NANOWALLS FORMATION ON GLASSY CARBON AND CARBON FIBER SURFACES BY HIGH-FLUENCE ION IRRADIATION

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Nanoscale carbon materials are promising materials for creating low-voltage field emission cathodes and electrodes in supercapacitor structures or lithium-ion batteries [1-3]. In addition to the ways of producing isolated nanoscale carbon materials, such as carbon nanotubes, nanofibers, nanoscales, etc., there are the ways of developing and transforming the surface structure and topography of polycrystalline and amorphous carbon materials into nanocrystalline ones with micro or nanoscale relief. Various methods are used to form micro and nanoscale elements on the surface of carbon materials, including high-fluence ion irradiation [4,5]. For example, high-fluence ion irradiation of highly oriented pyrolytic graphite at temperatures $T \approx 250$, 400°C leads to the appearance of low-voltage field emission with the thresholds from 3 to 17 $V/\mu m$ depending on the temperature and geometry of irradiation [2]. Also, to increase specific capacitive and energy characteristics of supercapacitors different methods of electrode surface modification from carbon fibers are used [6]. High-fluence ion irradiation of carbon materials depending on the target temperature T of irradiation leads to the processes of amorphization, recrystallization and development of the surface topography. The surface topography is manifested at temperatures $T \geq T_a$, where the temperature of dynamic annealing of radiation damage T_a in carbon materials is 150 - 200°C depending on the material and type of ion [5].

This work is aimed at studying the structure and development of a relief on the surfaces of carbon fibers from viscose and glassy carbons from the ion irradiation fluence and irradiation temperature. The samples were irradiated by Ar^+ ions with energies of 30 keV using a mass-monochromator of SINP MSU [7] at temperatures from RT to 700°C. Subsequent analysis of samples was carried out using scanning electron microscopy (SEM) and Raman spectroscopy.

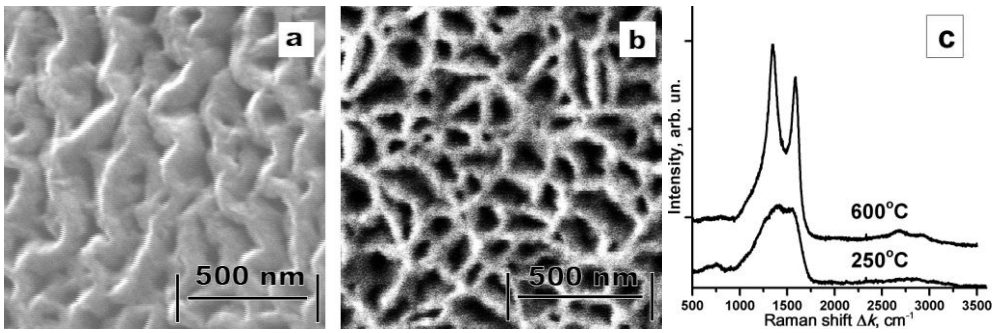

Fig.1. SEM images of nanowall structures formed after 30 keV Ar^+ ion irradiation on the surface of (a) carbon fiber based on viscose and (b) SU-2500 glassy carbon at temperatures of irradiation 200 and 500°C, respectively, and Raman spectra (c) of SU-2500 glassy carbon surface at temperatures of irradiation 250 and 600°C.

The analysis of SEM-images shows that at fluence of irradiation $\varphi t \geq 1 \cdot 10^{18}$ cm^{-2} the formation of nanosize wall structures is observed both on the carbon fibers based on viscose and on the glassy carbon (Fig. 1a,b). The Raman spectra are showed the presence of graphite-like and nanocrystalline structures of a modified layer for glassy carbon SU-2500 at temperatures T > 200 and 350°C (Fig.2c), respectively. Changes in the topography of the carbon fiber and glassy carbon surfaces are associated with anisotropic radiation-induced processes of carbon materials and sputtering of fibers under ion irradiation.

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