News

New molecules could bring super-dense, solid-state hard disk alternatives

Researchers have discovered a better way to store data in individual molecules

By Stephen Lawson
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IDG News Service - A recent breakthrough in storage research may someday produce a new type of solid-state device that can be used like a hard disk drive and holds 1,000 times as much data.

An international team of researchers led by a Massachusetts Institute of Technology scientist has discovered a new way of making molecular memory, which stores data in individual molecules. That breakthrough could help the technology graduate from labs to data centers and drive down its manufacturing costs.

The key to the discovery is a new molecule developed by chemists at the Indian Institute of Science Education and Research (IISER) in Kolkata. It allowed researchers to build magnetic memory with fewer layers of material, making it thinner, less expensive, and more usable at normal temperatures. The reward for consumers and enterprises could be storage that holds 1,000TB per square inch.

Storage devices based on the new discovery probably won't go on sale within five years, though they may arrive within a decade, said MIT's Jagadeesh Moodera, who led the research. The findings, published on Wednesday on the online edition of the journal Nature, should spawn many more projects to develop more such chemicals and refine memory designs, he said.

"Now we know, to some extent, which direction to go," Moodera said.

Molecular memory stores data in special molecules, using the magnetic states of individual molecules to represent the ones and zeroes of binary data. This technique can store data in less space per bit than current hard disk drives use.

Previous experimental devices for molecular memory sandwiched the layer of molecules used for storage, called the insulator, between two magnetically charged layers called ferromagnetic electrodes. Changing the relative magnetic orientations of these electrodes changes the conductivity of molecules in the middle, and the two states of conductivity can represent ones and zeroes.

The IISER researchers developed a new kind of molecule and discovered its conductivity could be changed with just one ferromagnetic electrode. That meant the other layer could be an ordinary metal electrode.

- The metal electrode is less expensive to make than a ferromagnetic one, but it also can detect the changes in state of the individual storage molecules. As a result, it could take the place of the sensors that are now used on the tips of hard-drive arms to read the bits on a disk, Moodera said. The resulting storage device would have no moving parts but would still have the long "write life" of a hard drive, he said. Write life, or the number of times new data can be written to a storage device, typically is much higher for hard disk drives than for today's flash storage. That's one factor that has held back solid-state storage in some enterprises.

  The new molecules and layering technique have also allowed the research team to use just one layer of insulator molecules, which should make it easier to manufacture molecular memory. Previous iterations of the technology have used five or six layers of molecules, which have to be aligned with each other to work well, a step that adds cost.

  In addition, the new developments have led to greater stability, so the whole system requires less cooling, Moodera said. Previous molecular memory devices in labs have had to be cooled to near zero Kelvin, or absolute zero, he said. The device built in this project can work at about zero Celsius, or the freezing point of water. That leap in temperature makes Moodera optimistic that with further refinement, such devices will eventually be able to meet the operating requirements of IT departments, which typically demand survival of data up to 100 Celsius, or the boiling point of water.

  With enough funding, further research over the next few years should come up with new types of molecules -- the ones developed at IISER are fragments of graphene molecules -- and ways of dealing with these new types of molecules without dissolving them, because they can be more fragile than the elements used in making storage devices today, Moodera said.

  In the meantime, today's time-honored hard disk drive design may yet yield more density than scientists have thought possible, he said. Demand is likely to drive exploration in all types of storage.

  "When you see something, you find a solution for the problem," Moodera said.

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