Magnetic substructure leads way to superfast and precise data storage

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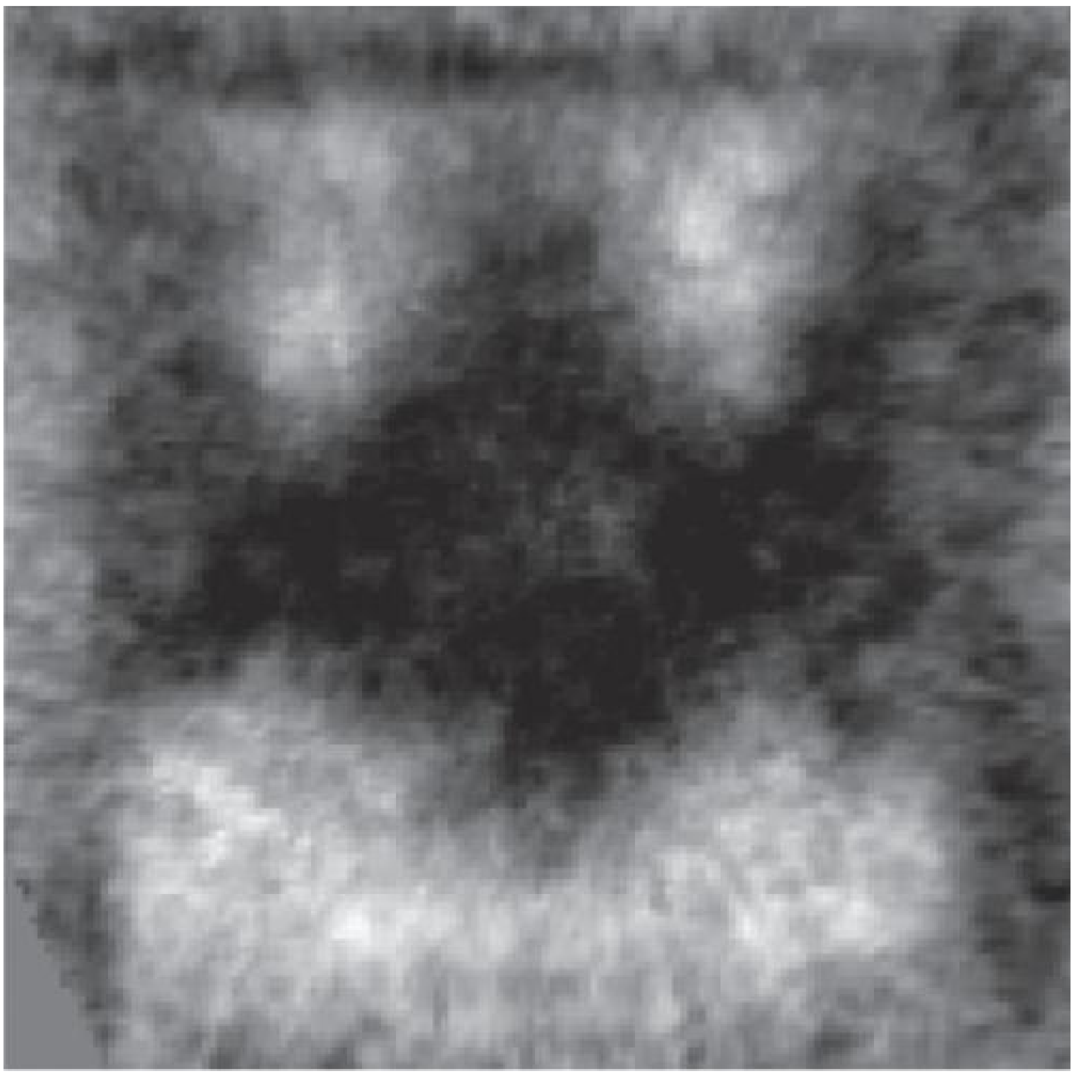

Figure 1. The magnetic structure, sized five by five thousandth of a millimeter (micron) shows a substructure in black and white, reminding of the Batman logo. Black areas indicate downward pointing magnetization, white areas indicate upward magnetization.

With a surprising discovery, an international team of scientists from Radboud University, Switzerland and Japan demonstrates the feasibility of selective magnetization switching inside a microstructure by using laser light. Their findings open opportunities for very-high-density information storage media.

The demand for the ever-increasing speed and density of information storage has triggered an intense search for ways to control the magnetic state of tiny magnets, as also used in computer hard drives. Aiming to improve magnetic recording speed and spatial resolution, the researchers tried to switch magnetization in microstructures by using a femtosecond - one millionth of one billionth of a second - laser pulse. This led to an unexpected discovery…

'Batman' shows the way

When the size of the magnetic microstructure was still pretty large, of the order of five thousandth of a millimeter, the laser light did not switch the structure homogeneously but formed a 'batman'-like pattern (see Figure 1). This pattern showed features which were smaller than the wavelength of the light, showing that light-matter interaction strongly depends on interference of the incident and the reflected light waves. Thus, the switching pattern can be controlled by structure design. Using computational methods the authors confirmed this hypothesis and revealed the feasibility of nanoscale magnetic switching even for an unfocused laser pulse.

Novel data storage opportunities

Controlling the switching pattern, which in this particular case had an ironic 'batman'-like shape, opens novel opportunities for very-high-density data storage, for example by recording several bits of information in a single magnetic structure.

Prof. Theo Rasing of Radboud University says: 'Since our group in Nijmegen discovered that femtosecond laser pulses are able to reverse magnetization, we started to work on how to minimize the size of the switched domain. You can in principle follow two approaches: make the structures smaller or focus the light to a smaller spot. By structuring the materials we discovered indeed that you can achieve sub-wavelength switching even on much larger structures. By controlling the laser pulse, this can be done in a controlled way. The ability to detect magnetic changes with sub-100 nm resolution was crucial for the whole project. Our collaborations through EU-networks with the main synchrotrons in Europe therefore played a decisive role for the success of this project.'

More information: "Nanoscale sub-100 picosecond all-optical magnetization switching in GdFeCo microstructures." L. Le Guyader, M. Savoini, S.E. Moussaoui, M. Buzzi, A. Tsukamoto, A. Itoh, A. Kirilyuk, T. Rasing, A.V. Kimel and F. Nolting, *Nature Communications*, 2014

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