The arc sputtering of the graphite in liquids

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Introduction

The well-known method of fullerenes synthesis by W. Kratschmer [1] is the process of electric arc sputtering of the graphite in the gaseous medium under lower pressure. In so doing, the chemical nature of the gas phase can essentially change the composition of the sputtering products. The composition of products of gas-phase sputtering of graphite or composite materials on its basis is intensively studied during last 15-20 years.

At the same time, it is possible to carry out graphite sputtering in liquids. This report at the first time deals with our experiments on graphite sputtering in water, toluene and alcohol. The task statement assumed to obtain the new products both in the solid and in the liquid phase.

Discussion

The method and facility for arc synthesis of the materials is described by A.G. Dubovoy [2].

In the course of graphite arc sputtering in liquids, it is necessary to take into account both processes taking place in the arc and, also, the interaction of the arc-sputtering products with liquid medium. In the first case the high temperature of product evaporation plays a special role. On the contrary, the product, being a mixture of the evaporated carbon, vapours and decomposition products of the liquid medium, undergoes the processes of the immediate quenching with the rate of 10^{10} to 10^{14} degrees per second.

As a result of the synthesis, the product is formed in two phases: the solid (nanostructural carbon in the various modifications) and the liquid, as a solution of the products of carbon interaction with the liquid.

The synthesis in water results in the formation of the highly-dispersed carbon where some quantity of hydrogen- and oxygen-containing groups formed in the course of water decomposition presents.

When water is replaced with an alcohol the content of hydrogen in the solid phase essentially increases.

The graphite sputtering in toluene results in the formation of both fractal carbon clusters and the soluble products. The liquid-phase products are the mixture of different hydrocarbons which is similar, as to its colour, to the extract of fullerenes mixture in toluene.

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To identify the fullerenes in the liquid-phase products, the analysis of the obtained solutions by optical spectroscopy in the range 340 to 600 nm was carried out. The SF-26 spectrophotometer with digital data output was used for these measurements.

The spectrum of the starting solution contains the single wide adsorpotion band with flat maximum in the region about 340 nm. The position of the maximum is shifted to long-wave region when the concentration of the solution increases. The characteristic adsorption bands for the C_{60} and C_{70} were not observed in the spectra.

Using the chromatographic column with activated graphite, d = 4 cm, l = 100 cm, the starting solution has been separated to 17 fractions. Two peaks related to the fractions VII and XII are visibly found in the chromatogram.

The spectroscopic study of the solutions from the fraction VII showed that their spectra are identical to the spectra of the starting solution. The two adsorption bands in the wavelength regions of 365 nm and 383 nm have appeared in the spectra of the solution from the fraction XII. The positions of the bands are closed to ones for C_{70} fullerene.

At the same time, the solid phase contains the order of magnitude more hydrogen than the one obtained in water.

Conclusion

1. The electric arc sputtering of the graphite in liquids is a new original method for obtaining the nanostructural carbon materials.

2. The electric arc sputtering of the graphite in hydrocarbons results, apart from the formation of modified carbon materials, in the appearance of soluble products that is accompanied by the change in colour and optical density.

3. The proposed method can yield the wide spectrum of new materials and become one of the ways to synthesize the carbon nanostructures.

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