Recent progress in dispersed detonation nanodiamond

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Manufacture of Dispersed Primary Particles

Attrition milling of the conglomerated detonation nanodiamond powder with spherical 30μm ZrO_2 beads still remains as the only viable method for the mass-production of its 5-nm primary particles. We find that combination of the mill with a 400W/24KHz powerful supersonic processor in series within circular disintegration process produces significant improvements. Re-optimization of operation conditions by *experimental design* led to overall reduction of milling time by 25%, and contamination with zirconia to 0.02 wt% (*S. Sasaki*).

Agglutination Structure and Mechanism

Abberation-corrected TEM and complementary computer simulations provide further confirmation on the mechanism of electrostatic and anisotropic self-assembly between crystal facets of the adjacent primary particles. While the strongest calculated interfacial interactions, $(111)^-/(111)^0$, could be observed and characterized, another predicted strong interaction, $(100)^+/(111)^0$, could not be found at all despite intensive search. The failure suggests that the latter interaction must have been dissociated by charging during TEM observation (*L.-Y. Chang, A. S. Barnard*). This conclusion leads to a possibility of partial non-milling disintegration of agglutinates by polarization, which later has been confirmed.

Nanospacer Lubrication, an Application Unique to the Dispersed Single-Nano Diamond Particles

Following our discovery of remarkably small friction coefficient of 0.01 for 1% 5nm-diamond aqueous colloidal solution as lubricant liquid in 2008, we found more dilute colloidal solutions of the same in water and in ethylene glycol showing similar lubricating behavior. The surprising results can be explained by invoking Bowden's fusion mechanism of lubrication at very early stages of true contacts between the asperities of interacting surfaces, very small rolling resistance of quasi-spherical and dispersed diamond particles, and high number density of single-nano colloidal solution. This is the first hint of promising and disposable spacer lubrication that will eventually be capable of replacing traditional but ineffective and environmentally hazardous lubricating oil (*S. Mori*).

Detonation Synthesis of Luminescent Nanodiamond

In view of the importance of intensely fluorescent nanodiamond in the emerging optically detected NMR technique in cell biology, detonation experiments of TNT-hexogen are being carried out in the presence of various elements X to produce versatile X-V color centers (X=Si, Ni *etc*) in the core of diamond crystals. Progress will be reported (*Y. Harada, P. Yan*).