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Hydrogenation of fullerenes as a method of storing hydrogen

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INTRODUCTION

One of the most promising direction in the development of alternative energy is the hydrogen energy – the replacement of fossil hydrocarbon fuels by environmentally friendly hydrogen fuel[1].

Today, to use the energy of hydrogen fuel it is necessary to solve the problem of cost-effective method of hydrogen storage. From this point of view, carbon nanostructures are promising materials for hydrogen storage.

Currently, the most common method of filling carbon nanostructured materials with molecular hydrogen is the use of high a nd ultra-high pressures that force hydrogen molecules to penetrate into the smallest pores and cavities of carbon structures, the size of which is comparable with the transverse size of the hydrogen molecule. During operation heated hydrogenated material gradually releases the accumulated hydrogen[2].

EXPERIMENTAL/THEORETICAL STUDY

In this paper, the method of catalytic hydrogenation of fullerenes was considered. To determine the optimal mode of the hydrogenation reaction of fullerenes the following conditions were used: hydrogen pressure of 12 MPa, temperature 200-600^0 C and mass of fulleriteC_{60} 0.501g.

At first, a vacuum was created in the reactor, then hydrogen was fed to the reactor to a pressure of 12.5 MPa and kept there for 4h. Then the reactor temperature was raised to 200^0 C (at a rate of 1° C per minute). At this point, the pressure in the reactor is changed on a 0.3 MPa (up to 12.8 MPa). This can be explained by the decomposition of solvates formed with fullerene crystallization. To stabilize the baro-temperature regime the sample was kept for another 4 hours at T = 200° C and P = 12.8 MPa. After 480 minutes, the temperature in the reactor was raised from 200^0 C to 600° C at a rate of 0.125 degrees per minute. In the experiment, it was found that the system reached the maximum speed of interaction on the 2150-th minute, which corresponds to a temperature of 433° C. The temperature, at which the rate of hydrogen interaction with the fullerene molecule is maximum, was determined. This temperature was in the range 425-455^0 C, when the total hydrogen content was about 8.2 mass %. Hydrofullerites were studied using Raman microscopy. The results show that the samples contained hydrogen atoms.

RESULTS AND DISCUSSION

In the study of the samples of fullerite crystals by the method of combined scattering a Raman scattering spectra were obtained, which indicate the presence of C60 and C70 in the composition of crystals obtained after soot purification Fig. 1.

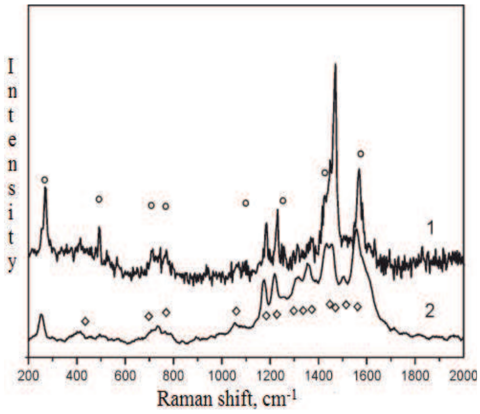

Fig.1. The Raman spectra of the fullerite after extraction from benzene (1) and after preparative liquid chromatography (2). The circles marked with published data on the position of the lines of fullerene C60.

CONCLUSION

In this work hydrofullerenes with different hydrogen content were obtained. Also, the optimum mode of C60 hydrogenation was determined. The study of obtained samples was carried out by Raman spectroscopy.

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