New data storage design likely to increase data capacity

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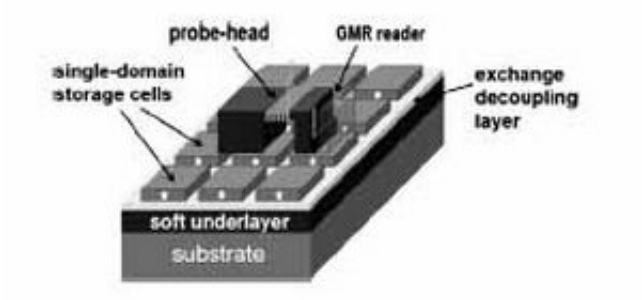

In this diagram of a patterned media recording system, each 43-nanometer island of magnetic material is isolated from the others, allowing each tiny cell to act as a bit. According to scientists at the University of Houston, the pattern could allow up to 20-40 terabits per square inch. Photo credit: Parekh et al.

If you always seem to be running out of memory on your computer to store songs or photos, be assured that increasing data storage is a hot topic in nano labs. Scientists have built a patterned magnetic recording medium for hard drives that will increase your gigabits (billions) into terabits (trillions).

In a sense, continuous data storage systems in computers work similar to record players. Inside a hard drive, disks spin around, and read-write heads on the ends of armatures record and retrieve data from the disks. Instead of grooves on a record, the disks have magnetic surfaces. To write on the disk, the heads – positioned only nanometers away from the

disks – apply a magnetic field to the disks as they revolve. To read the disk, the heads scan the disk and eventually the magnetic bits are interpreted as digital data.

The conventional method of magnetic recording systems is based on longitudinal magnetic recording. In longitudinal systems, the poles of magnetic bits are aligned on a disk parallel to its surface. However, the density of the bits is limited because if the bits get crammed too close together, their poles start flipping, erasing memory. Known as the "superparamagnetic limit," this effect limits the disk's data density to an estimated 250 gigabits per square inch.

To increase data density, computers have started (in 2006) coming out with perpendicular recording systems. In these systems, the bits stand perpendicular to the disks, allowing more bits and about 10 times greater density and memory. However, perpendicular systems will still eventually face the superparamagnetic limit at the point when the energy required to switch the bits' poles equals the inherent thermal energy of the disk. Scientists predict a limit around 1 terabit per square inch.

Now, a team of physicists from the University of Houston with members from Maryland and Florida has designed a system that looks very different from the above two continuous systems. Considered the next generation in data storage systems, the design is based on patterned media on top of magnetic multilayers (see figure).

"Magnetic multilayers such as cobalt and palladium exhibit very large and easily tunable vertical magnetic anisotropies, which makes them suitable for ultra-high-density magnetic recording applications," the team reported in a recent issue of *Nanotechnology*.

The patterned media system can alter both the variables in the superparamagnetic effect, and greatly postpone the limit. The

multilayered design increases the thermal energy in the disk, which means that more energy can be used if necessary to switch the bits' magnetic poles. The scientists can also tune the magnetic strength of the bits' poles by altering the physical and chemical properties of the highly uniform magnetic layers.

The scientists built the patterned media by scanning and patterning the bits' surface using ion beam proximity lithography – a high-resolution as well as cost-effective method, which is important considering the potential widespread use of the system. The ion beams patterned the storage bits into islands about 43 nanometers thick, the cobalt layer about 0.52 nanometers thick and the palladium layer about 0.66 nanometers thick.

"The design is a proof of concept," Dmitri Litvinov, physicist from the Center for Nanomagnetic Systems at the University of Houston, told *PhysOrg.com*. "We are aiming at substantially higher densities (smaller islands); for example, 20-nanometer islands on a 25-nanometer pitch."

Magnets in hard drives are also superior the more permanent they are. More permanent magnets have a higher degree of coercivity, which measures how much magnetic strength is required to completely diminish the magnetic field in a given material. The team of physicists found that the cobalt and palladium layers, when interacting with the ion beam in the lithography device, demonstrated a nearly 15-fold increase in coercivity.

"Our plan is to demonstrate a terabit-per-square-inch recording in one or two years," said Litvinov. "The ultimate limit will be somewhere in the 20-40 terabit per square inch range."

Citation: Parekh, Vishal, Chunsheng, E., Smith, Darren, Ruiz, Ariel, Wolfe, John C., Ruchhoeft, Paul, Svedberg, Erik, Khizroev, Sakhrat,

and Litvinov, Dmitri. Fabrication of a high anisotropy nanoscale patterned magnetic recording medium for data storage applications. *Nanotechnology* 17 (2006) 2079-2082.

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