TECHNOLOGY UPDATE

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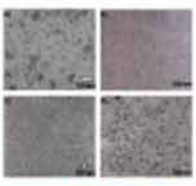
Making hard nanoparticles the easy way

Researchers have finally succeeded in making hard magnetic nanoparticles based on samarium-cobalt (SmCo), a technologically important magnetic material. J Ping Liu and colleagues at the University of Texas achieved their feat using a simple ball milling technique where the particles were suspended in a surfactant. The particles show a narrow size distribution, which leads to a significant room-temperature coercivity - a magnetic material's resistance to demagnetization.

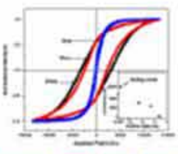
Rare earth transition-metal compounds based on $SmCo_5$ and Sm_2Co_{17} have the highest magnetocrystalline anisotropy (up to 20×10^6 J/cm^3) of all such materials, and therefore have an extraordinarily high coercivity. This makes them very attractive for applications. However, these materials oxidize easily as their particle size is reduced, which means that conventional methods - such as chemical solution techniques - are not suitable for producing dispersed nanoparticles. As a consequence, no hard magnetic nanoparticles of SmCo systems with room-temperature coercivity have ever been produced.



Ground nanoparticles

"After encountering tremendous difficulties in preparing SmCo nanoparticles by chemical solution methods, our group started on a straightforward (and cheap) approach to these nanoparticles - by crushing the ingots with a ball miller," Liu told *nanotechweb.org*.

Although ball milling is a common technique for making powder particles in the metallurgy and ceramic industries, only micron-sized particles are usually formed for metals - even if they are milled for long times. This is because the crushed particles can cold weld together during milling.



Magnetization loops

Liu and colleagues have now overcome this problem by adding a surfactant to the mix, which helps fine particles to float in the solvent and not to weld together again. An added bonus: these surfactants also protect the nanoparticles from contamination, which can destroy their magnetic properties.

The team also developed a size selection technique where relatively coarse nanoparticles, between 15 and 25 nm, were selected. These particles showed a room-temperature coercivity of up to 3 kOe. "In fact, our surfactant-assisted ball milling technique could be extended to produce any kind of nanoparticles," explained Liu. Indeed, the group has already tried its technique out on another important hard magnetic material, neodymium-iron-boron.

"Such magnetic nanoparticles could have huge potential applications in nanostructured permanent magnets, magnetic recording media, ferrofluids and the emerging biomedical technologies - like target drug-delivery and hyperthermia," said Liu.

The researchers, who reported their work in *Nanotechnology*, are now looking at the effects of heat treatments and coating on the obtained nanoparticles to further increase the magnetic hardening of these materials. "We are also working on compacting the nanoparticles using a warm pressing technique to produce bulk nanostructured SmCo magnets," added Liu.

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About the author
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