Materials Issues Driving Innovation in Large Technology Companies

Interview with Jerry Glembocki, Seagate Technology

We are probably most familiar with a number of large technology companies from the products that they provide, such as MP3 players, DVD recorders, personal computer systems, mobile communications, and other high-tech devices that have become a staple in our everyday life. We are seeing new products constantly being added at a faster and faster rate, but we may not be as aware of how these products are developed and some of the materials issues which drive these innovations and which are critical to further advancement in a particular industry. Understanding the close ties between materials and future product development can also give us a better perspective on what areas of materials research are especially important to these technology companies, as well as what type of educational backgrounds are needed in order to continue the fast-paced innovations. To give us a better understanding of how important materials can be for a technology company and its products, we present this interview with Jerry Glembocki, who is the senior vice president of Recording Heads and Recording Media at Seagate Technologies.

—S.M. Prokes, interviewer

As we all know, Seagate Technologies is a major hard disk drive manufacturer, with research and development (R&D) and manufacturing efforts in the United States and abroad.

Yes, we also offer various storage systems for back-up and portable storage. Our industry is experiencing explosive growth as almost all forms of content—such as pictures, movies, music, computer data and programs—are digitized and stored digitally.

Can you give us a brief description of the different parts and processes that are necessary in order to produce hard disks?

At the heart of a disk drive is the recording system comprised of a recording head and a disk. The head writes data to the disk when data needs to be stored, and then reads it back when the user wants to retrieve it. The other major systems of a hard drive include a very compact motor to spin the disk, a suspension and head stack that suspend the head over the disk, a magnetic actuator that rapidly moves the head and stack from track to track, a printed circuit board with microprocessors, recording channel, analog and digital circuitry, and finally a base and cover assembly that encloses the drive and holds the various parts together.

Jerry Glembocki, Senior Vice President of Recording Heads and Recording Media, gives a presentation to inspire his research team.

What are some of the important materials issues that are currently being addressed by Seagate in their R&D efforts?

Seagate's most significant materials challenges are in the design and manufacture of the recording heads and media. Today's most advanced disk drives store 150 billion bits of data in a square inch of disk space. This means that the surface area allocated to one bit is about 20 nm long and 170 nm wide.

> *"The challenge for researchers is to find novel materials that are not only able to support recording density but also to sustain all reliability testing under most extreme environmental conditions."*

When the recording head writes data, the magnetic flux it emanates has to be confined only to the area occupied by the bit; otherwise, it would erase neighboring data. This flux has to be strong enough to change the magnetic polarity on the disk. When the head reads data, it utilizes a tiny TGMR stripe to sense the minute magnetic flux lines from the written bit on the disk. Seagate was the first company to utilize TGMR transducers; this stands for "tunneling giant-magneto resistive." As the name implies, they utilize the giant-magneto resistive effect to convert magnetic flux transition patterns to electrical signals.

Likewise, the disk has to be designed to keep a magnetic bit magnetized for decades without thermal erasure and to be easily written with a tiny magnetic flux pattern. This involves using sputter deposition to build the magnetic layers one by one on the disk. A series of layers containing cobalt, platinum, chrome, ruthenium, and other elements are deposited with a final protective layer of carbon. The disk is then covered with a thin lubricant to prevent wear when the head flies over it.

In your opinion, what future materials-related problems will need to be solved in order to bring the next generation of hard disks to the market?

The next generations of disk drives will employ smaller and smaller bits to store more data. In fact, the bits have gotten so small that it is difficult to keep them thermally stable for many years. For this reason, the industry is turning to "perpendicular recording." With this recording technique, the data is written in such a way that the magnetic bits stand upward (perpendicular) on the disk as opposed to being in plane with the surface of the disk. Perpendicular recording allows media designers to deposit thicker magnetic layers without compromising the bit size. These thicker layers hold more magnetic material and are resistant to thermal erasure. Engineers and scientists at Seagate are pioneers in this technology, and as a result, Seagate is the first disk drive company to utilize perpendicular recording in its entire product line, providing our customers with a more reliable product than was previously available.

We believe that perpendicular recording will bring us to a range from 500 Gbits/in^2 to 1 Tbit/in^2 recording density, then heat-assisted magnetic recording (HAMR) and/or bit pattern media (BPM) will bring the density beyond 1 Tbit/in^2 [see Figure 1]. The challenge for researchers is to find novel materials that are not only able to support recording density but also to sustain all reliability testing under most extreme environmental conditions.

