A novel 'soft' magnetic material could enable faster computer memory

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Magnetic materials are a vital ingredient in the components that store information in computers and mobile phones. Now, A*STAR researchers have developed a material that could help these magnetic-based memory devices to store and retrieve data faster while using less power.

Memory devices work when a small magnetic field is applied to the storage medium to align atomic-level magnets known as spins. This spin alignment, or magnetization, in one region of the magnetic material can represent one 'bit' of information, which can be 'read' back again using a magnet. Scientists are trying to improve the performance of magnetic memories by reducing both the energy required to change the magnetization and unwanted noise.

One approach is to use a magnetic material with a property known as negative magnetocrystalline anisotropy. This means that less energy is required to align the spins in one direction then another, and so the material is generally easier to magnetize and demagnetize. This low coercivity is useful because this so-called 'soft' magnetic material can guide a magnetic field onto the storage layer, thus lowering the intensity of field that must be applied to alter the 'hard' material's magnetization.

Tiejun Zhou and co-workers from the A*STAR Data Storage Institute found a way to further reduce the coercivity of a soft material called cobalt iridium by adding rhodium.

The team created their magnetic material with a technique known as direct current magnetron sputtering. Cobalt, iridium and rhodium were simultaneously ejected from separate solid sources in a vacuum chamber and deposited on a silicon substrate. By changing the power supplied to each of the sources, the researchers could control the composition of the final material, increasing the amount of rhodium at the expense of iridium. Measurements of the magnetic properties of CoIr-Rh films demonstrated that the introduction of this rhodium reduced the coercivity and the damping constant by more than a half of that of unmodified cobalt iridium.

"When used in a device, such negative magnetocrystalline anisotropy materials enable higher frequency operation at lower driving current and the creation of a higher in-plane alternating-current magnetic field for effective assisted switching, and higher stability against stray fields and temperature fluctuations," explains Zhou. The team demonstrated this improved performance in a memory device called a spin torque oscillator.

The results show that CoIr-Rh could help to develop commercial low-energy magnetic storage. "By fine tuning the composition, we can continuously improve the properties of magnetic materials to meet the criteria required for industry-level applications," says Zhou.

More information: H S Wong et al. Reduction of magnetic damping and isotropic coercivity and increase of saturation magnetization in Rh-incorporated CoIr system, *Nanotechnology* (2016). DOI: 10.1088/0957-4484/27/45/455705

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