Novel approach to fabrication of magnetic memory elements may lead to new generation of ultra-high-capacity hard drives

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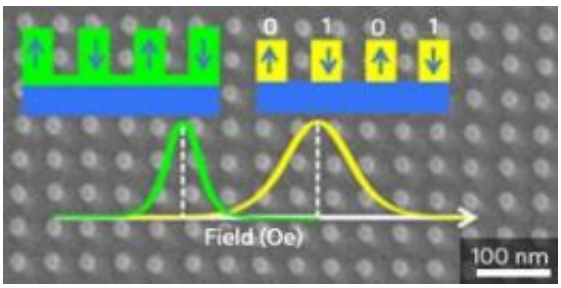

A magnetic film patterned into an array of dots (background) is known as a bit-patterned medium, and can store data at very high areal densities. Each dot requires a slightly different magnetic field to write or erase. Ranjbar and co-workers reduced this variation by adding a continuous layer underneath the dots, made of the same material as the dots themselves (green). By comparison, the traditional approach (yellow) had both a wider variation, and higher average switching fields. Credit: A*STAR

Information in most computer memories is stored in the form of 'bits' represented by the polarization of tiny magnets on the surface of memory devices such as the computer's hard drive. The capacities of these devices have increased exponentially over the last 30 years, a feat made possible by progressively reducing the area taken up by the magnets storing the information. In modern machines, these magnets are so small that reducing their size any further risks creating unstable data, due to random flipping of the direction of polarization of the magnets at

higher densities. Now, Mojtaba Ranjbar and colleagues at the A*STAR Data Storage Institute have honed a key technology, called bit-patterned media, to overcome this problem and allow data to be stored at previously unattainable densities.

Bit-patterned media technology replaces the continuous magnetic film traditionally used in hard drives with an array of small, patterned magnetic dots (see image), each of which stores a bit of data. By carefully designing the size and shape of these dots, data can be stored at very high densities without the instability that would be encountered if a continuous film were used.

Using bit-patterned media, however, is not without its own difficulties, chief among which is a problem known as 'switching field distribution', whereby the magnetic field required to write or erase data in each dot differs slightly and by an unknown amount. As a result, the magnetic field applied by a hard drive write head may be too small, or too large, resulting in data errors.

Previous work by other researchers sought to minimize the switching field distribution problem by covering all of the magnetic dots with a continuous magnetic film placed on top of the dots, which alters the magnetic interactions between individual dots. The approach called 'capped bit-patterned media' traditionally requires different magnetic materials for the dots and film, introducing additional fabrication complexity.

Ranjbar and co-workers used the same material for the film and dots, and positioned the dots above the film rather than below it. This approach allowed a particularly simple fabrication process, in which dots were etched in a controlled fashion, leaving a continuous, unetched film underneath and obviating the need for a separate deposition step to introduce a new magnetic material.

The researchers found that this simplified process successfully reduced switching field distribution, and also lowered the field strengths necessary for writing data. Ranjbar comments, “Combined with the ease of fabrication, this technology should prove useful in bit-patterned media for next-generation hard disk drives.”

More information: Ranjbar, M., et al. Anomalous Hall effect measurements on capped bit-patterned media. Applied Physics Letters 99, 142503 (2011).

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