Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

MIS020-11 Room:301A Time:May 24 17:45-18:00

Allende meteoritc nanodiamonds and their possible shock wave formation

Arnold Gucsik[1*]

[1]Tohoku University, Dept Earth Sci

Two main theories exist for the formation process of the meteoritic nanodiamonds (e.g., Daulton et al. 1996-and references therein): (1) Chemical vapor deposition (CVD), and (2) shock origin. TEM investigations, in particular, seem to suggest that formation by a CVD process is most likely.

According to supernova shock wave experiment of Hansen et al. (2007) the first step is the transition of the secondary shock wave through interstellar media nearby the supernova explosion resulting the grain-grain collisions. The initial shock wave occurs rapidly, which can give the physical conditions such as high pressure and high temperature adequately for the formation of diamond creating the second stage or the crystallization stage. A disadvantage of this process, however, is that, pressures obtained during such collisions are often so high that shattering, sputtering and vaporization become dominant over phase transformation (Tielens et al. 1987, Jones et al. 1994, 1996), which limits the effectivity of diamond formation.

In conclusion, these results from the previous literature alone are not conclusive, especially since it is currently difficult to distinguish between the effects of shock transformation and small grain size. They leave open, however, the possibility that a significant fraction of the nanodiamonds in primitive meteorites were formed by shock transformation from graphite/amorphous carbon in the interstellar medium. As noted above, this possibility has been immediately recognized after their discovery (Tielens et al. 1987), but more recent works have mostly concluded that a CVD-like process is more likely (e.g., daulton et al. 1996, Le Guillou et al. 2006, 2007). However, CVD theory does not explain details on the 2.6 nm as an average size of the meteoritic nanodiamonds, which may be related to the H-or N-related self-terminating crystal growth process (Sun et al. 2004) in the shock-wave front. On the other hand, the surface chemistry of the nanodiamonds shows a poor thermal stability between 850-1350 oC (Lu et al. 2007) indicating the low-temperature crytallization process of the single diamond grains. These factors may also support the shock wave origin of the meteoritic nanodiamonds.

Other processes that are possible in principle (see also Anders and Zinner 1998), but have received less attention, are photolysis of hydrocarbons (Buerki and Leutwyler 1991), annealing by UV photons (Nuth and Allen 1992) and transformation by energetic particle irradiation (e.g., Ozima et al. 1997).

Keywords: Allende, supernova, nanodiamonds, shock wave, interstellar media, meteorite