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Synthesis of fullerenes by arc discharge

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INTRODUCTION

Nowadays, fullerenes attract much attention of scientists all over the world. This material has a very high potential for using as additives in various industries[1].

Fullerenes can be synthesized by a variety of methods, but only two of them are used for the synthesis of traditional metal-fullerenes, and only one of them is used for production of trimetallic nitride endohedral metal-fullerenes. The most common method of producing fullerenes and metal-fullerenes is based on the use of arc evaporation of a graphite rod under the action of AC or DC current in the working helium atmosphere at a temperature above 3000 ºC. For traditional production of metal-fullerenes, a hollow graphite rod is filled with a metal oxide/graphite mixture, which is subjected to arc evaporation under the same conditions as those used to obtain usual carbon fullerenes. During rod combustion, the carbon black is formed in the process and collected from the bottom of the generator[2].

EXPERIMENT

In the experiments on arc spraying of graphite in helium medium, the products of plasma chemical reaction were obtained at the following discharge parameters: p=300 Torr, U = 30 V and I = 300 A. It was found that in the synthesis reaction during anode evaporation, a deposit of different configurations was formed on the cathode. This deposit can grow coaxially to the cathode and with deviation from its axis, but coaxially to the anode. It is found that the cross-section of the deposit has two zones - loose and smooth zones.

As the reaction products, there were obtained fullerene soot deposited on the reactor wall and the deposit material formed on the cathode electrode. After filtration and benzene evaporation, surface morphology, chemical composition and phase structure of the obtained samples (fullerite crystals) were studied by using scanning electron and probe microscopes (Fig. 1 and 2).

The samples, obtained as a result of graphite decomposition in the arc discharge, were studied by the scanning and transmission electron microscopy and Raman scattering method. It was found that the samples consisted of multi-walled carbon nanotubes, graphene planes and rings. Using these results, we explained the mechanism of growth of fullerenes and their derivatives in the arc discharge plasma.

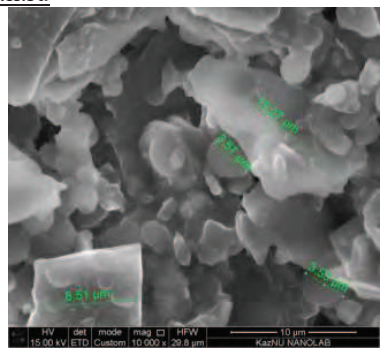

Fig.1. SEM image of fullerene crystals

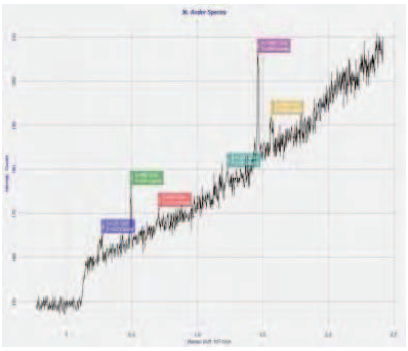

Fig.2. Raman spectra of fullerene crystals

CONCLUSION

In this work, the carbon fullerenes, multi-walled nanotubes and graphene planes and rings were synthesized in helium arc discharge. Investigation of synthesis process of fullerene and its derivatives allows us to development a mechanism of their growth.

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