and 2 above. Indeed, Dr. Victora offers no opinion that any disclosure unique to *Victora* would have motivated a POSITA to pursue his proposed combination with *Li*.

E. Dependent Claims

1. Claim 2

121. Dr. Victora asserts that *Li* "expressly or inherently discloses or renders obvious this claim" and that it is obvious of *Li* combined with any other asserted prior art reference. Victora Report ¶¶ 649-651. But Dr. Victora does not cite anything in *Li* or any other reference that purportedly discloses any of the requirements of claim 2. *See id*. Nor does he offer any motivation to modify *Li* to meet the additional requirements of claim 2. *See id*.

122. I did not find any disclosure in *Li* that meets claim 2. And I did not find any disclosure in *Victora*, *Berger*, or *Hagedorn* that meets claim 2. Dr. Victora cites Fig. 4 of *Victora-3*, but that is for *Victora's* bilayer, tilted media equivalent (not for Dr. Victora's proposed modification of *Victora*). Regarding *Berger*, Fig. 5C shows that *Berger*'s tilted media equivalent contradicts claim 2. The additional limitation of claim to requires that when Mz is in a region where it is switching from say down to up, so from -70% of Ms to +70% of saturation, the derivative, defined as k, which is the change in normalized magnetization to the change in normalized field should not change by more than a factor of 3. In other words, the loop should be linear in this region without large kinks or deviations from the slope of the loop around Hc. For example, a loop with insufficient exchange coupling will exhibit non-linearity or a kink in the curve as shown in the exemplary figure below.



123. *Berger*'s Fig. 5C shows that the loop for *Berger*'s media is not linear and has a significant deviation in this region:

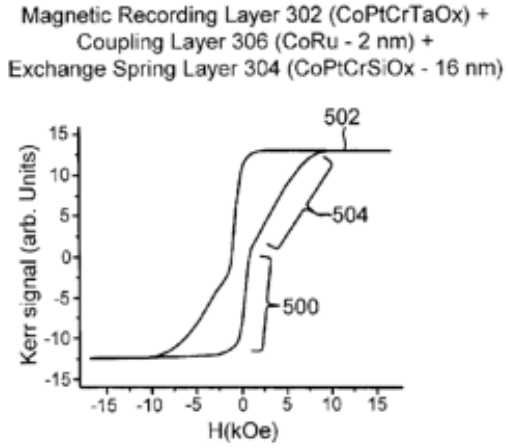


Fig. 5C

Berger Fig. 5C. *Berger* therefore does not disclose the additional limitation of claim 2.

124. Thus, in my opinion, Dr. Victora has not shown that any of his asserted combinations render claim 2 obvious.

2. Claim 10

125. Dr. Victora asserts that *Berger* "expressly or inherently discloses or renders obvious this claim" and that "[s]ome, if not all of *Berger*'s media has thickness less than 30 nm." Victora Report ¶¶ 649-651. Dr. Victora, however, does not identify any disclosure in *Berger* to that

purportedly discloses this. Nor does he offer any motivation to modify *Berger* or combine *Berger* with another reference to meet this limitation. I understand it is WD's burden to prove invalidity and Dr. Victora has not done so.

IX. OBJECTIVE INDICIA FURTHER DEMONSTRATE THAT THE ASSERTED CLAIMS WERE NOT OBVIOUS

126. There is significant evidence supporting secondary considerations of nonobviousness of each of the Asserted Patents, including significant evidence of commercial success, longfelt need, failures of others, skepticism and/or unexpected results, praise, awards, industry recognition, and/or copying. Each of these factors, individually and collectively, support my opinion that the asserted claims are not obvious. Any cited evidence for one particular factor is not intended to be necessarily relevant for only that factor, as it may also be relevant to another secondary consideration. Additionally, I incorporate by reference my analyses above to the extent they are also relevant towards secondary considerations and vice-versa.

A. Commercial Success

127. For each of the patents-in-suit, there is significant evidence showing commercial success of the patented invention through the sale of patent-practicing articles, including those sold by WD.

128. I understand from Mr. Bergman's report that the accused products have been very commercial successful. Mr. Bergman explains:

[redacted]

[redacted]

Ex. 1, Bergman Report ¶¶291-292 (footnotes omitted).

129. In my opinion, and as explained in my opening expert report regarding infringement which I incorporate herein, WD has attained significant technical benefits from its infringement of the patents-in-suit, including having stable media that can be written, higher media SNR, lower adjacent track erasure (ATE), and improved write-field gradient. These improvements result in the ability of WD to increase the areal density of its hard drive media and, ultimately, the capacity of its hard drive products. The increased areal density of the accused products resulting from WD's infringement the areal density of the accused products also results in faster read/write speeds and other benefits. *See* Dkt. 241, Ex. 1 ¶¶546-614. WD's sales and revenue would have been diminished without these technical benefits in the accused products would not be achieved. *See id.*; Bergman Report at ¶¶ 291-292 (analysis of *Georgia-Pacific* factor 8 regarding "the established profitability of the product made under the patent; its commercial success; and its current popularity"). Those benefits are the direct result of the unique characteristics of the inventions of the Asserted Patents and the particular combination of requirements set forth in their claims. *See* Bergman Rpt. at ¶¶ 291-292 (analysis of *Georgia-Pacific* factor 8); Dkt. 241, Ex. 1 ¶¶546-614 (analysis of benefits of asserted patents).

130. That the patented products are commercially successful is further evidenced by the fact that once WD introduced drives that implemented the patented invention, it never went back. Virtually all of WD's HDDs sold use the claimed invention.

