Harddrive boost comes in layers of iron and cobalt

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A*STAR researchers have created a promising new material from thin layers of iron and cobalt that could enable magnetic recording technologies such as hard drives to be boosted with microwaves.

Zhou Tiejun, Chung Hong Jing and colleagues at the A*STAR Data Storage Institute fine-tuned both the magnetic properties and the microwave response in their thin layers, creating an ideal material to drive a tiny quantum-powered microwave generator called a spin torque oscillator.

The team had previously studied layers of cobalt and iridium and found a surprising magnetic irregularity—the material strongly preferred having its magnetic field aligned in one particular direction, a property known as magnetic anisotropy. With careful alignment of the material, its anisotropy would make it easier to magnetize and demagnetize.

In this new work, the team found that sandwiching cobalt with iron, instead of iridium, produced stronger magnetic anisotropy and had superior microwave performance.

Microwaves generated by a spin torque oscillator embedded in the read-write head of a hard drive would make writing the data more energy efficient, Chung said.

"The microwaves effectively lower the energy barrier for flipping the direction of the magnetic domains," says Chung.

The microwave signal would aid the switching of magnetization required to write data to a hard drive by setting the magnetic fields of the atoms in the hard drive weaving in circles, in the same way that a spinning top wobbles in circles, an effect known as precession. The cobalt-iridium stack lost the microwave energy quickly, like a top spinning on a thick carpet, an effect known as damping. However, in the cobalt-iron stack, the damping was much lower, like a top spinning on a hard polished floor.

The breakthrough came from the team's work in separately engineering the magnetic and microwave properties of the stack, said Chung.

"We take a lot of care to achieve the desired interfacial quality of the layers. Control at the nanometer level is utterly important," he said.

The team tested more than 30 combinations of materials, first exploring the effect of layer thickness, annealing temperature and sputtering rate and temperature. Finally, they tested them in a full stack configuration, concluding cobalt and iron in equal layers of 0.625 nanometers thickness was optimal.

Chung says there is much work still to be done to bring this technology to fruition.

"It's difficult, because of the complexity of the material design and the challenges of integrating the spin torque oscillator into the magnetic read-write head."

More information: H. J. Chung et al. Co/Fe multilayers with ultra-low damping and large negative anisotropy as the free layer for spin torque oscillator, *Applied Physics Letters* (2016). DOI: 10.1063/1.4966274

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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