Spintronics: Resetting the future of heat assisted magnetic recording

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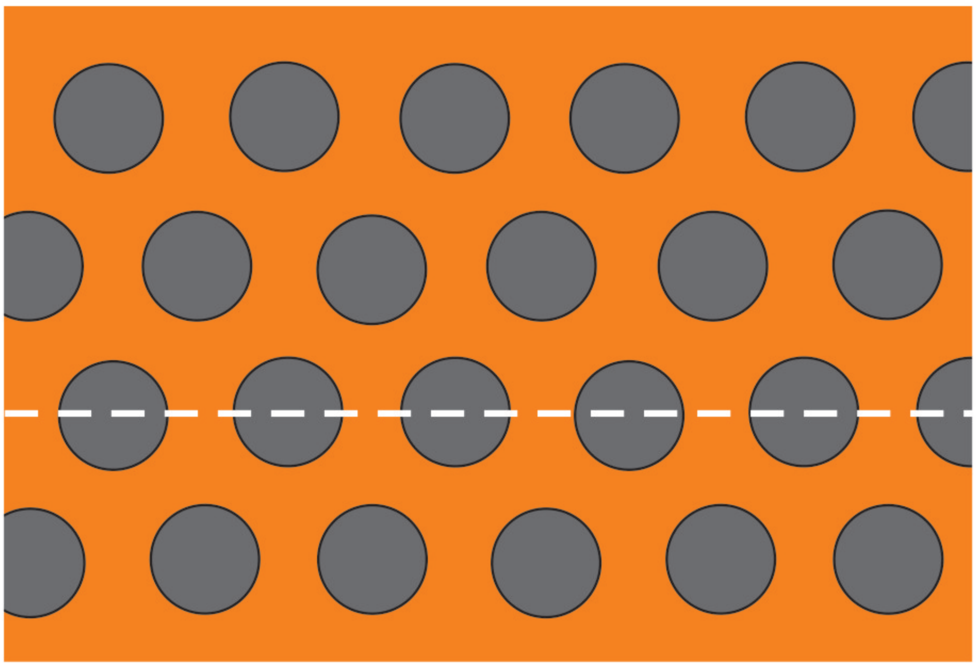