B. Long-Felt But Unsolved Needs and Failure by Others

131. Evidence supports significant long-felt need, failure by others, skepticism of the industry, and unexpected results with respect to the patented inventions. I incorporate my entire

discussion from the Background section above. I also incorporate my discussion above regarding *Li*, *Victora*, and *Berger* which also demonstrate long-felt need, failure of others, and unexpected results.

132. As I stated in the Background section above, before the invention, PMR media makers were unable to achieve greater areal density due to the super paramagnetic limit. The patents describe the long-felt need as follows:

> The invention proposes a recording media that overcomes the writeability problem of perpendicular recording media.

Ex. 2, '864 Patent at abstract.

> Modern magnetic recording media reaches ever higher recording densities. Further increase of the areal density is believed to be limited by the superparamagnetic limit. This limit represents that as the size of the magnetic grains in the media decrease, at some grain size the thermal fluctuations at room temperature k_BT_{300} become capable of overcoming the energy barrier $\Delta E=KV$, which separates the two magnetization directions of an isolated grain with a volume V and an uniaxial anisotropy constant K. This superparamagnetic limit, or thermal instability, can be overcome by increasing the anisotropy K, according to the Stoner-Wohlfarth theory. However, such an increase also results in an unfavourable increase of the coercivity H_c. As a consequence, these grains are thermally stable but can not be written with existing recording heads.
>
> Various improvements have been proposed to counter this thermal instability recently, also known as the writeability problem. …
>
> …
>
> In previous works it was not shown that a finite value of the anisotropy in the soft magnetic layer does not reduce the thermal stability of the structure. This question needs to be investigated, as larger anisotropies in the softer layer reduce the energy that is required to push a domain wall from the soft layer to the hard layer. Further, typical multilayer exchange spring media do not even contain a soft magnetic layer. Instead, it contains a nucleation layer which can be magnetically hard. The softest layer in the nucleation layer can have a coercive field similar to typical fields of recording heads.

> For all these reasons, the choice of layer architectures and their anisotropies to overcome the superparamagnetic limit in optimal fashion remain a topic of intense investigations.

Ex. 2, '864 Patent at 1:10-2:45.

133. Also in June 2006, around the same time as the earliest-filed application leading to the patents-in-suit, Dr. Suess published an article in the Applied Physics Letters journal titled, "Multilayer exchange spring media for magnetic recording" (Ex. 3, WD0008906) that was widely cited by others, as discussed below. Dr. Suess discusses the thermal instability problem in his paper:

> High coercive materials such as FePt are suitable for high density recording. The high magnetocrystalline anisotropy permits small, thermally stable grains which in turn allow high recording densities. However, high coercive grains cannot be written with conventional write heads' even if the write field is applied at a large angle to the easy axis," which reduces the switching field according to the Stoner-Wohlfarth theory. An increase of the spontaneous polarization reduces the write field but at the same time decreases the thermal stability because of larger demagnetizing fields. In modern perpendicular media the loss of thermal stability owing to the demagnetizing field is partly compensated by intergrain exchange interaction that stabilizes neighboring grains. This stabilizing effect vanishes for too large demagnetizing fields (produced by large values of the spontaneous polarization J,) where the grains rotate towards the in plane direction.
>
> Recently, composite media and exchange spring media were introduced theoretically" and experimentally by Wang et al. to reduce the write field requirements. In exchange spring media a magnetically hard layer and a magnetically softer layer are strongly exchange coupled. The coercive field of the hard magnetic layer is reduced by the exchange field of the neighboring soft magnetic layer. The magnetization reversal under the action of an external field of an exchange spring bilayer occurs in a two step process.

Ex. 3, WD0008906 at 8906. Dr. Suess then analyzes and discusses this two-step process, and his tests confirming the concepts of exchange spring multilayer:

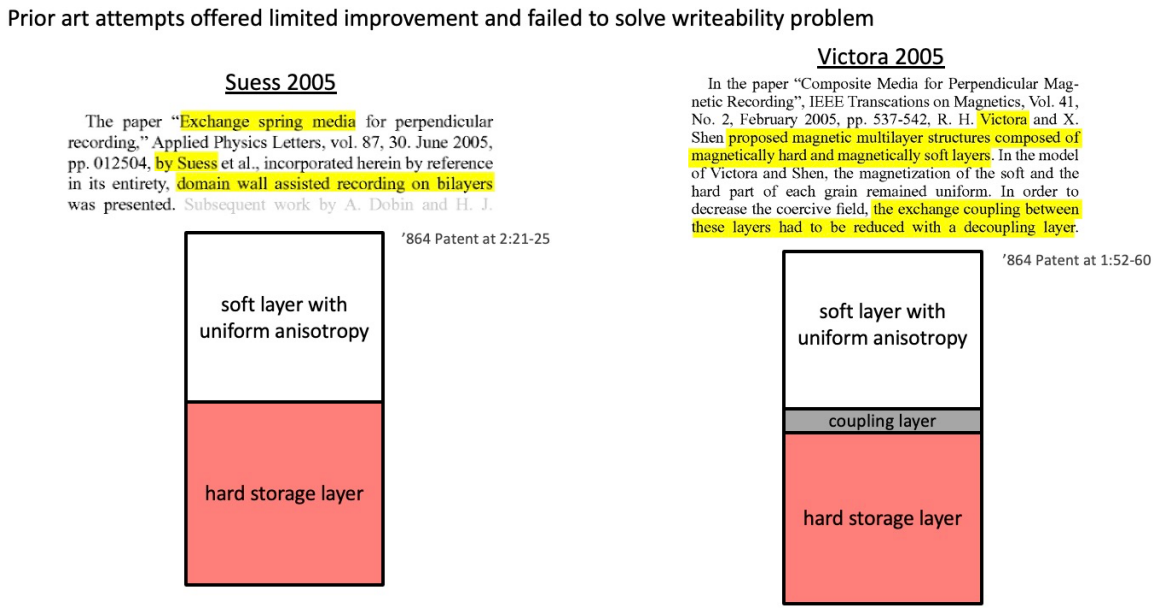
> Most important it was demonstrated that the energy barrier in multilayer exchange spring media is not proportional to the coercive field. The coercive filed is proportional to 1 over the number of layers while the energy barrier is constant.

