Editorial

Nanocrystalline Materials

Nanocrystalline materials! They are particles of nanometer dimensions and they are everywhere.

They are the dust in the off-gases from industrial operations. They are the earliest particles that precipitate from solutions.

And now they are being put to good use in the processing of composite materials.

The idea has really caught on in some materials research groups where the idea of "small is beautiful" is being applied to the particle sizes of the materials.

As the name implies, these nanocrystalline materials are characterized by particles in the nanometer (10^{-9}) range. In terms of the units of length we used to use, a 5 nm nickel particle is 50 A in diameter and, even more importantly, a full 15% of all its atoms are surface atoms. This means that 15% of all the atoms in the particle are in energy states that are higher than they would be if they were interior atoms. This means that the 15% group have uncoupled atomic bonds (or incomplete ionic bonds) and have exceptionally high chemical reactivity.

This means that oxides (a common group of nanocrystalline material) can be sintered at much lower temperatures than their customary powder starting materials (usually the particle size is somewhere in the 1 to 25 um size group).

Magnetic powders in this group of materials are characterized by the observation that each particle is one magnetic domain.

Metallic nanocrystalline materials obviously require precautions in order to prevent surface oxidation. Sometimes, the precautions must be extensive in order not to have metallic fires.

In spite of the precautions, nanocrystalline materials still arouse a great deal of interest because they offer the possibility of making entirely new classes of composite materials on (almost) an atomic scale.

There is no shortage of techniques for making nanocrystalline materials. Some depend on the tried and true wet chemistry techniques—a technique called sol-gel technology has been around for a number of years in the nuclear fuel industry and has a proven record for making nanometer-sized oxide particles from exotic organo-metallic compounds. Other techniques rely on plasma and gas processing techniques and large atomization chambers.

We will be watching the development of the type of material processing technology through the activity of the Specialty Materials Division, one of ASM's Technical Divisions. We will be keeping the readership up-to-date on developments, particularly on the property/performance/preparation aspects as they occur and are disseminated.

Keep an eye on the table of contents for future news.

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