NANODIAMONDS FROM PULSED PLASMA GENERATED IN WATER.

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INTRODUCTION

Presented data on the synthesis of nanodiamond in a pulsed plasma produced in the water.

Modern technologies for nanodiamonds are usually very complicated and involve the use of static ultrahigh pressures and temperatures or explosion energy [1]. Feedstock for their production is the carbon of explosives, and the high pressure and temperature needed for the diamond structure of carbon atoms is achieved in the explosion, which requires expensive the blast devices [2,3].

Search and study of new ways of producing carbon nanomaterials such as fullerenes, carbon nanotubes and nanodiamond is an urgent task.

EXPERIMENTAL

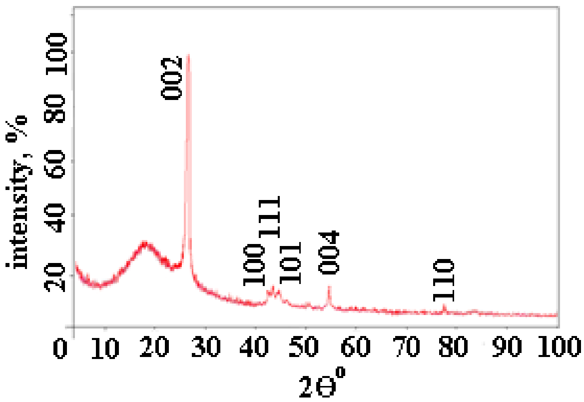
In the laboratory, Nanotechnology Institute of Chemistry and Chemical Technology, National Academy of Sciences of the Kyrgyz Republic for several years conducted research on the synthesis of fullerene soot (source of carbon nanostructures) using energy pulsed plasma produced in liquid and release C_{60}, carbon nanotubes and nanodiamonds [4,5]. Studies on the synthesis of carbon nanostructures and held at this time. We would like to draw the attention of the scientific community on these problems, which continue to be addressed in the caption above the laboratory:

- synthesis of nanodiamond by dispersion of graphite in a pulsed plasma generated in water;
- isolation of nanodiamonds;
- experimental and theoretical basis for the synthesis and isolation of nanodiamonds from a pulsed plasma in water.

As a result, the dispersion of graphite electrodes in toluene using the energy of the pulsed plasma obtained black precipitate at the bottom of the reactor, the color of toluene changes and becomes brown. The precipitate was separated from toluene by filtration. Then it was washed with ethanol, dried, and subjected to X-ray analysis. Fig. 1 shows the diffraction pattern of sediment obtained in toluene medium. Analysis of the diffraction pattern showed that reflections appear with indices (002) (100) (101) (004) (110) and (112) belonging to graphite.

Interplanar distance d = 2,06 Å(111) refers to the diamond with a lattice parameter a = 3.561 Å. Near 2θ = 17° halo is observed, characteristic of diffraction by a disordered amorphous carbon structure.

Figure 1. Diffractogram of the deposit obtained by dispersion of graphite in a pulsed plasma in toluene.



X-ray analysis of the dispersion of graphite products (sludge) in toluene showed that the sample contains amorphous carbon, graphite and ultra-fine diamond particles.

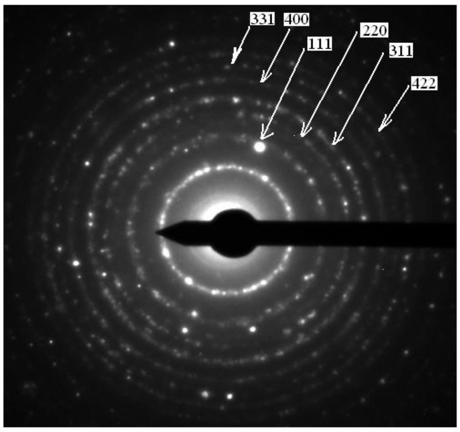
Pulsed plasma produced in toluene can be a great tool for obtaining of nanodiamond, but the precipitate obtained after dispersion of graphite in toluene contains a large amount of soot particles that are difficult to isolate the nanodiamond by known methods. To reduce sooting dispersion of graphite electrodes, we carried out in water in conditions similar to those for toluene. After graduating from the dispersion of graphite electrodes in water, a black precipitate is separated from water by filtration. Next, the precipitate was subjected to treatment technology selection nanodiamonds from fullerene soot, which is the most difficult stage in the process of nanodiamonds (ND). Selecting treatment based on the reactivity of nanodiamonds in comparison with other carbon nanostructures. The main task of the process - select the desired product with minimal loss. The relatively high chemical stability of diamond phase can make the process efficient enough.

