EVOLUTION OF NON-DIAMOND CARBON FORM AND ITS INFLUENCE ON STRUCTURAL TRANSFORMATIONS

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Introduction

In [1, 2] it was shown that in nanodisperse diamonds (UDD) prepared by detonation synthesis, on the surface of diamond cores, and amorphous carbon cover with the sp^2 and sp^3 type of bond hybridization is present. In X-ray diffraction patterns, this manifests itself in the presence of a halo at small angles ($2\Theta \approx 17\text{-}18^0$) along with reflection lines of diamond.

Changes, what become apparent in the diffraction picture of UDD as a result of their annealing at temperature above 1400 K in the argon atmosphere was considered in [3]. It is testifyed that after annealing at temperatures higher 1400 K amorphous carbon sp^2 - shell begins to participate actively in the process of UDD graphitization. The UDD graphitization process pass due to a diamond main body only at more high temperature. The research influence of high pressures on the indicated processes is actual.

Material and method

Changes which are observed on the diffraction pictures of nanodiamond powders after thermo-baric treatment in the conditions of high pressures up to 7 GPa and high temperatures of 1400-2200 K are considered in the present work. The powder of UDA of explosive synthesis, made by firm «Alite», Ukraine, with the size of particles to 10 nm, was utillized as a feedstock. High pressures were generated in the «toroid» type vehicle with the 7 millimetre working channel of container.

A X-ray phase analysis was conducted on the diffractometer of DRON-3M in copper Cu-K_α – radiation with digital registration of reflections.

Results and discussion

It is set that the X-ray pattern change take a place mainly with a halo, not causing the change of lines of diamond reflectionin in investigational temperature interval at the indicated value of pressure. Already it testifies to the changes of the structural state of nondiamond form of carbon.

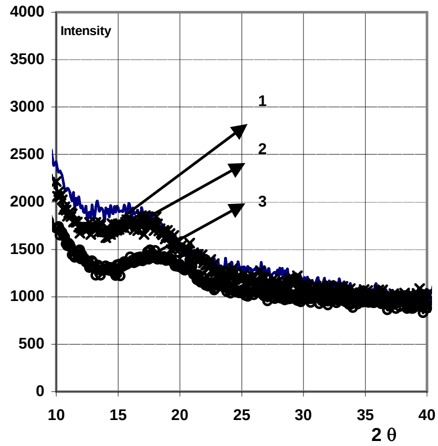

Fig.1. Diffraction patterns UDD, after baric-thermal treatment at P = 7 GPa, T = 1800 K (1); P = 4 GPa, T = 293 K (2); P = 7 GPa, T = 2000 K (3).

At a temperature of 1800 K and pressure of 7 GPa a form and position of halo ($2\Theta \sim 16^o$) corresponds such in the initial (before action of high pressures and temperatures) state of UDA. With growth of sintering temperature on the diffractograms of specimens an area es under the halo curve (intensity) diminish. The level of background diminishes (Fig.1) too. It testifies to flowing of process of carbon ordering. It is confirmed also displacement of maximum a halo toward large angles ($2\Theta \sim 18^o$). At more high temperature under pressure of 7 GPa is observed appearance of lines of graphite reflection (002). Thus, there is the further diminishing of halo intensity, that specifies on transition of unordered nondiamond form of carbon to the well-organized graphite. The changes of lines form of diamond reflection in the investigational range of pressures and temperatures were not observed. Pays attention on itself circumstance that the described tendency of change of the carbon undiamond form state was observed in area of temperatures 1800 – 2200 K at pressure of 7 GPa. However, a role of high pressure in considered processes is very substantial. The diffractograms, obtained from spesimens treated by the compression pressure 4 GPa at a room temperature demonstrate the same picture, as well as from spesimens, treated by pressure 7 GPa and temperatures up to 1800 K.

Thus, the present work achieved that changes, what be going on in phase composition of explosive synthesis UDD at sintering in the conditions of high pressures of 7 GPa and temperatures 1800 – 2200 K take a place due to the evolution of nondiamond form of carbon. The forming in the UDD particles high-dense volume formations at pressure of 4 GPa and room temperature which arise up due to the association of particles on the morphological flat surfaces of cutting can facilitate to pass of this process [4]. This process, presumably, activates at high temperatures and pressures and plays in the favour of passing of unregulated carbon nondiamond form to the well-organized graphite.

Conclusions

It is rotined that high pressures favourably influence on the ordering process of nondiamond amorphous form of carbon, up to its change to the form of graphite at baric-thermal treatment of UDD powders . Thus the substantial contribution of temperature factor to this process begins to show up at temperatures higher 1800 K.

References

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