The Distribution of Ar and Xe Inside Diamond Grains from Efremovka

Conference or Workshop Item

THE DISTRIBUTION OF AR AND XE INSIDE DIAMOND GRAINS FROM EFREMOVKA. A.V. Fisenko[1], A.B. Verchovsky[2], L.F. Semjonova[1], C.T. Pillinger[2]. [1]*Vernadsky Institute RAS, Moscow, Russia (anatolii@fis.home.chg.ru);* [2]*Planetary and Space Sciences Research Institute, The Open University, Milton Keynes, UK.*

Abstract. Analysis of the release pattern of Ar and Xe from grain size fractions of Efremovka presolar diamonds at stepped combustion and pyrolysis indicates that in both cases the gases release as a result of destruction of the diamond lattice.

In the paper we analyse in details the release patterns of Ar and Xe from three grain size fractions of Efremovka presolar diamonds ED-3, 4 and 9 [1, 2] at stepped combustion and compare them with new stepped pyrolysis data. The average grain sizes of the fractions are 1.8 nm for ED-3 and 4 and 3.7 nm for ED-9. Figure 1 shows the results of stepped combustion experiments; all the concentrations are normalised to the corresponding amount of carbon released at each step and to the total noble gas/carbon ratio for each sample. As can be seen, the release patterns for different grain size fractions are similar for the same element but different for Ar and Xe. The strongest differences in the concentrations during stepped combustion are observed for Ar in ED-9 (Fig. 1a). Maximum of Ar release in ED-9 is observed earlier than in ED-3 and 4: at 32 and 45% of carbon release that corresponds to removal of the grain layers with thickness of 0.16 and 0.22 nm (if combustion proceeds on layer by layer basis) accordingly. In other words, Ar is heterogeneously distributed within the diamond grains with maximum concentration at the distance of about 0.2 nm from the surface. However, taking into account the size of Ar atom (0.38 nm) and the fact that a fraction of Ar was released from all the samples in the first 700^{o}C pyrolysis step, preceding the combustion steps, one can suggest that concentration at the beginning of combustion should be higher. At the very beginning of combustion of the finest grain size fractions (ED-3 and 4) there is observed a drop of Ar concentrations. Similar effects are also seen for Xe (Fig. 1b) that appears to be connected with oxidation of the finest or/and most defective grains in the fractions.

Variations of Xe concentrations at the beginning of combustion in the samples ED-3 and 4 are larger than those for ED-9 (Fig. 1b), however, starting from about 40% of carbon release, the Xe release patterns for all the samples became similar with more or less constant Xe concentrations in the range between 40 and 80% of carbon release. For the plateau, the Xe concentrations in ED-4 are higher and in ED-3 are lower than those in the corresponding bulks. These observations can be explained if we suggest that Xe deep concentration profile has maximum at depth about 1 nm. In this case the Xe concentration should increase in the central part of the grains with size >2 nm and in the intermediate part for the grains with smaller grain sizes.

Obviously the differences in the release patterns of Ar and Xe from the diamond grains size fractions are connected not only with their space-distribution in the grains, but also with they “energetic” position within the diamond structure. Koscheev et al. [3, 4] suggested that Ar and Xe atoms are located in two types of defects with high and low energy. As Efremovka meteorite has experienced a thermal metamorphism in its parent body, most of the low energy defects, which P3 noble gases are associated with, have been released from the diamonds. Therefore, Ar/Xe ratios for the HL noble gases, left after the metamorphism and associated with high-energy defects, should show significant variations at combustion and pyrolysis due to differences in the temperatures used for these types of extractions. However, as can be seen from Figure 2, this is not the case: after about 20% of Xe release, Ar/Xe ratios at combustion and pyrolysis change by similar way. This allows concluding that release of Ar and Xe occurs as a result of the diamonds lattice destruction proceeding on the layer by layer basis. It appears that graphitisation is the main process of the gas release at pyrolysis.

Thus, we suggest that HL noble gases in Efremovka are distributed over the volume of diamond grains as single atoms in a way, determined by their implantation energy and the sizes of diamond grains. Both combustion and pyrolysis destroy diamond lattice by similar way, and noble gas atoms release according to their space-distribution within the diamond grains.

References. [1] Verchovsky A.B. et al. (1998) *Science*, 281, 1165-1168; [2] Fisenko A.V. et al. (2000) *Astronom. Vest. (in Russian)*, 34, ^{1} 1, 24-40; [3] Koscheev et al. (2000) *LPSC XXXI*, abstr.#1551; [4] Koscheev e al. (2000), MAPS 35., A92.

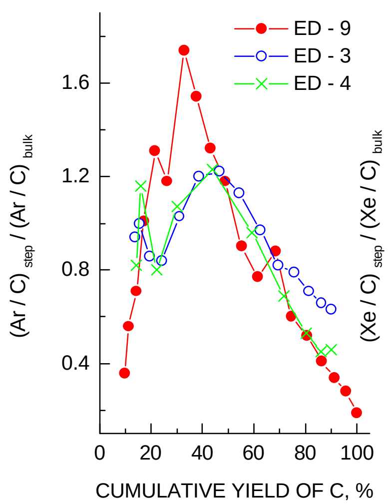

Fig. 1a

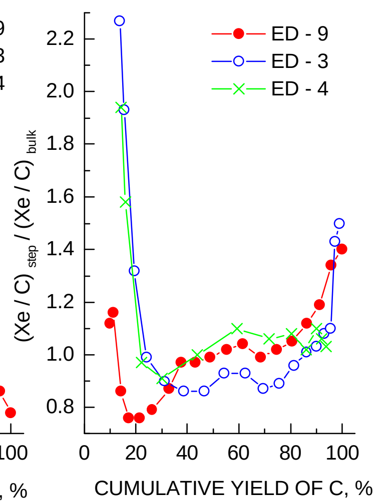

Fig. 1b

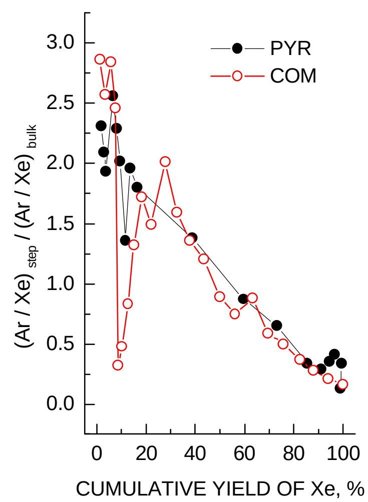

Fig. 2

Figure 1. Normalised release pattern of Ar (a) and Xe (b) from the Efremovka presolar diamond grain size fractions.

Figure 2. Variations of the Ar/Xe ratio during stepped combustion and pyrolysis of the fraction ED-9.