How the magnetoelastic effect can control the magnetic properties of nanoelements

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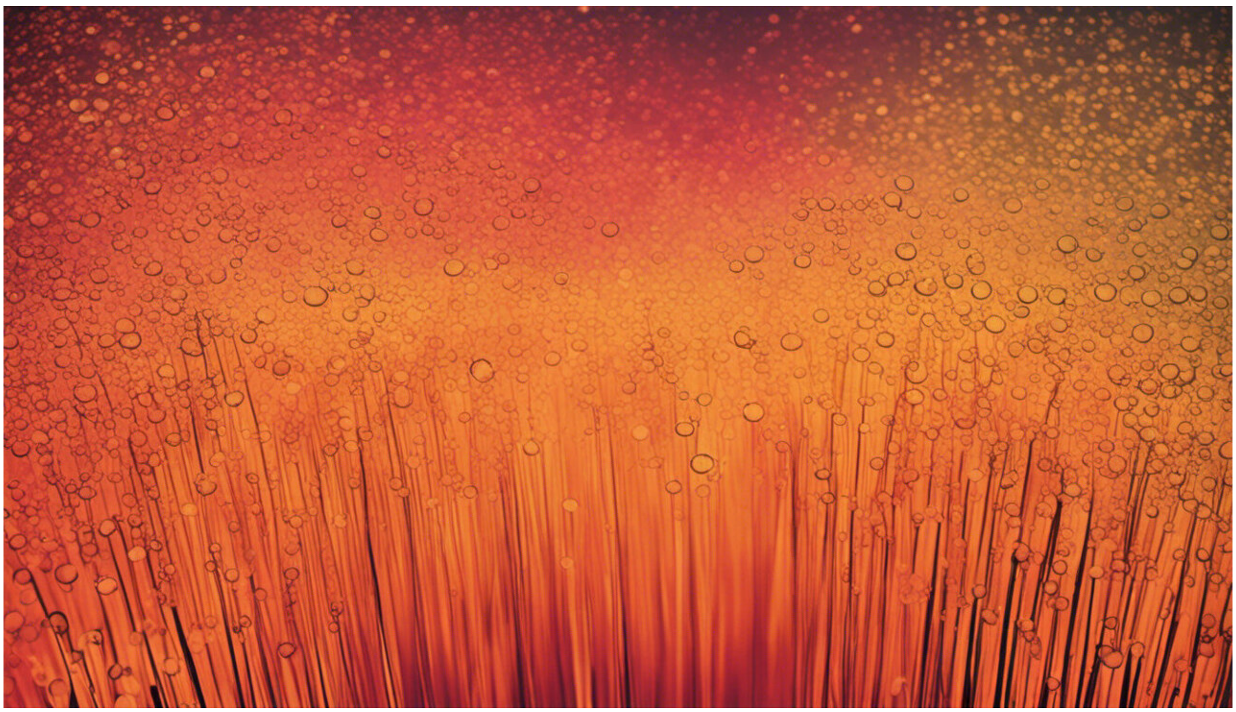

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Rapidly modifying magnetic properties is key for low power magnetic devices. The EU-funded MULTIREV project has contributed to a study which exploits magnetoelastic coupling, for the design of strain-controlled nano-devices.

Information Communications and Technology (ICT) devices rely significantly on being able to harness the magnetic properties of materials, especially for computing memory and processing. Researchers, drawing on work conducted under the EU-funded MULTIREV project, recently published an article in *Nature* in which they outline how they used cutting-edge dynamic imaging to visualise deformation (sound) waves in crystals, measuring the effect on nanomagnetic elements.

Their findings hold out both the prospect of controlled low power magnetisation of small magnetic elements, of benefit for ICT applications. Additionally, the methodology is transferable for the investigation of dynamic strains in a range of processes and products such as nanoparticles, chemical reactions and crystallography.

Quantifying the magnetoelastic effect

With the ever-mounting demand for better data storage and processing, the race is on for more efficient means to modify the magnetic properties of materials, especially at the nanoscale. The researchers in this study were studying the change of magnetic properties caused by the elastic deformation of a magnetic material. This change can be induced by magnetic fields but that requires high power charge currents.

The team were therefore specifically investigating how dynamic strain (or deformation) accompanies a surface acoustic wave (SAW) and so induce changes to magnetisation, at the nanoscale. They were able to conduct the quantitative study after the development of an experimental technique based on stroboscopic X-ray microscopy. Crucially, the study was undertaken at the picosecond time scale, unlike pervious studies which had mainly been conducted at significantly slower time scales (seconds to milliseconds).

The team were able to demonstrate that SAWs could control the switching of magnetisation in nanoscale magnetic elements on top of a crystal. The results indicated that the SAWs influenced a change in the property of the magnetic squares, causing the magnetic domains to grow or shrink depending on the SAW phase.

Interestingly, by simultaneously imaging the development of both the strain and magnetisation dynamics of nanostructures, the team discovered that magnetisation modes have a delayed response to the strain modes, and that this was adjustable according to how the magnetic domain was configured.

Energy efficient magnetic sensors

The MULTIREV project was actually set up to develop a less expensive and simplified multi-revolution sensor than those currently available. These sensors detect multiple rotations of components in industries such as automotive and automation. However, the current generation tends to have complex architecture, with limited applicability and comes at high cost.

Key to the project team's plan for developing a proof of concept was the replacement of non-magnetic sensors with a non-volatile magnetic device, which would be energy self-sufficient. This in turn opens up the possibility of a step-change in the number of revolutions possible to sense, even up to the thousands of revolutions.

More information: Multi-revolution non-volatile magnetic sensors: cordis.europa.eu/project/rcn/196351_en.html

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