Ex. 3, WD0008906 at 8908.

134. Even dating back to 1999, the industry was aware of this writeability problem and were spending significant resources to try and solve the problem. A June 1999 World Technology (WTEC) Division Panel Report on "The Future of Data Storage Technologies," reported Japanese companies and government "making major commitments to research on advance magnetic and other data storage," and that "Japanese companies were clearly aware of the long-term research issues such as barriers to increased storage density caused by thermal instabilities and had relatively large research programs addressing them," including research in perpendicular recording. The report states that there had been recent "major funding" by "[t]wenty-one Japanese companies in the magnetic data storage area" towards university research in increased storage density that was "a direct response to the success of the United States in creating centers for research on magnetic data storage at universities such as Carnegie Mellon University, the University of California at San Diego and Stanford University." Additionally, "the Japanese government [provided] ¥5 billion in funding to six industrial firms" for research in this area. The report further stated, "Advocates of perpendicular recording argue that it may be able to achieve 5-10 times higher density than conventional longitudinal recording, before thermal instabilities, which are expected to limit the density of conventional longitudinal magnetic disk drives, become a problem." However, "[m]ost U.S. disk drive companies have no activities in either perpendicular or probe recording." Ex. 4, WD0008512 at 8526-27, *see also id.* at 8540-44.

135. The patent-in-suit also describe the prior art attempts to improve the writeability problem, including two prior art attempts by proposed in 2005 by Dr. Dieter Suess, the inventor

of the patents-in-suit, and Dr. Randall *Victora*, WD's invalidity expert. *See* '864 Patent at 2:21-25 and 1:52-60, respectively. Both used a single homogenous soft layer with uniform anisotropy exchange coupled to a hard storage layer:



136. Moreover, the long-felt and unresolved needs of the patents-in-suit are exemplified and further confirmed by the fact that the asserted patents and their parent application have been cited by patent applicants and inventors that were still trying to solve the same problems in later-filed patent applications. *See, e.g.*, Exs. 2 and 5, (Google Patents "Cited By" sections for the '864 patent and the '997 patent indicating the '864 and '997 patents and family have been cited by dozens of patents and application, including by leading companies in the industry such as Hitachi, Seagate, and WD).

137. Others had tried to improve the writeability issue with perpendicular magnetic recording media but were unsuccessful. For example, [redacted]



Ex. 6, WD0010209 at 210. On "where we are in the process," they stated:

4. Dual Magnetic Layer PMR Media

PMR media with low Ms mag as bottom layer and high Ms mag as top layer were studied to see if Hc & SNR can be improved.

Bottom layer was RF magnetron sputtered and the top layer was DC magnetron sputtered.

If the top layer is sputtered without water the Hc can be improved by 300 to 500 Oe. The SNR remains unaffected.

More work is needed with different alloy combinations.

Id. at 226.

138. The failure of others to adequately address the problems solved by the asserted patents is further shown by the fact that the prior art cited by Dr. Victora do not anticipate or render obvious the asserted, claims teach or suggest the same solutions, or provide the same technical benefits. I discuss the differences and shortcomings of the prior art in my validity opinions above, and incorporate them as further evidence of long-felt need and failure by others.

C. Unexpected Results

139. The inventions in the patents-in-suit have also been recognized by Seagate. For example, in one presentation by a Seagate engineer, Stella Wu, cited one of Dr. Suess's 2006

publications regarding Hc decreasing faster than the energy barrier for a single phase media and trilayer, calling it "*unusual* and potentially useful dynamics."



Ex. 7 at 58, S. Z. Wu, "Magnetic Recording," IEEE Magnetics Society Summer School Rio, August 10-15, 2014, available at https://docplayer.net/23262160-Magnetic-recording-ieee-magnetics-society-summer-school-rio-august-10-15-stella-z-wu-seagate-technology.html. I understand this presentation was also cited by Gerardo Bertero in his declaration in support of WD's motion for summary judgment of non-infringement. Dkt. 245-3 at ¶43.

D. Praise, Awards, and Industry Recognition

140. Industry praise and recognition also supports non-obviousness of the patents-in-suit. I incorporate my opinions above regarding long-felt need as supporting praise and industry recognition.

141. The industry has recognized the value of the claimed solutions in each of the patents-in-suit. The recognition has come in various forms. I understand that Dr. Victora does not dispute that exchange-spring theory "was generally praised." *See* Victora Rpt. ¶ 921.