Currently, there are many discussions concerning the level of science education in the United States and suggestions of possible future shortages of science and engineering graduates. Do you see this as a problem? Has Seagate experienced problems in hiring or attracting qualified candidates in the U.S.?

We haven't experienced problems in

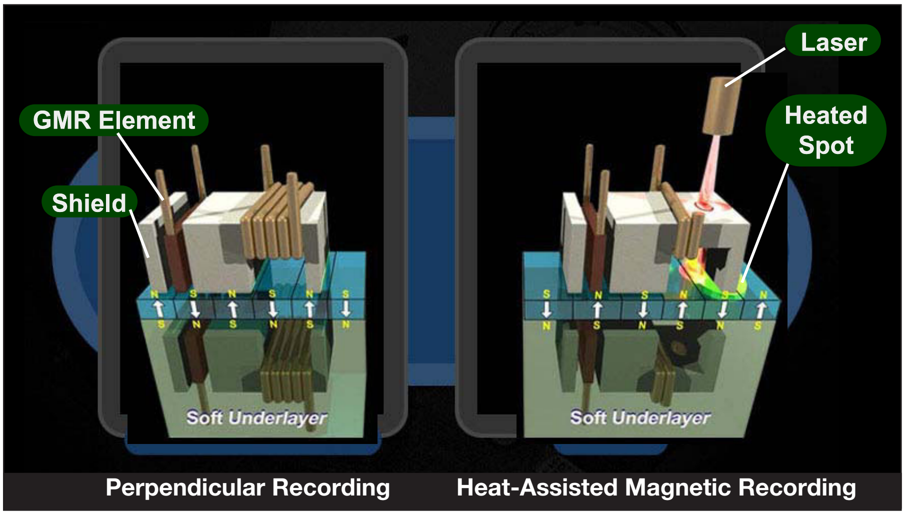

Figure 1. Perpendicular recording is expected to achieve a range from 500 Gbits/in^2 to 1 Tbit/in^2 recording density, then heat-assisted magnetic recording (HAMR) and/or bit pattern media (BPM) is expected to bring the density beyond 1 Tbit/in^2. GMR is giant magnetoresistance. Courtesy of Seagate.

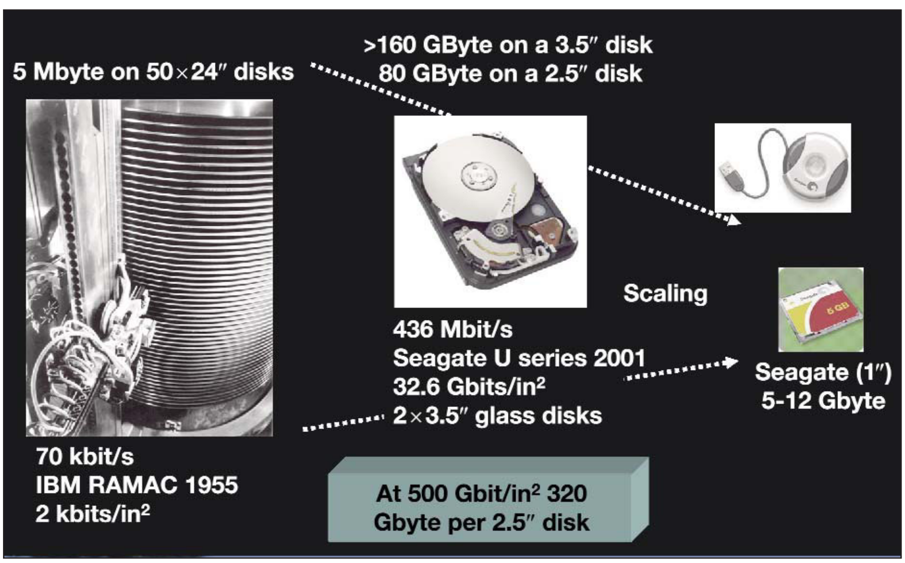

Figure 2. Areal density enables new smaller storage devices, for example (left to right): from a server, to desktop, notebook, and consumer electronics. Courtesy of Seagate.

hiring qualified candidates in the United States. Seagate operates in many countries around the world. As I travel to these locations and others, I have observed that many of them place a higher value on science and engineering than what I see in the U.S. Many governments outside the U.S. go out of their way to attract R&D work content to their countries.