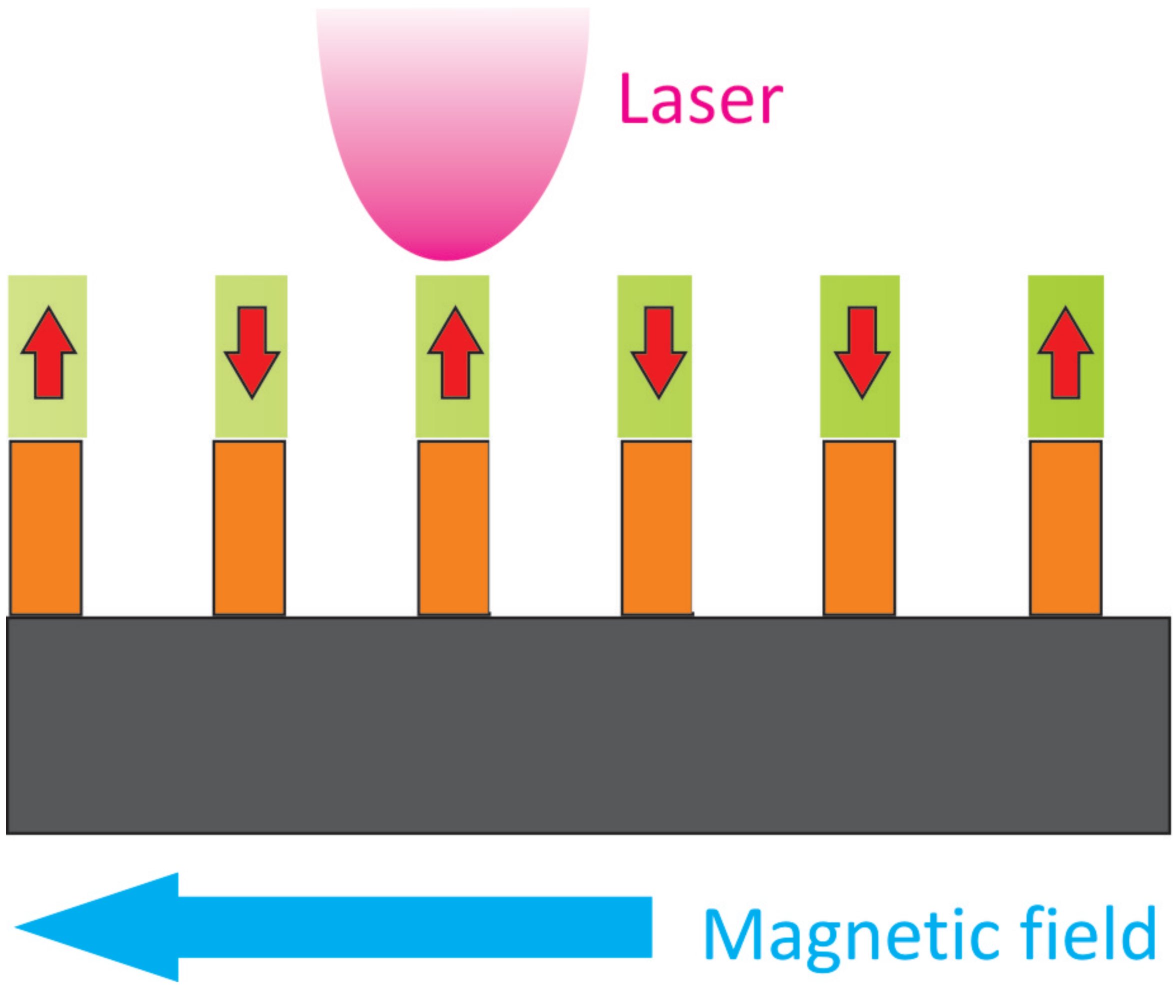
The nanostructured membrane has a honeycomb pattern with nanoholes of 68 nm in diameter. The nanoholes pin down the magnetic domains. Credit: HZB

A HZB team has examined thin films of Dysprosium-Cobalt sputtered onto a nanostructured membrane at BESSY II. They showed that new patterns of magnetization could be written in a quick and easy manner after warming the sample to only 80° Celsius, which is a much lower temperature as compared to conventional Heat Assisted Magnetic Recording systems. This paves the way to fast and energy efficient ultrahigh density data storage. The results are published now in the new journal *Physical Review Applied*.

To increase data density further in storage media, materials systems with stable magnetic domains on the nanoscale are needed. For overwriting a specific nanoscopic region with new information, a laser is used to heat locally the bit close to the so called Curie-Temperature, typically several hundred degrees Celsius. Upon cooling, the magnetic domain in this region can be reoriented in a small external magnetic field, known as Heat Assisted Magnetic Recording (HAMR). In industry, Iron-Platinum materials are currently used as magnetic media for the development of such HAMR-data storage devices.

