Effect of concurrent electron irradiation on structure and properties of the films OBTAINED USING HEAVY HYDROCARBONS DEPOSITION FROM GAS PHASE

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At present, coverings of thin carbon films with high fraction of bounds with sp3- hybridization are of significant interest. These films may have unique characteristics: high hardness, weariness, chemical passivity, biocompatibility and so on. The significant success achieved in carbon films growth based on graphite sputtering by ion beam assisted by ion and electron irradiation. In the work [1] we had shown that assisted electron irradiation of deposited carbon film may shift allotropic phase equilibrium concentrations toward increase of phase sp3 bound concentration. Therefore investigation of hydrocarbon films deposited from gas phase at heavyhydrocarbons evaporation at concurrent electron irradiation is of undoubted interest. The comparison of these films with carbon films received at graphite sputtering is also of interest.

We deposited films with thickness up to 200 nm on nickel substrates from gas phase of heavy hydrocarbons with concurrent electron irradiation with energy 0,5 keV and current density from 1 to 3 A/m2. We use two types of heavy hydrocarbons: naphthalene С10H8 and polyethylene (С2Н4)n. These hydrocarbons were placed to crucible of vaporizer and heated up to 405 и 498 K correspondingly. The temperature of substrates, measured by a platinum-rhodium thermocouple, did not exceed 370 K. In studying the films, the following methods were used: profilometry, optical microscopy, X-ray photoelectron spectroscopy (XPS). The microhardness was measured also.

The films received at heave hydrocarbons (С2Н4)*n* and С10Н8 deposition at concurrent electron irradiation was shown to have mainly hydrocarbon СН*n*-bounds and a small fraction of sp3 bounds.

Hydrocarbon films have micro hardness 3…8 times lower than the films deposited at graphite sputtering [1]. The films received at С10Н8 evaporation are 2 times more strength that the films received from (С2Н4)*n.* It is because the ratio H/C in (С2Н4)*n* is 2 times higher than that in С10Н8. The maximal micro hardness for hydrocarbon films does not exceed 4.5 GPa.

The difference of film deposition by evaporation of heavy hydrocarbons С10Н8 or (С2Н4)*n* and film deposition by graphite sputtering consists in presence of large molecules (С10Н8 or (С2Н4)*n*) and their aggregations in the flow of deposit matter. This is a reason of soft films formation. Concurrent electron irradiation destroys large molecules and promotes hard films creation with diamond like structures.

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Referenсes

1. Korshunov S.N., Martynenko Yu.V., Belova N.E., Skorlupkin I.D. Effect of concurrent electron irradiation on the structure of deposited carbon films, Journal of Surface Investigation: X-ray, Synchrotron and Neutron Techniques, 2017, Vol. 11, No. 4, p. 807–813.