Issues in the Detonation Reaction

More than half a century passed since the monumental success in the synthesis of artificial microdiamonds (AMD) by the HTHP method in 1955, but no remarkable applications of AMD has not yet been found, simply due to the fact that 'diamonds are unprocessable'. In 1987, Lewis and co-workers found nanodiamonds having diameters 2.4-2.8nm from presolar meteorites and inferred the formation of nanodiamonds in space when a shock wave hits plasma carbon atoms. In accord with this inference, detonation of a high explosive in water or inert gases in closed vessels produced agglutinates of single-nano diamond particles in 1963 but the isolation of elementary particles of detonation nanodiamond (EPDND) from the agglutinates took long time to achieve. It is only recent that EPDND was finally isolated, characterized and confirmed to have the same size as the meteorite nanodiamond of 2.6±0.5nm.

Production of EPDND consists of a few steps including detonation and disintegration of the crude product in an attrition mill, each step requiring high-level nanotechnology. We will concentrate here on the detonation process, which uses an well-known explosive Composition B （TNT+RDX,1:1）. However, simple detonation in water in a high pressure-reactor does not seem enough to produce sufficient temperature and pressure for the growth of good-quality nanodiamond crystals. While attrition milling is the only known method of disintegrating macroscopic amounts of the crude detonation product into EPDND, if the low-quality agglutinates were subjected to the milling, the elementary particles are totally destroyed. It is also important to avoid back reaction, namely the phase transition of diamond to graphite, to take place by quickly quenching the detonation mixture. For these reasons, detonation process requires to implement one or more of the following counter-measures: （1） addition of reducing agent in order to boost PT parameters of shock wave, （2） implementation of implosion lenses, and （3） quenching of the reaction vessel with ice water immediately after detonation:

（1） Many kinds of inorganic and organic reducing agents have been added to the detonation mixtures. Publications are available on the performance of organic reducing agents. It seems that good results are obtained by the use of an inorganic reducing agent, but details are not published.

(2) No information is available except for a few rumour.

(3) As Russia and surrounding countries usually prefer to use huge reactors to process a few hundred kg of explosive in one operation, it is difficult to apply ice-water cooling. Small reactors can be quenched easily and actually practiced, but naturally unsuitable for mass production.

It is truly unfortunate that artificial diamond industry including nanodiamond production is still under the anachronistic hiding principle. Actually the detonation process is the most important step in the sense that major properties of EPDND are determined herein.