That being said, in my experience, the engineers in the U.S. are the best at innovation and taking risks. The majority of the U.S. companies that expanded to other countries had kept the core technology and advance product development in the U.S. while they expanded the high volume manufacturing in other countries. This had created an environment in which the companies maintained the ingenuity of the U.S. engineers while the other countries' engineering skills focused on sustaining and improving cost, performance, and the reliability of technology-driven products.

In terms of the current and future R&D and manufacturing efforts, what type of science/technology backgrounds does Seagate look for in new hires? If one is considering future employment in R&D with companies such as Seagate, what type of education and educational level would be most appropriate?

Our Head and Media R&D organizations employ materials scientists, micro magnetic physicists, tribologists, electrical/mechanical engineers, statisticians, physicists, chemical engineers, and chemists. A significant number of our engineers have their doctorate degree.

How did you enter this industry and what career path brought you to this point?

I've been in the disk drive industry my entire professional life. I graduated in 1978 with a BSEE degree from the Polytechnic Institute of New York, prior to joining IBM. IBM invented the hard disk drive 50 years ago. I worked at IBM for six years as a disk test engineer on the 3380 disk drive that was the size of a large sub-zero refrigerator; it had 5 Mbytes of storage. I currently have a Seagate pocket drive that fits in my shirt pocket and has a 5 Gbyte capacity (1000 times larger) [see Figure 2].

I left IBM in 1983 and joined a small start-up company called Domain Technology that produced magnetic disks for drive companies such as Maxtor. An IBM PC that had a hard disk was announced that year. There was tremendous demand for small compact disc drives for personal computers as a result. Domain eventually went bankrupt and was acquired by Conner Peripherals in 1990, and six years later Seagate acquired Conner.

Over the years, I've held many leadership roles in magnetic disk and recording head R&D as well as manufacturing. Currently, as Senior Vice President of Heads and Media at Seagate, I'm responsible for all aspects of Seagate's Head and Disk business. This includes R&D and manufacturing.

What do you find the most challenging in your current position at Seagate?

Definitely the technology. Our industry is one of the most demanding in technology deployment in mass production. Every day we push the limits of science and engineering. I feel so very fortunate to be associated with the team here at Seagate.

When I joined the hard disk drive industry years ago, researchers had projected the recording limit will be ~1 Gbit/in^2 due to the superparamagnetic issue. Since then, the barrier has been broken to 1 Gbit, 10 Gbits, and now is believed to be beyond 1 Tbit/in^2. In February last year, Seagate introduced the 12-Gbit/in^2 disk drive, and two months later, the 750-Gbit/in^2 disk drive. The people here are the best in the world at what we do and have such a positive, "can-do" attitude.

Thank you for giving our readers an insight into this rapidly evolving technology. Perhaps now, as we make use of our 5-Gbyte thumb drives, our MP3 players, or our digital cameras, we will appreciate the amount of research and development that is involved, as well as the contributions of so many people, from research and development all the way to the manufacturing of these popular storage products.

***Jerry Glembocki** is Seagate's Senior Vice President of Recording Heads and Recording Media, responsible for overseeing all component research, product development, hard drive integration, production launch, materials, and volume production activities for the worldwide operations relating to recording heads and recording media, which are located in the United States, Asia, and Europe.*

***S.M. Prokes** is a senior research scientist in the Electronics Science and Technology Division at the Naval Research Laboratory.*

LIBRARY

The following recently published books, relevant to materials research, have come to *MRS Bulletin's* attention. Some of the books listed here may be reviewed in future issues of *MRS Bulletin*. To review a book from the list or to offer recommendations of additional books, contact Editorial Assistant, *MRS Bulletin*, 506 Keystone Drive, Warrendale, PA 15086-7573, USA; e-mail bulletin@mrs.org.

Books

Applications of Materials

Growth Market Nanotechnology: An Analysis of Technology and Innovation, Norbert Malanowski, Wolfgang Luther, Thomas Heimer, and Matthias Werner, Editors, Wiley, 2006, 294 pp., $125.00, ISBN 3-527-31457-7.

