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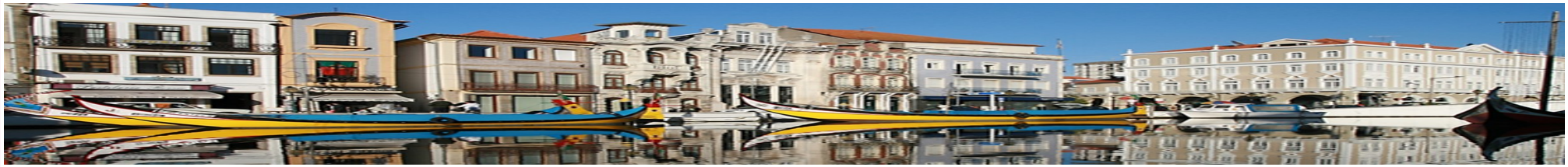

Synthesis of carbon nanostructures on copper films by the method of oxy- acetylene torch

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INTRODUCTION

In recent years carbon nanostructures have shown promising new applications in many fields due to its physical, chemical and surface characteristics. The method of oxy-acetylene torch refers to the most simple but efficient methods for producing carbon materials, wherein the deposition occurs at atmospheric pressure, i.e. it does not require complex vacuum and electronic equipment. It has various advantages over other methods, such as high synthesis speed and the safety and low cost of the equipment used[1,2]. Furthermore, conduction of synthesis does not require expensive precursors, including high purity. At present, this technique is widely used for synthesis of diamond-like hard coatings[3], but it is almost never used for obtaining nanostructured carbon materials. The most interesting results of experiments on the synthesis of carbon nanostructures by the method of oxygen-acetylene torch on the surface of copper film, previously deposited on silicon plates by Raman scattering (RS) and scanning electron microscopy are presented in this work.

EXPERIMENTAL STUDY

The monocrystalline silicon plates (analogue of brand KDB-20, manufacturer Siegert Wafer GmbH, Germany) 1×1 cm with orientation (100) and (111) were used as substrates and basis for copper films. The substrates were previously chemically cleaned. The treatment was carried out in a mixed solution of NH_4OH, H_2O_2 and distilled water at a volume ratio of 1:1:6.5, at a temperature of 45°C for 10 minutes, using sound waves with a frequency of 850 kHz, power 250 Watts. Further, washout in distilled water and drying were performed. Copper films were deposited on substrates of polished silicon plates by DC magnetron sputtering in equipment VUP-5M. Sputtering was carried out in the flow of working gas Ar at a pressure of 10^{-2} Torr. The time of depostion was varied from 15 to 60 minutes in 15 increments.

A series of experiments in which the distance from the torch nozzle to the substrate was changed (h = 4÷10 mm in 2 mm increments) was carried out. The tilting angle of the torch nozzle to the substrate remained constant and was equal to 90°, the duration of deposition was changed from 5 to 60 minutes in 5 increments, the concentration ratio of oxygen and acetylene (O_2/C_2H_2) was varied from 0.7 to 0.94 in 0.01 increments.

The obtained samples were studied by SEM and RS. Investigation of the samples was carried out in the NNTOT using spectrometer NT-MDT NTegra Spectra (laser wavelength λ = 473 nm) and Quanta 3D 200i.

RESULTS AND DISCUSSION

In the course of the studies exploratory experiments on synthesis of carbon nanostructures by the method of oxy-acetylene torch on copper films were carried out. According to the analysis by Raman spectroscopy and SEM, the obtained samples have different structures and morphology. According to the performed analysis by RS and SEM some obtained samples have a diamond structure with well-defined crystal faces and edges. And also as a result of the experiments, carbon structures that are nanotubes or nanofibers were obtained. For details of morphology and structure of the obtained samples it is necessary to carry out additional investigations by atomic force and transmission electron microscopy and electron diffraction.

CONCLUSION

Analysis of the results of experiments showed that the parameters rendering an important influence on the structure formation are:

- The distance between the torch nozzle and the substrate;
- The orientation of silicon plates;
- The thickness of deposited copper films;
- The concentration ratio of oxygen and acetylene.

Further studies will be directed to determination of the optimal combinations of the process parameters in order to obtain the necessary carbon nanostructures.

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