Hitachi Achieves Nanotechnology Milestone for Quadrupling Terabyte Hard Drive

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Hitachi, Ltd. announced today they have developed the world's smallest read-head technology for hard disk drives, which is expected to quadruple current storage capacity limits to four terabytes (TB) on a desktop hard drive and one TB on a notebook hard drive.

Researchers at Hitachi have successfully reduced existing recording heads by more than a factor of two to achieve new heads in the 30-50 nanometer (nm) range, which is up to 2,000 times smaller than the width of an average human hair (approx. 70-100 microns). Called current perpendicular-to-the-plane giant magnetoresistive (CPP-GMR) heads, Hitachi's new technology is expected to be implemented in shipping products in 2009 and reach its full potential in 2011.

Hitachi will present these achievements at the 8th Perpendicular Magnetic Recording Conference (PMRC 2007) to be held October 15-17, 2007 at the Tokyo International Forum in Japan.

"Hitachi continues to invest in deep research for the advancement of hard disk drives as we believe there is no other technology capable of providing the hard drive's high-capacity, low-cost value for the foreseeable future," said Hiroaki Odawara, Research Director, Storage Technology Research Center, Central Research Laboratory, Hitachi, Ltd. "This is an achievement for consumers as much as it is for Hitachi. It allows Hitachi to fuel the growth of the 'Terabyte Era' of storage, which we started, and gives consumers virtually limitless ability for storing their digital content."

Hitachi believes CPP-GMR heads will enable hard disk drive (HDD) recording densities of 500 gigabits per square inch (Gb/in2) to one terabit per square inch (Tb/in2), a quadrupling of today's highest areal densities. Earlier this year, Hitachi GST delivered the industry's first one-terabyte hard drive at148 Gb/in2; the company's highest areal density shipping in products today is in the 200 Gb/in2 range. These products use existing head technology, called TMR (tunnel-magnetoresistive) heads. The recording head and media are the two key technologies controlling the miniaturization evolution and the exponential capacity growth of the HDD.

Cutting Through the Noise – The Strongest Signal-to-Noise Ratio

The continued advancements of HDDs requires the ability to squeeze more, and thus, smaller data bits onto the recording media, necessitating the continued miniaturization of the recording heads to read those bits. However, as the head becomes smaller, electrical resistance increases, which, in turn, also increases the noise output and compromises the head's ability to correctly read the data signal.

High signal output and low noise is what is desired in hard drive read operations; thus, researchers try to achieve a high signal-to-noise (S/N) ratio in developing effective read-head technology. Using TMR head technology, researchers predict that accurate read operations would not be conducted with confidence as recording densities begin to surpass 500 Gb/in2.

The CPP-GMR device, compared to the TMR device, exhibits less of an electrical resistance, resulting in lower electrical noise but also a smaller output signal. Therefore, issues such as producing a high output signal while maintaining a reduced noise to increase the S/N ratio needed to be

resolved before the CPP-GMR technology became practical.

In response to this challenge, Hitachi, Ltd. and Hitachi GST have co-developed high-output technology and noise-reduction technology for the CPP-GMR head. A high electron-spin-scattering magnetic film material was used in the CPP-GMR layer to increase the signal output from the head, and new technology for damage-free fine patterning and noise suppression was developed. As a result, the signal-to-noise ratio, an important factor in determining the performance of a head, was drastically improved. For heads with track widths of 30nm to 50nm, industry-leading S/N ratios of 30 decibels (dB) and 40 dB, respectively, were recently achieved with the heads co-developed at Hitachi GST's San Jose Research Center and Hitachi, Ltd.'s Central Research Laboratory in Japan.

Recording heads with 50nm track widths are expected to debut in commercial products in 2009, and those with 30nm track widths will be implemented in products in 2011. Current TMR heads, shipping in products today, have track widths of 70nm.

The Incredible Shrinking Head

The discovery of the GMR effect occurred in 1988, and that body of work was recognized just last week with a Nobel Prize for physics. Nearly two decades after its discovery, the effects of GMR technology are felt more strongly than ever with Hitachi's demonstration of the CPP-GMR head today.

In 1997, nine years after the initial discovery of GMR technology, IBM implemented the industry's first GMR heads in the Deskstar 16GXP. GMR heads allowed the HDD industry to continue its capacity growth and enabled the fastest growth period in history, when capacity doubled every year in the early 2000s. Today, although areal density growth has

slowed, advancements to recording head technology, along with other HDD innovations, are enabling HDD capacity to double every two years.

In the past 51 years of the HDD industry, recording head technology has seen monumental decreases in size as areal density and storage capacity achieved dizzying heights. The first HDD recording head, called the inductive head, debuted in 1956 in the RAMAC – the very first hard drive – with a track width of 1/20th of an inch, or 1.2 million nm. Today, the CPP-GMR head, with a track width of about one-millionth of an inch, or 30nm, represents a size reduction by a factor of 40,000 over the inductive head used in the RAMAC in 1956.

Source: Hitachi