Propellants and Explosives: Thermochemical Aspects of Combustion, *Second Edition, Completely Revised and Extended Edition,* Naminosuke Kubota, Wiley, 2007, 530 pp., $175.00, ISBN 3-527-31424-5.

Smart Material Systems and MEMS: Design and Development Methodologies, Vijay Varadan, K.J. Vinoy, and S. Gopalakrishnan, Wiley, 2006, 418 pp., $135.00, ISBN 0-470-09361-0.

Thin Film Solar Cells—Fabrication, Characterization and Applications, Jef Poortmans and Vladimir Arkhipov, Editors, Wiley, 2006, 502 pp., $235.00, ISBN 0-470-09126-6.

Biomaterials

Nanodevices for the Life Sciences, Challa S.S.R. Kumar, Editor, Wiley, 2006, 489 pp., $175.00, ISBN 3-527-31384-6.

Tissue, Cell, and Organ Engineering, Challa S.S.R. Kumar, Editor, Wiley, 2007, 540 pp., $175.00, ISBN 3-527-31389-1.

Experimental Techniques

Force Microscopy: Applications in Biology and Medicine, Bhanu P. Jena and Johann Karl H. Hörber, Editors, Wiley, 2006, 300 pp., $125.00, ISBN 0-471-39628-4.

Pulsed Laser Deposition of Thin Films: Applications-Led Growth of Functional Materials, Robert Eason, Wiley, 2006, 682 pp., $175.00, ISBN 0-471-44709-2.

Scanning Probe Microscopies Beyond Imaging: Manipulation of Molecules and Nanostructures, Paolo Samori, Editor, Wiley, 2006, 570 pp., $190.00, ISBN 3-527-31269-6.

Scanning Probe Microscopy—Electrical and Electromechanical Phenomena at the Nanoscale, Sergei Kalinin and Alexei Gruverman, Springer, 2007, 980 pp., $349.00, ISBN 0-387-28667-5.

Metallurgy

Copper in the Automotive Industry, Hansjörg Lipowsky and Emin Arpaci, Wiley, 2007, 191 pp., $75.00, ISBN 3-527-31769-4.

Thermal Spraying for Power Generation Components, Klaus Erich Schneider, Vladimir Belashchenko, Marian Dratwinski, Stephan Siegmann, and Alexander Zagorski, Wiley, 2007, 285 pp., $125.00, ISBN 3-527-31337-0.

Virtual Fabrication of Aluminum Products: Microstructural Modeling in Industrial Aluminum Production, Jürgen Hirsch, Editor, Wiley, 2007, 405 pp., $150.00, ISBN 3-527-31363-X.

Physics & Electronics

Basic Electromagnetism and Materials, André Moliton, Springer, 2007, 430 pp., $79.95, ISBN 0-387-30284-3.

Colloid Stability: The Role of Surface Forces, *Part 1, Volume 1*, Tharwat F. Tadros, Editor, Wiley, 2007, 448 pp., $175.00, ISBN 3-527-31462-8.

Metal Based Thin Films for Electronics, *Second, Revised and Enlarged Edition,* Klaus Wetzig and Claus M. Schneider, Editors, Wiley, 2006, 424 pp., $165.00, ISBN 3-527-40650-6.

Solid-State Physics—Introduction to the Theory, James D. Patterson and Bernard C. Bailey, Springer, 2007, 717 pp., $99.00, ISBN 3-540-24115-9.

Polymer Chemistry

Activation of Small Molecules: Organometallic and Bioinorganic Perspectives, William B. Tolman, Editor, Wiley, 2007, 382 pp., $175.00, ISBN 3-527-31312-5.

Block Copolymers in Nanoscience, Massimo Lazzari, Guojun Liu, and Sébastien Lecommandoux, Editors, Wiley, 2007, 447 pp., $165.00, ISBN 3-527-31309-9.

Frontiers in Transition Metal-Containing Polymers, Alaa S. Abd-El-Aziz and Ian Manners, Wiley, 2007, 533 pp., $135.00, ISBN 0-471-73015-7.

Organic Coatings—Science and Technology, *Third Edition*, Zeno Wicks Jr., Frank N. Jones, S. Peter Pappas, and Douglas A. Wicks, Wiley, 2007, 722 pp., $150.00, ISBN 0-471-69806-7.