Data storage: Measuring the downside of downsizing

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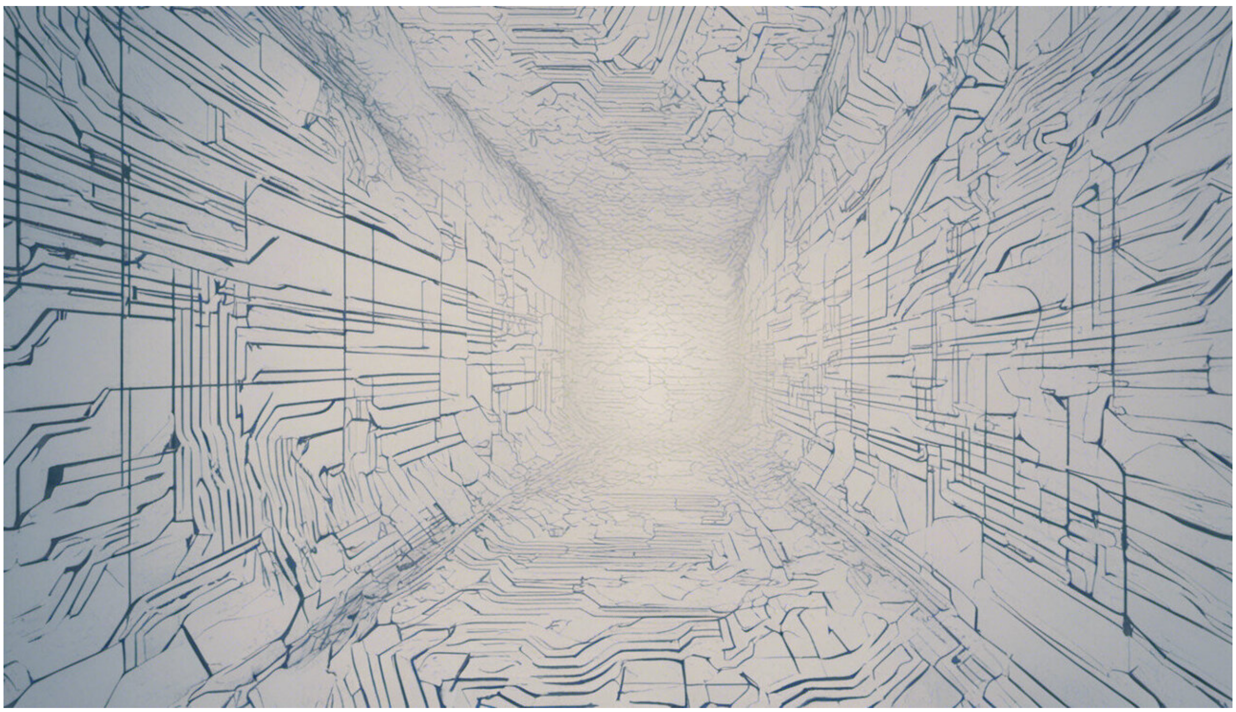

Credit: AI-generated image (disclaimer)

To keep pace with the rapidly growing consumer demand for data storage, hardware engineers are striving to cram as much electronic information into as small a space as possible. Jinmin Zhao, Mingsheng Zhang and co-workers at the A*STAR Data Storage Institute, Singapore, have now devised a technique to assess the impact of making these devices more compact. Insights resulting from this work will guide the future design of stable disk drives.

The primary components of a hard disk drive are a rotating disk coated with a thin film of magnetic material and a magnetic head on a moving arm, also called a slider (see image). The slider includes magnetic write/read elements that can encode a single bit of binary information by altering the properties of the thin film at a small spot on the surface. A smaller spot enables a higher density of data storage.

Current technology is rapidly approaching one trillion bits per square inch, but this requires the separation between the head and disk to be less than 2 nanometers. This narrow requirement, however, creates its own problems. Lubricant used on the surface of the disk to protect it from corrosion can attach to the slider, which adversely affects the reliability of the hard disk drive. "We have carried out a systematic and quantitative study on how the variation of slider optical properties affects the accuracy of the measured lubricant thickness on the slider surface," says Zhang.

Zhao, Zhang and their co-workers analyzed a lubricant-coated slider using a technique known as spectroscopic ellipsometry. Measuring the intensity of light reflected from a sample slider provided a highly accurate estimate of the thickness of the lubricant film. Ellipsometry is a fast and non-destructive technique that, unlike some of the alternative approaches, does not require ultra-high vacuum conditions. This technique, however, does require accurate knowledge of the optical properties of the slider. A typical slider is made of aluminum oxide and grains of titanium carbide of many different shapes and sizes; thus, its optical properties vary from position to position.

Zhao and the team's study demonstrated that the uncertainty in lubricant thickness is approximately proportional to the uncertainty in the slider's optical constants, and it becomes particularly pronounced for thicknesses below 2 nanometers.

"This lubricant transfer will be more serious in future heat-assisted magnetic recording," explains Zhang. "The next step in this research will focus on how to reduce the lubricant transfer, especially in this type of device."

More information: Zhao, J. M., Zhang, M. S., Yang, M. C. & Ji, R. Ellipsometric measurement accuracy of ultrathin lubricant thickness on magnetic head slider. *Microsystem Technologies* 18, 1283–1288 (2012). dx.doi.org/10.1007/s00542-012-1519-8

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