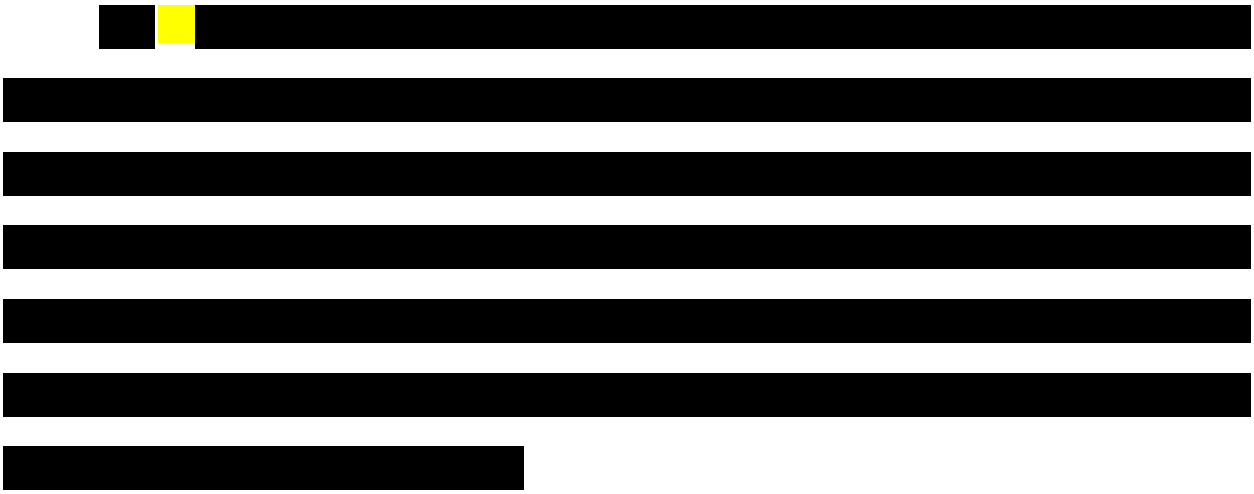
142. For example, Dr. Dieter Suess is widely recognized as the inventor of multilayer exchange spring media. *See* Ex. 8, WD0051532 at 51532 (2012 article titled "New Paradigms in Magnetic Recording" by Plumer, et. al. of WD, stating "Recently, the HDD industry has been using so-called Exchange Coupled Composite (ECC) media (aka 'exchange spring media')", citing to Dr. Suess).

143. For example, in a 2011 publication, titled "Writeability Enhancement in Perpendicular Magnetic Multilayered Oxide Media for High Areal Density Recording," by Hitachi Global Storage Technologies[1] employees including Yoshihiro Ikeda, Hitachi employees wrote, "Recently the concept of exchange spurring media was extended by increasing the number of layers with varying anisotropies with potential benefit of switching field reduction which is proportional to the number of layers," citing Dr. Suess's 2006 publication. Ex. 9, WD0021494 at 21500-501; Ex. 26, Ikeda Tr. 91:16-20 (WD0021494 [redacted]"); Ex. 26, Ikeda Tr. 91:23-93:2 ([redacted]); Ex. 26, Ikeda Tr. 91:8-20, 92:24-93:2 ([redacted]).

144. Hitachi also credited Dr. Suess in other publications. *See* Ex. 26, WD0008823 at 8823 (2011 article titled "Recording Performance Analysis of Perpendicular Magnetic Recording Media with Anisotropy Graded Oxide and Cap Layers" by Choe, et. al. of Hitachi Global Storage

[1] Hitachi Global Storage Technologies was acquired by WD in 2012. *See* http://www.hitachi.us/press/03092012 (Hitachi press release).

Technologies, stating "Recently, the concept of ECC media was extended by increasing the number of layers with varying Ku values for the potential benefit of reducing the switching field without loss of thermal stability." The article cites Dr. Suess's 2006 article "Multilayer exchange spring media for magnetic recording" for this statement.); Ex. 11, MRT_WD00004375 at 4375 (2009 article titled "Switching volume change and recording performance correlation for weakly coupled exchange spring media" by Ikeda, et. al. of WD-acquired Hitachi Global Storage Technologies, stating "Exchange spring (ES) or exchange coupled composite (ECC) perpendicular media is one of the key technologies to obtain sufficient writability on high anisotropy media while maintaining thermal stability required for future high areal density recording. ES media have an exchange coupling layer (ECL) between the soft layer and hard layer." The article cites Dr. Suess's 2005 article for this statement.).





[redacted]



[redacted]

[redacted]



[redacted]

[redacted]

148. In a 2013 article by Mr. Srinivasan and another WD employee, titled "Magnetic Reptation and the Exchange-Spring Effect in Composite Perpendicular Recording Media," Mr. Srinivasan states in the introduction that "The exchange-spring (ES) mechanism is the basis on which recent progress in perpendicular magnetic recording (PMR) media technology has been achieved. Hard-soft composite perpendicularly oriented layers have provided a boost in improving the switchability of the media without sacrificing the thermal stability, by taking advantage of the

incoherent, spring-like switching that begins in the soft layer and propagates across the interface into the hard layer." Ex. 15, KS0000097 at 97 and 100 (citing four references, including the 2005 and 2006 publications by Dr. Suess); *see* Ex. 27, Srinivasan Tr. 124:4-13 [redacted]

149. In a 2012 article by Mr. Srinivasan, titled "Magnetic viscosity, hysteresis reptation, and their relationship with adjacent track interference in advanced perpendicular recording media", Mr. Srinivasan states, "Current generation PMR media, labeled as exchange-coupled composite (ECC) media in general, consist of multiple recording layers, with or without nonmagnetic spacer layers between them." Ex. 16, KS0000068 at 69 and 81 (citing 2006 Suess article). Mr. Srinivasan testified that [redacted] His article also states, "The exchange-spring effect between the magnetic layers with different anisotropies helps to reduce the switching fields and thus improve writability without compromising the thermal stability of the media," which was "referring to a generation of PMR media and product handling in the advanced research." Ex. 27, Srinivasan Tr. 133:5-18. Figure 1 in Mr. Srinivasan's article showed a three-mag layer media design with two exchange-break layers that was "one of the designs [WD was] considering for [WD's] current generation PMR media":



Ex. 16, KS0000068 at 70; Ex. 27, Srinivasan Tr. 133:19-25, 134:12-18; *see also* Ex. 27, Srinivasan Tr. 135:6-9 (

