

SELECTIVE LASER EXTRACTION OF Xe-H FROM Xe-HL IN METEORITIC NANODIAMONDS: REAL EFFECT OR EXPERIMENTAL ARTIFACT? A. P. Meshik, O. V. Pravdivtseva and C. M. Hohenberg
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Selective optical absorption may provide a means for the demonstration that Xe-H and Xe-L are contained in distinct C δ carrier populations. Previous studies, prompted by the observation that the nitrogen content of C δ correlate with absorption features [1], suggest that Xe-L may be depleted relative to Xe-H in nanodiamond populations with more optically active absorption sites at 1064 and 266 nm [3].

In the previously reported experiment made for Murchison CM2 [2, 3], a colloidal solution of nanodiamonds was deposited onto a sapphire substrate in two different ways to achieve different surface concentrations of diamonds. High surface concentrations were obtained by application of a single 2.0 μ l drop of colloid containing \sim 20 μ g of diamonds. Low surface concentrations (thin film) were obtained by application of a diluted colloid, spread onto the entire surface of a stack of several optically transparent 10 \times 7 \times 0.5 mm sapphire plates. The first, more concentrated, sample contained \sim 2500 layers of diamond grains, while the second sample, distributed over a larger area, consisted of roughly a single diamond layer. Dried samples were loaded into the vacuum optical cell where they were subsequently rastered by a defocused laser beam. Nearly all Xe was extracted from the high surface concentration sample, with the isotopic composition indistinguishable from that of the traditional oven extraction. Rastering of the second sample, with a low surface concentration of diamonds, by the same laser beam, released only few percent of the total Xe and small but significant depletion in light isotopes, if compared to first bulk laser extraction, have been observed. This effect was reproduced in subsequent experiments [3] for 1064 nm and 266 nm laser beams, but it was not reproducible for the 532 nm beam.

Although these first results obtained for Murchison nanodiamonds were promising, we realized that the observed effect of apparent preferential release of Xe-H may be an artifact related to uncontrolled increase of atmospheric blank due to overheating of the sapphire substrate where the diamond films were deposited. This does not make a big difference for the heavy Xe isotopes, while it may noticeably modify the isotopic abundances of light isotopes, resulting in apparent separation of Xe-H from Xe-L. This was certainly a case for our UV-extractions, since experimental points lay, on average, on the mixing lines between the bulk Xe composition and atmospheric Xe. This is probably also true for the IR-beam, however, there is a tendency

for experimental points to lie below this mixing lines (Figure 1, Murchison, two top panels).

In order to understand whether the selective extraction of Xe-H is real or it is an experimental artifact, we analyzed, in the same manner as Murchison, nanodiamonds from Indarch EH3-4, one of the richest meteorite in Xe-HL. The results were disappointing. A combination of lower (compare to Murchison) Xe signal and the presence of SiC did not allow us to reach any conclusion on Xe-HL separation.

We then prepared a diamond separate from Allende CV3, with little Xe-P3, hence Xe isotopic ratios significantly differ from atmospheric Xe (right side in Figure 1). This time we had sufficient Xe signal, so blank was not a problem. $^{136}\text{Xe}/^{132}\text{Xe}$ ratios were nearly the same for bulk and thin film laser extractions. But the ratio of Xe-L/Xe-H in thin film laser extraction did not change much either, as is evident from $^{124}\text{Xe}/^{132}\text{Xe}$ and $^{126}\text{Xe}/^{132}\text{Xe}$ vs. $^{136}\text{Xe}/^{132}\text{Xe}$ plots.

However, once again, there is a weak tendency for slightly lower $^{124}\text{Xe}/^{132}\text{Xe}$ and $^{126}\text{Xe}/^{132}\text{Xe}$ ratios, at the $\sim 1\sigma$ level, in Xe released from thin film of Allende diamonds (Figure 1). Interestingly, this shift is in the same direction as for Murchison diamond separates.

We have attempted to modify the optical properties of the diamonds hoping that grains containing Xe-L and Xe-H may respond to this modification differently. Prior to the laser rastering, the entire stack of plates with thin diamond films deposited on all surfaces (front and back) has been annealed *in vacuo* at 800 $^{\circ}$ C for 20 min. This annealing was performed in the side finger attached to the cell. After annealing the cartridge with the stack of the plates was move in back to the cell magnetically, thus the vacuum was not broken and the diamonds were not exposed to air after annealing. This procedure was performed for the Indarch and Allende samples. It did modify their optical properties, probably due to graphitization of the diamond surfaces. The absorbance of 1064 nm light has dramatically increased (at least 7 times), but there was no improvement in the separability of Xe-HL.

In summary, we have to admit that in spite of our efforts, we have presently no solid evidence for selective laser separation of Xe-HL in meteoritic diamonds. At the same time, there is no proof of the opposite. We probably need to tune the laser wavelength to the appropriate absorption peak, but unfortunately neither are there powerful commercial lasers available in a most

promising far infrared range, nor are the optical spectra of nanodiamonds completely understood.

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[1] Hill H. G. M., Jones A. P., and d'Hendecourt L. B. (1998) *Meteoritics & Planet. Sci.*, 33, A67. [2] Meshik A. P., Pravdivtseva O. V. and Hohenberg C. M. (1998) *Meteoritics & Planet. Sci.*, 33, A106. [3] Meshik A. P., Pravdivtseva O. V. and Hohenberg C. M. (1999) *LPS XXX*, Abstract #1621, LPI, Houston (CD-ROM).

Figure 1. Isotopic ratios of Xe released from Murchison (left), Indarch (middle), and Allende (right) nanodiamonds when an IR laser beam (1064 nm) rastered areas with high (blue solid round symbols) and low (red empty diamond symbols) surface diamond concentrations. Dashed lines represent mixing between the Xe-P3 and Xe-HL end members. Solid lines indicate addition of atmospheric Xe to Xe released from bulk Murchison and Allende diamonds. Data for Indarch are not precise enough and contain Xe-S contribution as evident from the $^{130}\text{Xe}/^{132}\text{Xe}$ vs. $^{136}\text{Xe}/^{132}\text{Xe}$ plot. Xe extracted from thin films of Murchison diamonds is depleted in ^{124}Xe and ^{126}Xe due to addition of atmospheric Xe and possibly to slight deficit of light isotopes. Xe from thin films of Allende diamonds is not affected by atmospheric blank, but, once again, there is a tiny ($\sim 1\sigma$) shift in the same direction towards the depletion in light isotopes. Error bars (1σ) are too big to make a definite conclusion of whether or not the selective laser separation of Xe-HL is working.

