

SOME FEATURES OF NOBLE GASES RELEASE FROM THE GRAIN-SIZE FRACTIONS OF THE ORGUEIL CI METEORITE NANODIAMONDS. A. V. Fisenko and L. F. Semjonova, Vernadsky Institute of Geochemistry and Analytical chemistry, RAS, Russia (e-mail: anat@chgnnet.ru)

Abstract. The main amount of P3 component noble gases in meteoritic nanodiamonds is contained in non-diamond carbonaceous phase. This phase (e.g., ordered graphite-like phase) located on local sites of diamond grains surface. The contents of this phase increase with increasing of the grains size. It is the most probable, that P3 component noble gases have been adsorbed by non-diamond carbonaceous phase rather than implanted into diamond grains.

Introduction. The research of the grain-size fractions of meteoritic nanodiamonds allows to receive the information on the contents and isotopic compositions of the main and the impurity chemical elements in nanodiamond grains [1]. Here, on the basis of the analysis of the data for grain-size fractions of Orgueil nanodiamonds [2, 3], we have shown that P3 noble gases could be adsorbed rather than implanted, as it was supposed in works [1, 4].

Experiment. Methods of nanodiamonds release from sample of the Orgueil meteorite, its separation on grain-size fractions and measurements of noble gases, C and N are similar to those in [1, 5]. The released fractions of Orgueil nanodiamonds with increasing of grain sizes are in the following number: OD14, OD13, OD17, OD12, OD11, OD16 and OD15. We establish this sequence on the basis of sedimentation conditions at their separation. Some data of the analysis of these fractions at pyrolysis up to 800°C and at the subsequent oxidation are given in the Table.

Results and discussion. It is possible to note the following basic features of Xe-P3 and Xe-HL release from grain-size fractions.

1. The main amount of Xe-P3 (up to 85 %) is released at pyrolysis up to 800°C from all fractions. All fractions are identical on kinetics of Xe-P3 release and a maximum of Xe-P3 release falls in a temperature interval 400–500°C.

2. At stepped oxidation the dependence of the ratio of Xe-HL amount to those for carbon on the cumulative yields of carbon is similar for all fractions and they have the opposite directions to similar dependence for Xe-P3 after pyrolysis (Fig. 1).

One can see that a minimum in curves for Xe-HL and accordingly a maximum in curves for Xe-P3 conform to initial stages of oxidation of the grain-size fractions.

The dependencies on Fig. 1 can be interpret as

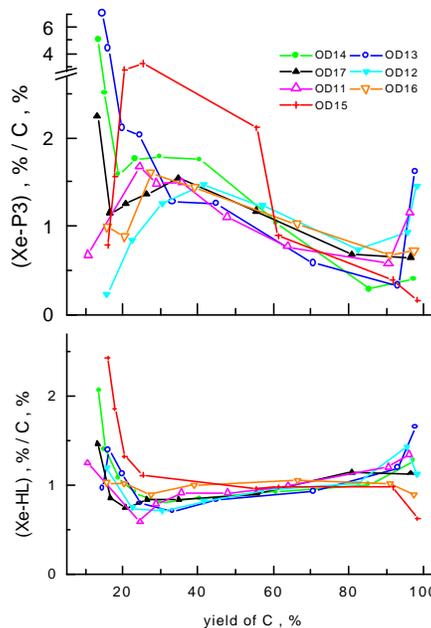


Fig. 1. The $^{132}\text{Xe-P3}$ and $^{132}\text{Xe-HL}$ distributions in grain-size fractions of Orgueil nanodiamonds after pyrolysis up to 800°C.

result of differ of Xe-P3 and Xe-HL distributions in nanodiamond grains. Namely, the residual Xe-P3 after pyrolysis is mainly located in outer shell of diamond grains whereas Xe-HL is distributed almost uniformly in the volume of grains with small depletion in the shell. Such distributions of P3 and HL components of noble gases, and also release of main Xe-P3 amount at pyrolysis up to 800°C agree with the assumption that noble gases of P3 component is in surface layers of nanodiamonds grains [6].

At superficial localization of P3 gases it is necessary to expect that their concentration should decrease with increasing of the grains size. However this is not observed (Table). This contradiction is eliminated, if P3 gases are contained in some sites of grains surface only. It is realized, if P3 gases are consisted in non-diamond phase and this phase is present on some sites of diamond grains surface. Such phase may be the sp^2 -coordinated carbon atoms in surface shell of grains.