151. For example, the inventions in the patents-in-suit were recognized in a 2007 article by A. Yu. Dobin and H. J. Richter, "Domain wall assisted magnetic recording":

IV. COMPOSITE MEDIA WITH GRADED ANISOTROPY

Abraham and Aharoni[18] discovered that linear variation of anisotropy in the soft layer reduces the domain wall assisted switching field beyond the 1/4 value for $\gamma=1$. Hagedorn[25] demonstrated that stacking multiple layers with consecutively reduced anisotropy may be used to reduce the switching field to infinitesimally small values. A similar idea was proposed by Suess[26] for the magnetic recording applications, and it was shown that the maximum switching field reduction is achieved if the anisotropy profile is approximately quadratic, i.e., $H_{\text{graded}}(z)=H_{\text{hard}}(z/t_{\text{graded}})^2$ ($z=0$ at the free surface of the graded layer).

Apparently, the quadratic graded layer yields the largest switching field reduction for sufficiently thick graded layers. However, for thin graded layers, domain wall assisted switching is not efficient because the domain wall nucleation is impeded. In order to facilitate the domain wall nucleation and hence achieve the maximum energy barrier gain, we propose the following optimization of the exchange stiffness in composite films with graded anisotropy.

ACKNOWLEDGMENTS

We would like to acknowledge Jinhua Xue for providing the FEM writer fields used in our simulations, Peter Visscher for sharing the unpublished results (Ref. 27), and Pierre Asselin and Dieter Suess for very useful discussions.

Ex. 18, WD0018945 at 950-51.

152. As another example, Dr. Suess was invited by Stefano Sanvito and Michael Coey "to give a Semi-Plenary Lecture to JEMS'08, to be held in Dublin on September the 14th through the 19th 2008," proposing that Dr. Suess's presentation be titled "Recording – a micromagnetic ***miracle***." Ex. 19, (12/04/07 email from Sanvito to Suess) (emphasis added). JEMS (Joint European Magnetic Symposia) is a prestigious annual symposium in Europe hosted by the European Magnetism Association. JEMS homepage, available at https://magnetism.eu/4-jems.htm. Both Dr. Sanvito and Dr. Coey are both very well-known individuals in magnetics, each with a number of their own awards and publications. *See* https://en.wikipedia.org/wiki/Michael_Coey (Wikipedia

article on Dr. Coey); https://www.spincomp.com/group/stefano-sanvito/ (bio for Dr. Sanvito). I understand from Dr. Suess that his lecture at the JEMS 2008 conference included discussions of the "trilemma" problem (*see* Ex. 20, (Suess 2008 lecture slides) at slide 15) and multilayer media solutions with exchange spring media allowing "thermal stability and writeability [to] be decoupled" and "breaking the superparamagnetic limit".

153. As another indicator of non-obviousness, the patents-in-suit, applications to which they claim priority, and claimed inventions have been cited by or discussed in other patents 35 times, which demonstrate that the claimed inventions met the long-felt need and evidence praise by others, unexpected results, and copying by others. *See, e.g.*, Ex. 2, (Google Patents "Cited By" section, https://patents.google.com/patent/US9928864B2/en?oq=9%2c928%2c864#citedBy). Such references include patents and patent applications of Hitachi (*e.g.*, U.S. Patent Nos. 7,582,368, 7,572,526, 7,588,841, 8,163,405); WD (*e.g.*, U.S. Patent Nos. 8,940,418, 9,028,985, and 8,597,723); and Seagate (*e.g.*, U.S. Patent No. 9,142,240).

E. Nexus

154. As I discussed in my opening expert report regarding infringement, I have analyzed the accused products and concluded that they practice the asserted claims. *See* Dkt. 241, Ex. 1 (sealed Mark Re report). In that report, I also analyzed the technical benefits provided by the claimed inventions and reflected in the accused products. *See id.* ¶¶546-614. I further understand that MR Tech's damages expert, Jim Bergman, has analyzed sales information for the accused products and economic benefits provided by the claimed inventions. As discussed in the relevant sections of my report and declaration, my analysis and conclusions and Mr. Berman's analysis and conclusions show that there is a very tight, strong nexus between the claimed features and associated secondary considerations (e.g., commercial success).

155. In addition, as explained above, there is a nexus between the claimed features and secondary considerations given the overlap in the unique characteristics from the invention and the evidence described in the above associated secondary considerations. The excerpted articles from others in the industry, internal WD documents, witness testimony, presentations, and internal WD documents praise the important role of the invention, including the multilayer nucleation host having ferromagnetic layers that increase toward the hard storage layer and resulting benefits such as improved writability, increased areal density, and higher thermal stability.

X. THE ASSERTED CLAIMS ARE NOT INVALID FOR LACK OF WRITTEN DESCRIPTION OR ENABLEMENT

A. The Written Description Supports the "Nucleation Host" Limitation

156. Dr. Victora asserts that the specification lacks written description support for a nucleation host with coupling layers. He asserts that the specification only discloses a coupling layer between the nucleation host and the hard storage layer. I disagree.

157. The specification discloses that in embodiments where the nucleation host has multiple ferromagnetic layers, "[t]he exchange coupling can be direct or ***via a thin coupling layer***." '997 patent, 2:63-3:2. A POSITA understood that this discloses that adjacent ferromagnetic layers of the nucleation host may optionally be exchange coupled via a thin coupling layer. It does not refer to a coupling layer between the nucleation host and the hard storage layer. *See id*. ("The ***nucleation host*** significantly decreases the coercive field of each grain … [and] ***where the host layer comprises more than one layer … [t]he layers can be strongly exchange coupled***. The exchange coupling can be direct or ***via a thin coupling layer*** in order to achieve strong coupling.").

