Storing vast amounts of data in tiny spots

As the number of people who use computers grows each year, so does the need for better ways to record and preserve electronic information.

Compared to the first disk storage systems in 1956, today's magnetic hard disk drives record nearly 500,000 times as much data in the same space—almost 1 billion bits of data per square inch of memory. Yet even that barely satisfies the mushrooming demand for more capacious computer memories.

To meet that need, researchers are developing recording materials that can rapidly store and retrieve huge amounts of digital data, scientists reported this week at a meeting of the Materials Research Society in San Francisco. By the year 2000, magnetic hard disk drives may hold 5 billion bits of data per square inch, and by 2005, perhaps 50 billion, says Mark H. Kryder, a computer scientist at Carnegie Mellon University in Pittsburgh.

"These will be the parking lots for the information superhighway," he says. Among the new compounds under investigation are thin films of barium ferrite and layered materials containing iron and silicon oxide. These magnetic sandwiches can potentially hold 10 billion bits of information per square inch, says Kryder. Barium ferrite has the additional advantage of relative hardiness. It resists corrosion and damage so well that, unlike its counterparts, it may not need a protective coating, says Kryder.

Today, a typical 3.5-inch diameter floppy disk holds 1.4 million bytes of data. Within 5 years, new magnetic materials could yield 1.8-inch disks capable of storing 3 billion bytes — equivalent to 3 hours of compressed video signals, says John L. Simonds, a computer scientist at the National Storage Industry Consortium in San Diego.

Moreover, new magneto-optical materials could lead to hybrids of hard drives and compact disks holding as much as 100 billion bits of information per square inch. With such dense data storage, a small tape cartridge could hold 2 trillion bytes of information — nearly equivalent to all the medical information stored in a year by the average hospital, Simonds says.

The key to achieving reliable high-density memories lies in nanotechnology, says Kryder. For a recording material to move data in and out of storage speedily, its surface must have magnetic grains as small as 10 nanometers across, Kryder says. Future materials may sport billions of rows of tiny magnetic rods.

Stephen Y. Chou, a materials scientist at the University of Minnesota in Minneapolis, and his colleagues report fabricating "interactive arrays" of magnetic nickel pillars, each only 15 nanometers tall. Using ultra-high-resolution electron beam lithography, Chou's team has made recording materials that resemble microscopic metallic carpets.

With this material, the group wants to make disks capable of recording 65 billion bits of data per square inch. "This storage density would be more than 100 times greater than [that of] state-of-the-art materials," Chou says. He calls these devices "quantum magnetic disks" because each pillar acts as a single magnetic unit.

To record on the new disks, one need only "flip" the magnetic orientation of each pillar, he says. To store a bit of data, a recording head magnetizes a tiny nickel rod with its north pole pointing up. To erase it, the same head reverses the magnetic polarity.

Because each pillar has only two possible magnetic states, Chou maintains that quantum magnetic disks do not require a recording head to track as precisely as current systems do, an advantage that makes the new disks faster and more accurate.

Stuart Parkin, a materials scientist at the IBM Almaden Research Center in San Jose, Calif., and his colleagues are investigating ways to store data using the so-called giant magnetoresistance effect that appears in tiny metallic structures. The effect amounts to a sudden jump in electric resistance on application of a magnetic field.

Scientists believe that the effect results from charge "scattering" at the interface between magnetic and nonmagnetic surfaces in multilayered materials, but they do not fully understand the phenomenon.

Nevertheless, Parkin reports that his team's work with cobalt and copper alloys that exhibit giant magnetoresistance at room temperature has helped them figure out how to layer the material to maximize its magnetic and resistive effects.

A recording system that takes advantage of giant magnetoresistance could record and play back data with "unprecedented capacity and speed," says Bruce A. Gurney, a physicist at IBM Almaden. The rates of data transmission could exceed 10 megabytes per second, or up to 10 times faster than current systems.

— R. Lipkin

New Congress moves on science budgets

The new, Republican-led Congress completed its first 100 days on the job last week. Many members, particularly in the House, had promised to radically change how government does business during that time (SN: 1/14/95, p.20). Although scientists in and out of government have yet to see their funding sharply decreased, plans to do just that continue moving through the legislative process.

Both the House and Senate have approved cuts in science agency budgets for fiscal year 1995, which ends Sept. 30, and are putting the bills in final form to send to President Clinton (SN: 3/11/95, p.159).

The House Budget Committee is also floating a document, "Illustrative Republican Spending Cuts," listing programs and agencies that Congress should target to reduce government spending by $100 billion over the next 5 years. In it, committee members spell out their support for basic research and their opposition to government programs that help companies develop new technologies — programs the administration has promoted.

The document, released March 16, recommends that over a 5-year period Congress should "begin termination of the Department of Energy," which would include a $2.3 billion reduction in energy supply research and development; "dissolve the National Biological Service," for $326 million in savings; decrease the Agricultural Research Service's budget by 10 percent; and reduce transportation research funding.

House Science Committee chairman Robert S. Walker (R–Pa.) recently announced his desire to have the space station funded separately from NASA, which faces deep cuts, to protect the station's current level of funding until its completion, expected in 2002.

"The specter of finishing the first session of the 104th Congress with science and technology resources slashed by a meat ax is a real one," White House Science Advisor John H. Gibbons asserted at an American Association for the Advancement of Science colloquium in Washington, D.C., last week.

"While the National Science Foundation hasn't appeared on a public hit list yet, [NSF] Director Neal Lane has been told to expect at least a 20 percent [budget] cut," Gibbons said. But a Walker spokeswoman said NSF would face a less than 20 percent cut.

In these tight budget times, the administration can't protect science from some cuts, Gibbons acknowledged. "The reality is grim for science and technology funding," he said.

Indeed, the President's fiscal year 1996 budget proposal recommends billions of dollars in cuts over the next 5 years for NSF, DOE, NASA, the National Institutes of Health, and other departments that fund research. *— T. Adler*