As shown for ultradispersed grains of diamond of detonation synthesis these atoms covers partially the surface of grains [7]. It is supposed, that the formation of various functional groups on the surface

of diamond grains of detonation synthesis occurs mainly on uncovered by shell the parts of the diamond core [7].

If it also occurs for meteoritic nanodiamonds then the negative correlation should be observed between $\delta^{13}\text{C}$ value and Xe-P3 contents at pyrolysis. This is connected by that the carbon in functional groups may be the carbon of an atmosphere and this carbon is more enriched with a heavy isotope, than carbon of meteoritic nanodiamonds. As can be seen on Fig. 2, such correlation is observed, if we not consider the most coarse-grained fraction OD15.

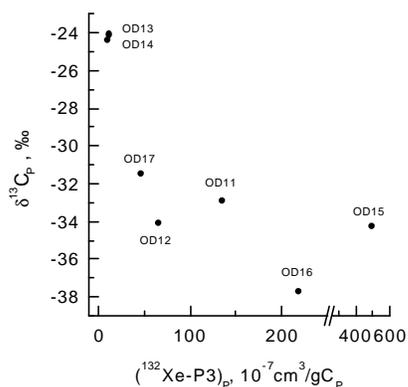


Fig. 2. The negative correlation between $\delta^{13}\text{C}$ for carbon and $^{132}\text{Xe-P3}$ released at pyrolysis of fractions.

The OD15 fraction being a final residue after removal of all fractions and so it contains greatest amount of the SiC grains. Therefore the isotopic composition of carbon of OD15 fraction is considerably modified by carbon from SiC.

Conclusion. The main amount of P3 component noble gases in meteoritic nanodiamonds can be contained in non-diamond carbonaceous phase, which is in local sites of diamond grains surface. This phase can be, e.g., ordered graphite-like phase. Its contents increase with increasing of the grains size. It is the most probable, that P3 component noble gases have been adsorbed by this phase rather than implanted into diamond grains as it is supposed in [1, 4].

Noble gases of HL component were most likely implanted into nanodiamond grains. The observable distinction in Xe-HL contents between fine- and coarse-grained fractions (Table) is probably due to the reduction of safety efficiency of fine grains at presence impurity chemical elements. Probably the implantation of HL gases has been occurred at high temperature as this suggests in [4]. Therefore the surface non-diamond carbonaceous phase is not contained the HL component gases and as a consequence the depletion by Xe-HL is observed on initial stages of oxidation (Fig. 1).

References. [1] Verchovsky A. B. et al. (1998) *Science* 281, 1165-1168. [2] Verchovsky A. B. et al. (2006) *69th Meet. Met. Soc.*, Abstract #5245. [3] Verchovsky A. B. et al. (2008) *MAPS* (in press). [4] Koscheev A.P. et al. (2000) *LPS XXXI*, Abstract #1551. [5] Fisenko A.V. et al. (1998) *Geochem. Int.* 36, 467-470. [6] Huss G., Lewis R. (1994) *Meteoritics* 29, 791-810. [7] Panich A.M. et al. (2006) *Eur.Phys. J., B Cond. Matter Phys.* 52, 397-402.

Table. The data for grain-size fractions of the Orgueil nanodiamonds

Frac-tions	^{132}Xe , 10^{-7} cm^3/gC	$^{132}\text{Xe-HL}$, 10^{-7} cm^3/gC	$\frac{^{132}\text{Xe-P3}}{^{132}\text{Xe-HL}}$	$(^{132}\text{Xe-P3})_p$, 10^{-7} cm^3/gC_p	$\delta^{13}\text{C}_p$, ‰	$\delta^{13}\text{C}_T$, ‰
OD-14	4.0	2.23±0.03	0.8±0.1	11.0±0.1	-24.4	-28.5
OD-13	4.9	2.52±0.05	0.9±0.1	12.8±0.2	-24.1	-27.6
OD-17	10.4	3.96±0.05	1.6±0.1	46.7±0.3	-31.5	-38.0
OD-12	12.1	3.50±0.03	2.5±0.1	65.4±0.5	-34.1	-39.5
OD-11	21.6	3.99±0.14	4.4±0.2	136±1	-32.9	-42.2
OD-16	32.1	3.12±0.31	9.0±1.0	219±1	-37.7	-45.1
OD-15	83.0	4.68±0.26	16.7±1.0	499±1	-34.3	-38.0

Index «P» – pyrolysis, T - total carbon