Amorphous hydrogenated carbon thin films deposited by segmented hollow cathode (Invited talk)

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Abstract

Diamond-like carbon (DLC) is a metastable form of amorphous carbon with attractive properties such as high hardness, low friction, chemical inertness and high wear resistance. From a physicochemical point of view, the fraction of sp3 sites, the nature and the energy of sp3 bonds and the amount of hydrogen influence the morphology and properties of DLC thin films. Amorphous carbon hardness is principally due to strong non-hydrogenated sp3 bonds. In fact, the relationship among mean energy of ionic species, sp3 fraction and mechanical properties has been widely studied. Several experimental measurements showed that a maximum of sp3 bonds takes place in ion energies between 80 and 120 eV, yielding the amorphous carbon thin films with the highest hardness values [1].

In this work, amorphous hydrogenated carbon (a-C:H) thin films were deposited using a simple, low cost and efficient pulsed DC - plasma-enhanced chemical vapor deposition technique provided by a segmented hollow cathode arrangement [2]. The samples were characterized by Scanning Electron Microscopy, Energy Dispersive X-Ray Spectroscopy, Raman Spectroscopy, Nanoindentation measurements, Elastic Recoil Detection Analysis, and Glow Discharge Optical Emission Spectroscopy. a-C:H thin films are homogenous in terms of carbon and hydrogen contents along the film. According to Raman spectra, the thin film hardness depends linearly on both G peak position and ID/IG ratio. Moreover, the hardness depends on the working conditions such as power supply voltage and total working pressure. The sample with the highest hardness (14 GPa) was obtained by a voltage of 800 V and a pressure of 15 Pa. There are no significant changes on hardness when the proportion of methane is varied. Finally, a physical scattering model is proposed to estimate the mean

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ion energy of carbonaceous species arriving on a-C:H thin films as a function of processing parameters as pressure and voltage. This model allows to develop a relationship between the mean ion energy of carbonaceous species and the hardness of thin films and provides a simple and powerful tool to estimate the final hardness of a-C:H thin films, in particular those with properties of DLC, as a function of processing parameters.

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S. Corujeira Gallo, Â. E. Crespi, F. Cemin, C. A. Figueroa, and I. J. R. Baumvol, IEEE Transactions on Plama Science, 39 (2011) 3028-3032.

Keywords: amorphous carbon, hardness, scattering model, pressure, voltage