Recent Progress and Prospects in Single-Digit-Nano Particles of Diamond

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Merits of Nanodiamond

Why do we pay attention to nanodiamonds in spite of two adverse features; microdiamond has been used extensively in industry for the past half a century (first prepared in 1955) and there are other so attractive new class of carbons like fullerenes and nanotubes among nanocarbons? This is because there are overwhelming advantages in nanodiamonds which will be illustrated in this lecture. In short, merits unique to the nano-size are (1) non-toxity[Dai, 2006], (2) large surface are, (3) surface re-structuring capability, (4) processability, (5) low cost, and (6) excellent bulk properties. These merits appear most prominently in the single-digit nano-range.

Improved Manufacturing Technique

Traditional procedures of producing detonation nanodiamond have undergone extensive modifications in our laboratory. Removal of amorphous by-products with hot concentrated nitric or other corrosive acids was replaced by a series of environment-friendly physical methods. Purity is assessed by quantitative analysis of diamond carbon contents and expressed on the basis of theoretically attainable purity.

Disintegration and Dispersion Technique

It is now possible to disintegrate agglutinates of primary particles by stirred-media milling with micron-size zirconia beads on laboratory scale of a few grams. It is now routinely possible to prepare loose aggregates of purified nanodiamond crystals that can be re-dispersed readily. This small improvement made it possible for us to export dispersed nanodiamond abroad.

Properties of Dispersed Particles

Dispersed and purified particles of nanodiamond are drastically different from the previously available crude agglutinates. For example, BET surface area of the former (700 m^2/g [Rozhkova 2006]) compares very favourably against those of commercial agglutinates (200-400 m^2/g).

Prospects of Application

With the almost unlimited availability of dispersed and purified crystalline nanodiamond particles in the single-digit size-range, the possibility of application is wide and varied. Preliminary results with strengthened alloys, cell imaging and increased thermal conductivity will be demonstrated.