158. In addition, the claims recite "an exchange coupled magnetic multilayer structure" having a "nucleation host" that "comprises ferromagnetic layers with increasing anisotropy constant K from layer to layer." It was well known that exchange coupling between ferromagnetic

layers can be controlled using a thin coupling layer. *See, e.g.*, 10/27/23 Bertero Tr. 39:22-40:2

[redacted]

159. Consistent with the plain meaning of "comprises," the patent office recognized that the claims permit unrecited layers. '864 File History, August 28, 2014 Office Action at 3 ("The instant claims are open to unrecited layers"); '864 File History, July 6, 2015 Office Action at 2 ("The instant claim is open to unrecited layers"); id. at 3 ("The Examiner notes that instant Claim 1 is open to unrecited layers..."); '864 File History, March 10, 2016 Office Action at 9 ("Examiner notes that instant Claim 1 is open to unrecited layers.").

160. Claim 7 of the '997 patent expressly recites a coupling layer between ferromagnetic layers of the nucleation host. '997 patent, claim 7 ("wherein at least two of the ferromagnetic layers [in the nucleation host] are coupled with a thin exchange coupling layer."). I understand this indicates that the patent office found written description support for a nucleation host with coupling layers.

161. Dr. Victora asserts that the addition of coupling layers to embodiments where pinning can be reduced by increasing the number of layers in the nucleation host "may significantly alter this purported benefit" and that the patents do not "teach an incentive for including such layers." Victora Report ¶ 933. I understand that there is no requirement that the patents must

expressly describe an "incentive" to use coupling layers. As discussed above, the use and benefits of coupling layers were well known.

162. Dr. Victora asserts that background discussion in the '864 patent comparing Dr. Suess's 2005 paper and *Victora-2* somehow suggests that that the specification lacks written description support for a nucleation host with coupling layers. It does not. That discussion compares those prior art references and says nothing about whether the nucleation host can have coupling layers.

163. Dr. Victora asserts that the disclosure that the exchange coupling between ferromagnetic layers of the nucleation host "can be direct or ***via a thin coupling layer***" is ambiguous. As discussed above, however, the preceding sentences make clear that the thin coupling layer is between ferromagnetic layers of the nucleation host. Indeed, Dr. Bertero acknowledged that the preceding sentence that "[t]he layers can be strongly exchange coupled" refers to the layers of the nucleation host. 10/27/23 Bertero Tr. 132:9-15.

164. Dr. Victora asserts that because the '864 patent claims or claims submitted during prosecution of the '864 patent do not recite a coupling layer in the nucleation host and only claim 7 of the '997 patent recites one indicates that the specification does not describe such a coupling layer. I understand, however, that the written description analysis is based on what the specification discloses. And as shown above, the specification expressly describes the use of coupling layers within the nucleation host.

165. Thus, in my opinion, the specification provides written description such that one of skill in the art would understand that Dr. Suess' invention included optional coupling layers between the ferromagnetic layers of the nucleation host.

B. The Nucleation Host Limitation Is Enabled Under the Court's Construction

166. Dr. Victora asserts that his opinions that the specification lacks support for a nucleation host with coupling layers also demonstrate lack of enablement. Victora Report ¶ 940. I disagree with those opinions for the reasons above.

167. Dr. Victora asserts that the specification provides no teaching of how to implement coupling layers in the nucleation host. But a POSITA would have known how to do so. As of the date of the invention, it was well-known that exchange coupling can be modified, and that one common way to modify the exchange coupling was with coupling layers. It was also well-known to those of skill in the art as of the date of the invention how to modify exchange coupling using coupling layers. *See, e.g.*, 10/27/23 Bertero Tr. 39:22-40:2 [redacted]

168. Dr. Victora asserts that "[i]ncluding coupling layers (that typically decrease coupling) within the nucleation host may interfere with [reducing coercive field and pinning effect at the interface between layers] in unknown ways, and the patent fails to teach: (a) how to make or incorporate any such coupling layers, or (b) what one would be trying to achieve by including coupling layers in the nucleation host." As discussed above, however, a POSITA would have known how to use coupling layers to control and optimize the exchange coupling between ferromagnetic layers of the nucleation host.

169. Dr. Victora's opinions regarding lack of enablement are also refuted by his opinions that the prior art renders obvious the claimed invention. For example, Dr. Victora asserts that a

POSITA would have known how to use coupling layers to adjust the exchange coupling between adjacent ferromagnetic layers. *See, e.g.*, Victora Report ¶¶ 200, 216, 244, 248. This contradicts his opinion that a POSITA would not have known how to use coupling layers to make the claimed invention.

170. In addition, I understand that it is WD's burden to prove lack of enablement and that this requires showing a POSITA could not make and use the invention based on the specification without undue experimentation. Dr. Victora's report, however, does not appear to provide any opinion as to the amount of any experimentation needed to make and use the invention much less that undue experimentation would be required.

171. Thus, it is my opinion that the specification enables the claimed invention.

C. The "Nucleation Host … Comprises Ferromagnetic Layers with Increasing Anisotropy Constant K from Layer to Layer" Limitation Is Enabled Under the Court's Construction

172. Dr. Victora asserts that the asserted claims are not enabled under Court's construction of this limitation: "nucleation host includes two or more ferromagnetic layers which have anisotropy constants K, and the values of the anisotropy constants K for the layers increase as the layers get closer to the hard magnetic storage layer, such that the nucleation host has an overall increase in anisotropy toward the hard magnetic storage layer." Victora Report ¶¶ 943-944; Claim Construction Order at 30. I disagree.

