Data storage capacity is enhanced by mixing hard and soft magnetic materials

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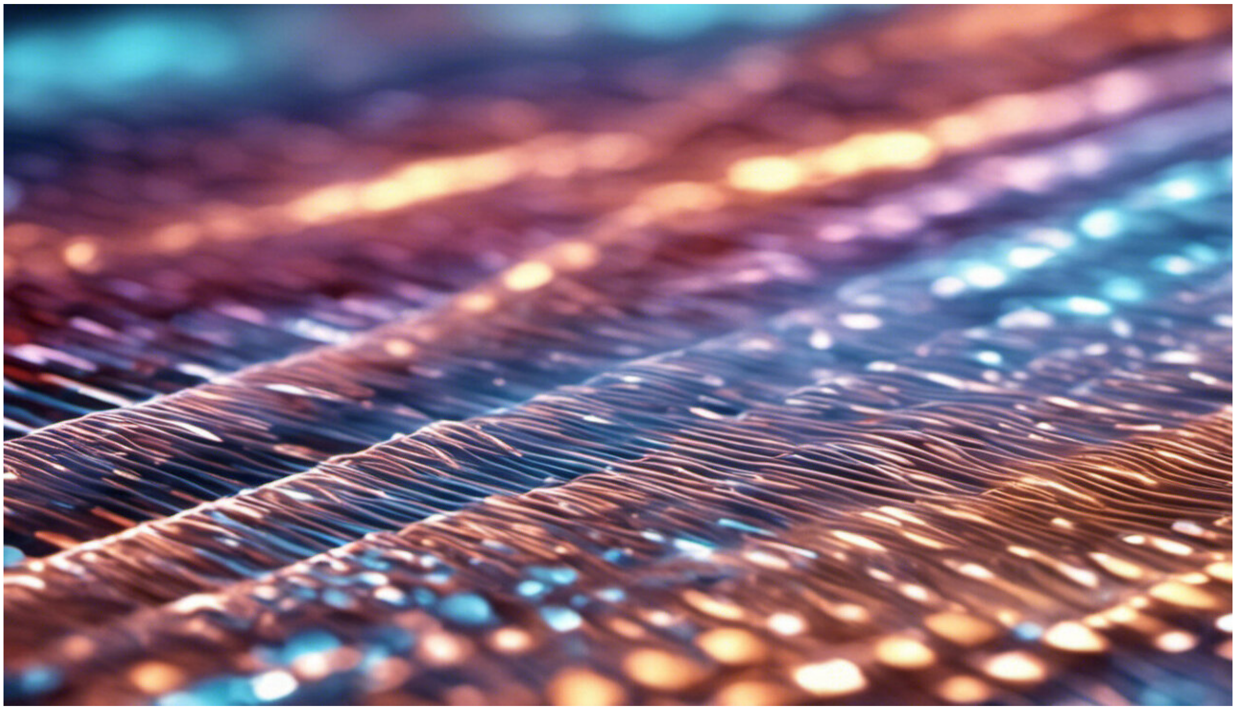

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A computer hard disk uses a process called magnetic recording to store digital data. This involves applying a small field to switch the physical properties of grains of a magnetic material. The grains exist in one of two possible states, which represent the '1's and '0's of binary information.

Now, Tie-Jun Zhou and co-workers at the A*STAR Data Storage Institute in Singapore show that a combination of two magnetic materials can reduce the size of these grains while maintaining the ideal magnetic properties for magnetic recording1. Smaller grains allow information to be stored at higher densities, enabling the fabrication of disks with much larger storage capacities.

The iron–platinum (FePt) alloy is a common choice for magnetic storage as it has several beneficial properties: it forms grains that are just a few tens of nanometers wide, and it maintains its magnetic state even when heated because of a large protective 'energy barrier'. But FePt has a notable drawback—to switch its state, FePt requires a much larger magnetic field than those produced by conventional hard drives. These characteristics make FePt a 'hard' magnetic material.

To tackle this high-field problem, Zhou and his team combined FePt with a 'soft' magnetic material—a material that is relatively easy to magnetize by applying only a small magnetic field. "Exchange-coupled composite materials can reduce the energy required for writing," explains Zhou. The important question, however, is whether the composite material still has the beneficial energy barrier of FePt.

Zhou and co-workers measured the energy barrier in thin films of FePt and titanium oxide. They observed that exchange coupling has little effect on the energy barrier, but that the energy barrier decreases as the soft-layer thickness increases.

Previous studies have measured the energy barrier of exchange-coupled composites by applying the switching magnetic field in a direction perpendicular to the thin films. In contrast, Zhou and the team used an alternative approach that applies the field at an angle of 45 degrees. They found that this method gives a more accurate result—the conventional approach could produce overestimates by as much as 70 per cent.

"Such an error leads to an overestimation of the lifetime of recording grains by several orders of magnitude," says Zhou. "So these results should prevent future mistakes in predicted lifetime that might have led to data loss in hard disks." Gains could also be made by optimizing the soft-layer thickness and the interlayer exchange-coupling strength.

More information: Zhou, T.-J., Cher, K. M., Lwin, P. W. & Hu, J. F. "Energy barrier measurement and optimization in exchange coupled FePt/TiO2 nano-composite thin films." *Journal of Magnetism and Magnetic Materials* 331, 187–192 (2013). DOI: 10.1016/j.jmmm.2012.11.044

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