Magnetic signals mapped at BESSY II before and after heating

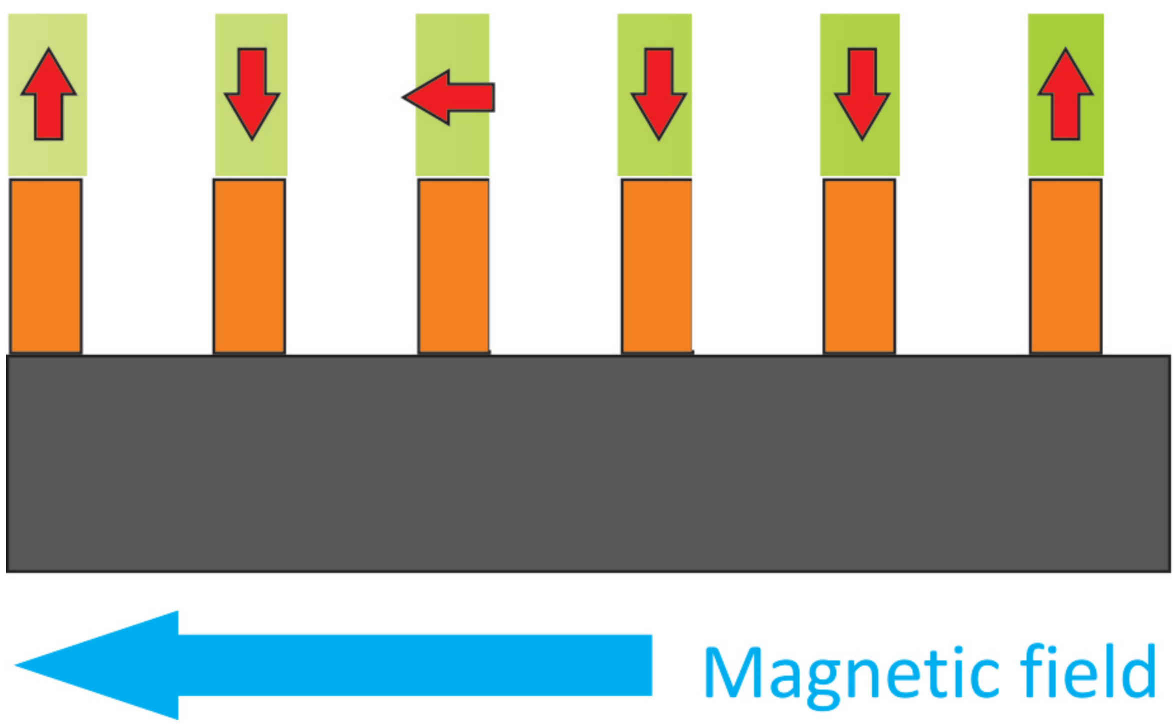
A HZB team has now examined a new storage media system of Dysprosium and Cobalt, which shows key advantages with respect to conventional HAMR materials: A much lower writing temperature, a higher stability of the magnetic bits, and a versatile control of the spin orientation within individual magnetic bits. They achieved this by sputtering a thin film of Dysprosium and Cobalt onto a nanostructured membrane. The membrane was produced by scientific cooperation partners at the Institute of Materials Science of Madrid. The system shows a honeycomb antidot pattern with distances of 105 nanometers between nanoholes, which are 68 nanometers in diameter. These nanoholes act themselves as pinning centers for stabilizing magnetic wall displacements. The magnetic moments of $DyCo_5$ are perpendicular to the plane and stable against external magnetic fields.



A thin film of Dysprosium-Cobalt (green) has been sputtered on top of the membrane, resulting in an array of antidots. The magnetic moments of DyCo5 are perpendicular to the plane and stable against external magnetic fields. A laser pulse can be used to locally increase the temperature of individual bits. Credit: HZB

Energy efficient process

HZB-physicist Dr. Jaime Sánchez-Barriga and his team could demonstrate that warming the system to only 80 degrees Celsius is sufficient to tilt the magnetic moments in the DyCo5 film parallel to the surface plane. With measurements at the PEEM and XMCD instruments at BESSY II they could map precisely the magnetic signals before, during and after warming. After cooling to room temperature it is then easy to reorient the magnetic domains with a writing head and to encode new information. "This process in DyCo5 is energy efficient and very fast", states Dr. Florin Radu, co-author of the study. "Our results show that there are alternative candidates for ultrahigh density HAMR storage systems, which need less energy and promise other important advantages as well", adds Sánchez-Barriga.



Moderate heating up to 80° Celsius does tilt the magnetic moment associated to a single bit into the plane. Upon cooling to room temperature, the magnetic moment stays in plane, until it is overwritten by a magnetic writing head. Credit: HZB

More information: A. A. Ünal et al, FerrimagneticNanostructures for Bits in Heat-Assisted Magnetic Recording, *Physical Review Applied* (2016). DOI: 10.1103/PhysRevApplied.5.064007

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