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Higher-Density Data Storage

A novel nanolaser could cram more data onto a hard disk.

By Prachi Patel-Predd

A laser that focuses light into a 30-nanometer-wide spot could be an important advance toward ultra-high-density hard disks. Researchers at the University of California, Riverside (UCR), and at the University of Houston, in Texas, who have developed the nanolaser, say that it could lead to hard disks with 10 terabits of data packed into a square inch.

Today, hard disks can carry up to 200 gigabits per square inch. Data is stored magnetically. Using existing technology, manufacturers could increase a disk's capacity to at most one terabit per square inch. The nanolaser is an important step toward a disk-writing system that many researchers are currently working on. Such a system would use both light and magnetic fields to store data on a disk, packing up to 50 terabits per square inch of data.

The smaller the light spot of the laser, the smaller the bit size, which means more bits per square inch. Right now, the laser can concentrate 250 nanowatts of power on a 30-nanometer-wide spot. "Our technology can be scaled down to 5 to 10 nanometers for sure," says Sakhrat Khizroev (http://www.physics.miami.edu/~khizroev/) , an electrical-engineering professor who is leading the work at UCR. A 10-nanometer spot size should be small enough to get a density of 10 terabits per square inch.

Present-day magnetic storage technology has doubled data density on hard disks nearly every year for the past three decades. But now the technology is approaching its limit. On a hard disk, each bit is a tiny area in which the material's crystals all have their magnetic fields aligned in the same direction. As more data is recorded on a disk, bits get smaller and comprise fewer crystals of the material. At about one terabit per square inch, the bit areas become so tiny that the crystals do not have enough energy to keep their magnetic fields aligned, and the bits end up losing their information.

Hard-disk manufacturers such as Seagate are now looking at a new method to store more data on disks. The technique, called heat-assisted magnetic recording, involves using a tightly focused light spot to heat up the bits when they are being recorded. This gives the magnetic crystals energy to retain their magnetic-field orientations. "There are various ways one could imagine bringing light on the disk," says Mark Kryder (http://www.ece.cmu.edu/directory/details/91) , an electrical- and computer-engineering professor at Carnegie Mellon University. "The most elegant way would be to use a nanolaser."

So far, the challenge has been to make a laser that delivers sufficient energy into a small enough light spot. With previous lasers, Khizroev says, "the light, when focused on a 30-nanometer spot size, has energies that are a fraction of a nanowatt." He and his colleagues make their 250-nanowatt laser by depositing a very thin layer of aluminum on the emitting side of a semiconductor diode laser. Then they focus a beam of positive gallium ions on the aluminum to etch tiny nanoscale apertures. As predicted by physics theory, a C-shaped aperture lets the most energy come through into the smallest spot size. Khizroev says that his colleagues are now trying to engineer the laser with an even smaller spot size of 5 to 10 nanometers.

Ed Schlesinger (http://www.ece.cmu.edu/directory/details/155) , head of the Electrical and Computer Engineering department at Carnegie Mellon, says that the new nanolaser is "an important aspect of making heat-assisted magnetic recording a reality." But he cautions that there are many engineering challenges to solve before the technology can be brought to market. They include mounting the laser on a slider so that it can move to various areas of the hard disk to record data, designing a new disk material that works with heat-assisted recording, and

making disk lubricants that can handle the high temperatures during the heat-assisted writing process.

"Heat-assisted magnetic recording is a real systems problem and requires development and progress on a lot of fronts simultaneously," Schlesinger says. "The nanolaser is a nice step forward and brings the technology closer."
