Computer hard drives perform better, last longer with novel polyester lubricant

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Much discussed among computer circles is the so-called end of Moore's Law and its predictions of ever-smaller circuits. Less known is a challenge facing the next generation of hard disk drives: **lubricant coatings that can hold up to faster speeds and denser data.** Perfluoropolyethers (PFPEs), the current industry standard, are running up against the polymer's limits in protecting hard drives against daily wear and tear. So University of Illinois Ph.D. candidate Wei Xiao developed an entirely new lubricant, based on inexpensive and abundant polyester. She presented her work today for the first time at the 228th national meeting of the American Chemical Society, the world's largest scientific society.

In short, the lubricant, called SHP — sterically hindered polyester — "acts like a solid when cast as very thin films," says Xiao. "And it has very good adhesion properties."

Both qualities are important for lubricant design. A computer's hard drive is polished to a mirror finish to create as perfect a surface as possible on which to record, retrieve and erase thousands of hours' worth of data over its lifetime. A lubricant coating shields the disk from damage during contact with the head, which can fly back and forth across the disk dozens of times per second.

As a magnetic recording device, the head itself relies on a magnetic field rather than physical contact to read or write to the disk. But at rest, tiny arms called sliders drop down to the disk surface to protect the head.

"The lubricant needs to be solid enough that the sliders don't sink. But it needs to be liquid enough so that any debris from contact between the head and surface would sink back in," says Xiao's advisor James Economy, Ph.D., a professor with the school's department of material science and engineering. He came to Illinois after 14 years of heading up polymer research at IBM.

The sliders do sink into PFPEs, however, and the attractive forces of 'stiction,' short for static friction, can keep them from retracting quickly enough when the disk begins to spin again. That 'stickiness' can damage the disk or even snap off the head when the disk starts spinning again.

Two other problems have arisen as disk drives spin ever faster to speed performance, he notes. At the 10,000-plus revolutions per minute now typical of computer hard drives, centrifugal forces can ripple the lubricant like a washboard. The uneven surface can hamper reading and writing, and can leave some tracks less protected from slider strikes.

Secondly, PFPE lubricants "can also spin off entirely," says Economy. To prevent that, researchers "often try to chemically bond it to the disk surface. That's a disadvantage because you've got to figure out the chemistry to do that."

"In our approach, the polymer is very polar," Xiao explains. "So it bonds to the surface on its own." The result is a simpler and less expensive solution, the Illinois researchers believe.

To make their lubricant more stable, Xiao used polyester building blocks containing offshoots of bulky organic molecules. As they polymerize, the bulky groups surround and protect the ester bonds. The effect, called steric hindrance, also helped the team achieve the balance of solid and liquid characteristics they wanted.

Their data also suggest the SHP lubricant is more resistant to corrosion than PFPEs.

"Solving the problems [with PFPE] forced us to make a completely new kind of polyester," Economy says. "I don't think any other [research] group has tried to design new materials in this area."

Indeed, the Illinois team believes their invention may have far broader application, such as the mining industry, for example, or metals manufacturing; perhaps even automobile engines. "Any place where there are wear surfaces," says Economy.

Xiao has sent samples of SHP to the Center for Magnetic Recording Research, an industry-sponsored facility at the University of California, San Diego, which can conduct real-world testing.

The American Chemical Society is a nonprofit organization, chartered by the U.S. Congress, with a multidisciplinary membership of more than 159,000 chemists and chemical engineers. It publishes numerous scientific journals and databases, convenes major research conferences and provides educational, science policy and career programs in chemistry. Its main offices are in Washington, D.C., and Columbus, Ohio.

Source: American Chemical Society