173. In particular, Dr. Victora asserts that the specification lacks enablement for "a nucleation host where only some, but not all, of the ferromagnetic layers have increasing anisotropy constant K from layer to layer." Victora Report ¶ 944. The specification, however, expressly describes that adjacent ferromagnetic layers in the nucleation host may have the same anisotropy constants or anisotropy constants that decrease toward the hard storage layer—so long

as two or more ferromagnetic layers having anisotropy constants that increase toward the hard storage layer such that there is an overall increase toward the hard storage layer:

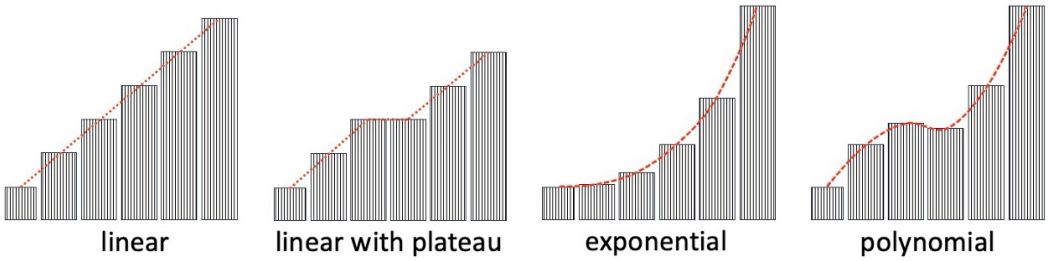
The increase in anisotropy K along the z-axis can take different forms so long as there is an overall increase across the nucleation host

Generally, the above embodiments provide marked improvement against the superparamagnetic limit as the coercive field is reduced by the spatially varying anisotropy in the nucleation host, while the thermal stability is determined only by the domain wall energy in the hardest magnetic storage layer, which is not influenced by the variations of the anisotropy of the nucleation host.

'864 Patent at 3:48-53

The variation of K(z) can take many different form. The rise can be linear, or follow any polynomial or other rising function. It can have plateaus or steps, connected by rising segments. It can also have decreasing segments. In some embodiments, the functional form of K(z) is chosen to optimize the switching properties of the recording media, e.g. by increasing the thermal energy barrier while keeping the writing field, or coercive field, essentially unchanged, or even decreasing it.

'864 Patent at 8:34-42



174. I understand that the Court agreed. Claim Construction Order at 13. In fact, I understand that the Court disagreed with WD that the disclosure that K(z) can take different forms and have plateaus or decreasing segments only applies to the bilayer embodiments of the patents. For example, it found that:

> Western Digital excludes the description of figure 2, ***which speaks to both embodiments*** ('bilayer' and 'trilayer'): '[t]he variation of K(z) can take many different form. ***The rise*** can be linear, or follow any polynomial or other rising function. It ***can have plateaus*** or steps, connected by rising segments. It can also have ***decreasing segments***.' ***This is not limited to a single-layer embodiment as Western Digital contends***[.]

Claim Construction Order at 13.

175. Dr. Victora asserts that the discussion of *Hagedorn* in the patents suggests the anisotropy must increase "monotonically." It does not. Dr. Victora disregards the express disclosure in the patent that the increase in anisotropy toward the hard storage layer "can take

many different form[s]" including "any polynomial or other rising function [and] can have plateaus … [and] decreasing segments." '864 patent 8:34-42.

176. Dr. Victora asserts that the prosecution history suggests lack of enablement because the applicant purportedly disclaimed layers of decreasing anisotropy in distinguishing the Honda reference. Victora Report ¶ 949. That is wrong. Honda discloses a hard layer on a soft layer. There is no increase in anisotropy at all toward a hard storage layer, only two layers that decrease toward the substrate. The applicant's arguments do not remotely disclaim the disclosed embodiments in which adjacent ferromagnetic layers can have the same or decreasing anisotropy.

177. Dr. Victora asserts that there is no disclosure of how to optimize switching or decrease the coercive field using layers having the same or decreasing anisotropy. He further asserts that using such layers would be "the opposite of the desired optimization of the switching media" and the model of *Hagedorn*. I understand, however, that enablement does not require that a POSITA be able to make an optimal or ideal version of the claimed invention. In addition, a POSITA understood that what is optimal or ideal for some applications may not be for others and that optimization can depend on a variety of factors including material properties, design requirements, manufacturing complexity, cost constraints, storage requirements, etc. *See, e.g.*, '864 patent at 4:59-5:2 and 5:17-18 (disclosing dozens of exemplary alloys and compositions for the hard storage layer and ferromagnetic layers of the nucleation host); '864 patent 8:37-42 ("In some embodiments, the functional form of K(z) is chosen to optimize the switching properties of the recording media, e.g. by increasing the thermal energy barrier while keeping the writing field, or coercive field, essentially unchanged, or even decreasing it.").

178. Dr. Victora asserts that optimizing switching properties "cannot be achieved without significant experimentation." But again, I understand that enablement does not require the

specification to teach a POSITA how to achieve optimal switching properties. The claims do not require the claimed recording medium to be optimized and as discussed above, a POSITA understood that what is optimal may differ depending on a variety of factors. Indeed, Dr. Victora does not impose any optimization requirement in opining that his prior art combinations render the asserted claims obvious.

179. Thus, in my opinion, the specification enables the nucleation host limitation under the Court's construction.

XI. THE ASSERTED CLAIMS ARE NOT INVALID FOR INDEFINITENESS

180. Dr. Victora asserts that the "coercive field" limitations are indefinite because "the measurement of the coercive field of a magnetic structure is highly dependent on the time scale used for the measurement." I disagree.

