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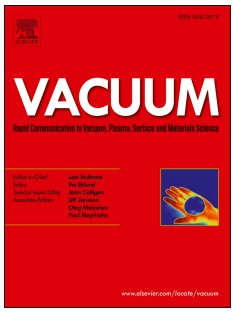

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Effect of nitrogen ion irradiation parameters on properties of nitrogen-containing carbon coatings prepared by pulsed vacuum arc deposition method

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Abstract

Studies of the effect of nitrogen ion irradiation on the structure and properties of nitrogenated amorphous carbon coatings prepared on polished sitall and silicon substrates by the pulsed vacuum arc deposition method are presented. The techniques used in the investigations were electron energy loss spectroscopy, Raman spectroscopy, and atomic force microscopy. The elemental composition of the coatings was estimated by secondary ion mass spectrometry. It has been found that an increase in the intensity of nitrogen ion irradiation of a carbon nitrogen-containing coating results in an increase in its electrical conductivity, decreases in internal stresses, density, and modulus of elasticity, and also changes in the structure and morphology of the surface. In an additional experiment with a thin a-C:N layer the absence of nitrogen diffusion in a-C during annealing at the temperature up to 1000^{o}C was confirmed.

Key words: ta-C, vacuum arc deposition, nitrogenated ta-C, ion irradiation

1 Introduction

Diamond-like carbon (DLC) coatings, also known as amorphous carbon (a-C), are attractive for microelectromechanical systems (MEMS) [1] and biomedicine [2]. The structure and properties of DLC coatings can be varied in wide limits by doping with nitrogen, which opens up the possibility of obtaining new functional coatings. The addition of nitrogen to an amorphous DLC coating matrix results in higher electrical conductivity [3-5] and emission characteristics [6], a more developed surface relief [4,7], lower residual stresses [4,8], and modified mechanical properties [4,9].

If DLC coatings are obtained by the vacuum arc deposition method, their doping is typically carried out by filling the vacuum chamber with the nitrogen gas, the dissociation and ionization of molecules of which occur directly in the flow of highly ionized carbon plasma [3, 5, 7]. The partial nitrogen pressure is varied from 10^{-7} to 10^{-2} mbar. In [4,9], the N_2 gas was fed into the chamber by using a radio-frequency ion beam source, and an ionized gas flow with ion energy of 0 - 1000 eV was obtained at the output. The incident angle was set at 30° to the normal of the substrate. Abnormally high hardness and modulus of elasticity obtained by the nanoindentation method were observed at a nitrogen ion energy of 100 eV. When the ion energy was further increased, these properties became poorer. In [8], another approach to controlling the coating properties was used. It involved studies of the effect of a negative accelerating potential