POLYAMORPHIC AND POLYMORPHIC TRANSITIONS IN THE IRRADIATED DIAMONDS

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To study structural changes in unordered amorphous systems which take place at volume increasing the short-range order of diamond powers irradiated up to the fluence $1{,}51 \cdot 10^{21}$ as a function of density was investigated by means of neutron diffraction.

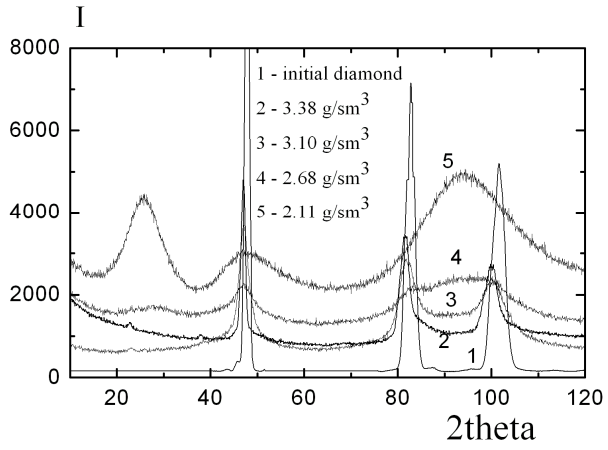

Fig. 1. Diffraction patterns upon the transition from a diamond-like glass to a graphite-like structure upon change in density

One can see (fig.1) that with density decreasing the broadening of the diamond diffraction lines, overriding of the "tails" of the diffraction lines, and creation of a "gallo" which corresponds a appearance of fine-grained ("amorphous") diamond-like material occur. On further density decreasing, in the diffraction pattern the new "gallo" appears which intensity gradually increases and position corresponds the location of the first maximum on the diffractogram of an irradiated graphite or amorphous carbon. Obtained results can be treated as the polyamorphous transition from the diamond-like to graphite-like glass operating at density decreasing and associated with the decreasing of the number of nearest neighbours in the first coordination shell from 4 to 3 (contrary to its increasing at high pressure). This transition is accompanied by change of powder electrical resistivity measured with help of hold-down contacts. The total change of the electrical resistivity accounts for six orders in the investigated range of a density and corresponds the transition from the dielectric to metallic state. The "critical" density at which the transition take place accounts for $\rho \cong 2{,}7\text{-}2{,}9$ g/cm^3 and is approximately equal to the average density of the crystalline analogs.

Stability of the graphite-like phase which appears in the irradiated diamonds as a result of polyamorphic transition with big decrease of density, was studied using neutron and x-ray methods. The graphite-like structure was shown to be stable up to 50 kbar from ambient temperature to 1500 K at normal pressure. Simultaneously at rapid heating to 900-1000 K new (apparently metastable) modifications of carbon are formed, with the diffraction patterns which do not coincide with those of known structures of carbon (diamond, lonsdeylite, graphite, chaoite, carbine, fullerene and its derivatives *etc*). Density of these structures is shown not to differ much from the density of graphite, and at least one of these phases corresponds to a surerstructure based on the bcc modification of C_8 with modified density. The geophysical aspects of problem are also considered, it is shown that the recently found new carbon modification from the Popigay [1] crater is actually a mixture of phases containing those which were found in the graphite-like diamonds after annealing after irradiation.

This research was supported by RFFR under grant 03-02-17387

References

1. A.El Goresy et al. C. R. Geoscience 2003; 335:889-898.