

NANODIAMOND IN COLLOIDAL SUSPENSION: ELECTROPHORESIS; OTHER OBSERVATIONS.

A. P. Meshik, O. V. Pravdivtseva, and C. M. Hohenberg. Laboratory for Space Sciences and Physics Department, Washington University, CB1105, One Brookings Drive, Saint Louis, MO 63130 (am@wuphys.wustl.edu).

Introduction: Selective laser extraction has demonstrated that meteoritic diamonds may consist of sub-populations with different optical absorption properties [1]. It is not clear, however, what makes them optically different. It could be that nitrogen, or some other impurity, may be substituted for some carbon atoms, there may be different surface properties, or something else entirely. More work is clearly needed to understand the operative mechanism for selective laser extraction. This work is an attempt to investigate the properties of meteoritic diamonds in colloidal suspension. Knowledge of these properties may also allow us to find a better way to deposit a mono-layer of diamond and consequently improve the selective laser extraction experiment. Two experiments were performed, with the concentrations of Xe-HL being used as a tracer for the diamond distributions.

Direct deposition on sapphire substrates: A 4 μ l aqueous solution, containing ~20 μ g of Allende diamond, was placed onto the sapphire substrate as a single drop and allowed to dry. The residue, after evaporation, was about 3 mm in diameter with clearly visible dark rim (Fig 1). Similar patterns, each resembling the cross section of a tree, were observed for Murchison and Indarch diamond suspensions.

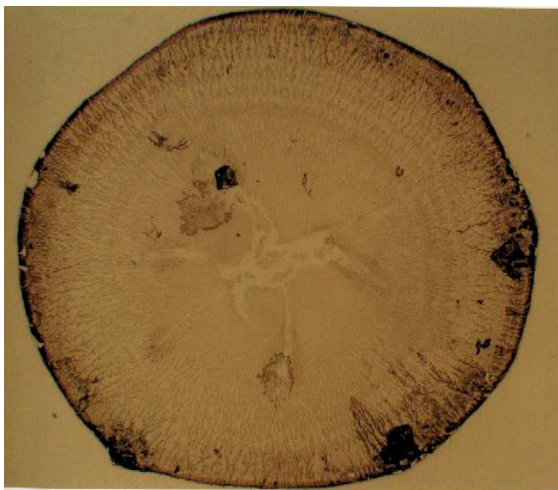


Fig. 1. Evaporated colloidal solution of Allende diamond on sapphire substrate (transmitted light).

Selected $\frac{1}{4} \times \frac{1}{2}$ mm areas of the residue were rastered by slightly defocused Q-switched IR laser and the released Xe measured mass spectrometrically. The isotopic composition of Xe extracted from different areas of the residue was found to be uniform and

indistinguishable from that of bulk Allende diamond. However the surface concentration of Xe-HL extracted was not uniform, but was somewhat lower in the center and outermost parts of the residue (Fig. 2).

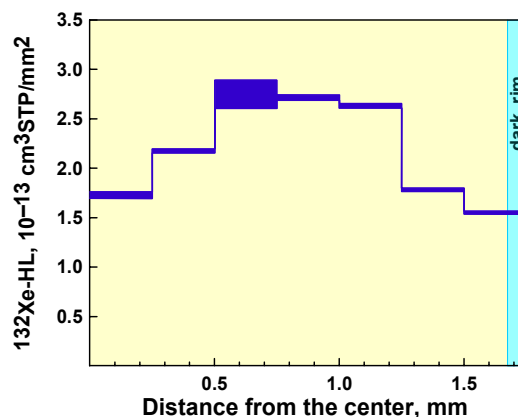


Fig. 2. Xe-HL profile from the center to the outer rim of evaporated diamond colloid indicates that the rim does not carry diamonds.

Interestingly, there is no enrichment in surface concentration associated with the rim where a dark ring is clearly visible. There is also no depletion at the center of the residue where there is visibly less material. That means that what we see as the evaporated residue is not diamond itself but impurities in the colloidal suspension. Since the weight of the residue is used in abundance calculations, and the visible parts of the residue may account for the bulk of the weight, this observation may have implications for current estimations of the diamond abundances in meteorite using Xe-HL [2]. The experiment also suggests that diamond residue can be further purified.

Electrophoretic deposition of nanodiamonds:

Although this experiment is unique for meteoritic diamonds, it has been done for man-made explosion-produced nanodiamonds [3]. These artificial nanoparticles are generally coated with oxidized products of the explosives in the form of carbonyl, carboxylic lactone, and epoxide [4]. Meteoritic diamonds may also be coated, but with amorphous carbon films [5] or products of chemicals used for their separation, or have surface defects. Due to these properties, the particles can be variably charged and subject to differing forces if an electric field is applied to the colloidal solution. While charged nanodiamonds start to move toward the oppositely charged electrode, their mobility depends

on a number of other properties Van der Waals forces, micro-viscosity, etc).

A teflon electrophoretic cell made for this experiment, having a volume of ~ 4 ml, with electrodes of 0.0005" thick Pt foil and a working area of ~ 1cm². The applied electric field was 20V/cm. De-ionized (15 MΩ-cm) water and isopropyl alcohol were used as the electrophoretic media. Current results for Allende nanodiamonds are summarized in the Table 1.

Table 1. Xe-HL extracted from each electrode, expressed as a percentage of the total Xe-HL contained in the initial colloidal solution.

Media	Deposition time (h)	Positive electrode	Negative Electrode
W	1	1.7	0.3
W	18	7.3	1.0
IP	1	8.3	0.9
IP	18	17.8	2.5
IP	24	50.2	5.2

W– water, IP – isopropyl alcohol .

The main message from the table is clear: nanodiamonds are mostly charged negatively, both in aqueous and organic solutions, although a small fraction of them seem to be positively charged. Deposition is much more efficient in organic solution. Deposition requires a surprisingly long time. Complete deposition in isopropanol would take about 2 days. Data in the table suggests that deposition is non-linear in that 8 percent of the diamond is deposited in the first hour in isopropyl alcohol, while it takes 17 hours to deposit the next 8 percent. This means a range of mobilities must exist in the solution. However, little if any, difference in isotopic composition can be detected in these two samples. The same effect is qualitatively seen in the water solution, but to somewhat less degree.

Supported by NASA grant NAG5-9442.

References: [1] Meshik A. P., Pravdivtseva O. V., Hohenberg C. M. (2001) *LPSCXXII*, CD-ROM, abstract #2158. [2] Huss G. R., Meshik A. P., Hohenberg C. M., and Smith J. B. *LPSCXXX* abstract (this CD-ROM). [3] Affoune A. M., Prasad B. L. V., Sato H., Enoki T. (2001) *Langmuir* **17**, 547–551. [4] Shergold H. L. and Hartley C. (1982) *J. Int. J. Min. Process* **9**, 219.