To remove carbon and soot particles in order to isolate the nanodiamond from fullerene soot from a pulsed plasma sample was subjected to heat treatment at (3000 °C) in argon for 3 hours followed by treatment with hydrochloric acid. As a result of multiple repetition of this procedure cannot clean the sample from graphite and amorphous carbon. Further processing was performed with 50% nitric acid solution at a temperature of 140-1600 °C . Then, the sample was washed with water and dried in air at 2000 °C.

RESULTS

The phase composition of the resulting gray powder was investigated by microdiffraction. Electron diffraction (MEG), shown in Figure 2 describes the resulting substance is a polycrystalline structure. An analysis of MEG found that using a pulsed plasma in water obtained ND. At MEG identified point of reflection, located on the Debye rings (111) (220) (311) (400) (331) and (422). These reflections are darkfield images of single crystal of large particles of cubic diamond. The lattice parameter of NA = 3,56 Å.

Figure 2. Electron diffraction pattern of ND by pulsed plasma in water.



Raman spectrum of the sample ND, obtained by pulsed plasma in water is shown in Figure 3. Clearly visible asymmetric band with a maximum of 1580 cm^{-1} and the peak of the nanocrystalline diamond 1322 cm^{-1}.

It is well known that changes in the Raman spectra of carbon materials, occurring near 1600 cm^{-1}, to reflect changes in structure and size of sp^2 - bonded carbon. Peak with maximum at 1580 cm^{-1} agrees well with the maximum in the density of states of carbon, which indicates the presence in a sample of amorphous graphite phase.

Electron microscopy studies confirmed that the powder obtaining by a pulsed plasma in water contain the single-crystal particles of ND with sizes 1-10 nm (Fig. 4). There are also large particles, up to 20 nm.

Figure 3. Raman spectrum of the sample of ND by pulsed plasma in water.

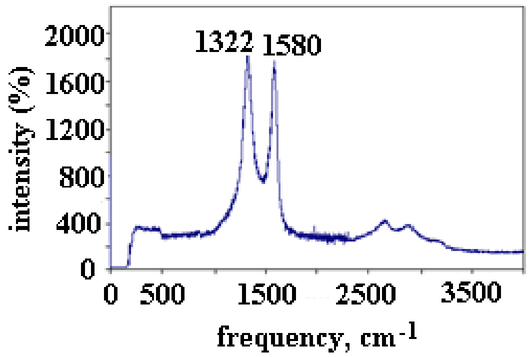
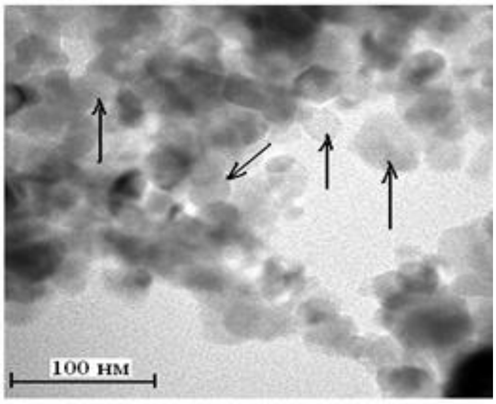


Figure 4. TEM image on ND after treatment received by the pulsed plasma in water.



CONCLUSIONS

Established that in pulsed plasma produced in toluene and water formed nanodiamonds.

By acid and thermal treatment of fullerene soot obtaining in water allocated nanodiamond, is installed morphology and phase composition of the nanodiamond particles.

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