Origin of Ultra-Fast Manipulation of Domain Walls Discovered

EurekAlert!

An international team of researchers has found at the free electron laser FLASH, a surprising effect that leads in ferromagnetic materials to a spatially varying magnetization manipulation on an ultrafast timescale. This effect could be the key to further miniaturization and performance increase of magnetic data storage devices. From Mainz, the group of Professor Dr. Mathias Kläui from the Institute of Physics at Johannes Gutenberg University Mainz and in particular Felix Büttner, a member of the Graduate School of Excellence "Materials Science in Mainz", were involved. The results have been published in the current issue of *Nature Communications*.

It is known that magnetization can be manipulated by short light pulses but so far the spatially-resolved magnetization change could not be determined due to the limited spatial resolution of conventional optical techniques. Since most of the ferromagnetic materials consist of multiple domains with different magnetization directions, the local change of the magnetization in these domains and at the interfaces between the domains, i.e. at the so-called domain walls, is of particular interest. At the FLASH free electron laser at the DESY Research Center in Hamburg, results were obtained that are in agreement with a recently theoretically predicted mechanism: due to the laser pulses, highly excited electrons are generated that move quickly through the material. They thus move from one domain into a neighboring domain with a different magnetization direction. Since the electrons carry part of the magnetization, they manipulate the magnetization in the domains as they move across a domain wall. This means that domain walls can change their geometry on the fs time scale.

As domain walls are also used in memory devices, such as the racetrack memory, these investigations could be the first step to improving the performance of such devices. The racetrack memory is a development by IBM and could in the future be a fast and low power alternative to conventional random access memory or hard drives.

The experiments were carried out by the researchers from Johannes Gutenberg University Mainz (JGU) with colleagues from TU Berlin, the universities of Hamburg and Paris, and six further research institutes at the free electron laser FLASH at DESY in Hamburg. The samples investigated consist of a cobalt-platinum multilayer system, which forms labyrinth-type domain structures.

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discovered?qt-most_popular=0