181. While it is true that coercive field is time dependent, the patent expressly states how to measure coercive field, which a POSITA would understand corresponds to the time scale that reflects normal operating conditions. The patent expressly states: "The coercive field is Hc=2Keff/Meff." '864 patent 6:54. Thus, the measure of coercive field described and claimed in the asserted patents is:

$$Hc = 2\ K_{eff} / M_{eff}$$

where K_{eff} is the average anisotropy constant and M_{eff} is the average saturation magnetization. '864 patent 6:54; Dkt 242-3 at ¶¶ 112-113. A POSITA understood that this is the coercive field under normal operating conditions (i.e., at a time scale on the order of 1 nanosecond, which is the approximate time that a write field is applied during normal operating conditions). Dr. Victora agrees that the patent discloses that the claimed coercive field is $Hc=2K_{eff}/M_{eff}$: He states in his report: "The '864 Patent claims the Coercive field is Hc=2*Keff/Ms." Victora Report ¶ 313 (citing '864 Patent 6:54). Dr. Victora then uses 2*K/Ms as the measure of coercive

field throughout his report to support his obviousness opinions. *See, e.g.*, Victora Report ¶¶ 313-316, 458-460, 616-618.

182. A POSITA reading the patent would understand that the relevant coercive field is the short-time coercivity that corresponds to the write time during normal operating conditions. The patents are directed to improving writability, meaning the ability of the write head in a hard disk drive to write to the hard storage layer. In describing the writability problem with conventional media, the patents disclose that while smaller grains can be made thermally stable by increasing their anisotropy, "these grains are thermally stable but cannot be written with existing recording heads … also known as the writeability problem." The patents disclose that embodiments of the claimed invention "provide marked improvement against the superparamagnetic limit as the coercive field is reduced by the spatially varying anisotropy in the nucleation host" and as a result, "overcome the writeability problem of extremely hard magnetic storage layers with high thermal stability." This would have confirmed to a POSITA that the claimed coercive field should reflect normal operating conditions—i.e., the coercive field when a write field (~1 nanosecond) is applied by the write head in a hard disk drive operating at room temperature.

183. WD's own journal article recognizes that that 2K/Ms is the correct measure of the coercive field of a recording medium under normal recording conditions:

> In perpendicular magnetic recording (PMR), achieving high recording densities is enabled by decreasing media grain volume V and increasing the media magnetic anisotropy constant K in order to provide a reasonably high thermal stability at ambient temperature T_{RT} so that $KV/(k_B T_{RT}) > 65$. Since recording occurs on a short time scale (~1 ns), the medium coercivity and saturation field approach the anisotropy field $H_K = 2K/M_S$ where M_S is the saturation magnetization. The

Ex. 31, WD0262477-260 at 1. Thus, WD's article confirms that on a short time scale like that used in normal operating conditions, the coercive field (called coercivity in the article) approaches Hk=2K/Ms, which is the formula set forth in the patent.

184. WD's witnesses agree that the coercive field of the alloys it uses as hard storage layers is equal to Hk (i.e., 2K/Ms) under normal operating conditions (short time scale of approximately 1 ns). Papusoi Tr. 21:19-22:2 ([redacted]

185. I understand the Court has already found that claimed measurements should reflect normal operating conditions. Regarding claim 8 of the '864 patent, WD had argued that it was indefinite because "the process of switching in magnetic materials … may not be measured precisely—that is ***time and temperature dependent***." Dkt 162-1 at 21. The Court found that WD did not meet its burden of proving indefiniteness because "[e]ven accepting that 'the reduction of magnetization is time and temperature dependent,' it is no barrier for a POSITA." Claim Construction Order at 23. The Court explained that a POSITA understood that the claimed measurements "***should reflect normal operating conditions***" and thus, for example, "[t]he temperature should be around room temperature given that computer hard drives implementing

the claimed recording medium are typically used in indoor environments." *Id*. (quotations omitted). The Court concluded: "That the claim language does not specifically disclose every testing parameter ***does not render the claims indefinite***." *Id*.

186. Dr. Victora asserts that various passages in the patents describe different ways of characterizing magnetic properties such as the energy barrier of a layer and other parameters. But none of these passages suggest that arbitrary time scales can be used to measure the claimed coercive field. Similarly, Dr. Victora cites the testimony of Dr. Suess that there are different ways to measure coercive field and that it depends on parameters like temperature and time scale. Dr. Suess did not testify, however, that arbitrary temperatures and time scales can be used to measure the claimed coercive field. *See* Victora Report ¶ 959 (citing Suess Tr. 92:7-93:18, 376:11-388:8, 380:18-25, 475:16-20).

187. Dr. Victora asserts that certain methods "measure the coercive field at a time-scale that is orders of magnitude longer than the 'recording' time-scale" and that a coercive field measurement will differ depending on which time-scale is used. But that is why a POSITA would know to use the recording time scale—not an arbitrary time-scale orders of magnitude longer—and would never use one-time scale to measure Hs (the coercive field of the hard storage layer) and a different time-scale to measure Hn (the coercive field of the nucleation host).

188. Notably, Dr. Victora offers no opinion that when using the recording time-scale of approximately 1 nanosecond for both Hs and Hn, the claim limitations Hs > 0.5 T and Hn < Hs are met under some methods but not others. Nor does Dr. Victora offer any opinion that there are different acceptable methods for determining the coercive field using the recording time-scale at room temperature that would yield materially different results.

189. Thus, in my opinion, the coercive field limitations are not indefinite.

* * *

I declare under penalty of perjury that to the best of my knowledge, information, and belief, the foregoing statements are true and correct.

Executed on this 26th day of February 2024 in Minneapolis, Minnesota.

By: *_/s/ Mark Re_*