EFFECT OF PRECURSOR FLOW RATE ON PHYSICAL AND MECHANICAL PROPERTIES OF a-C:H:SIO_X FILMS DEPOSITED BY PACVD METHOD[1]

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Amorphous silicon-carbon (a-C:H:SiO_x) films have recently attracted considerable attention due to their wide range of technological uses. Typically, such films consist of two interpenetrating structures - diamond-like a-C:H and SiO_x, which makes them a new class of diamond-like materials [1, 2]. a-C:H:SiO_x films have attracted large interest mainly because of their unusual mechanical, tribological, optical, and electrical properties, comparable with the characteristics of diamond like coatings [3-6]. One of the main advantages of a-C:H:SiO_x films are low internal stresses (less than 1 GPa), which allow forming films with a thickness of a few tens of micrometers with good adhesion [7]. The most common method for the formation of a-C:H:SiO_x films is PACVD with RF bias voltage. However the deposition on large area substrates makes the industrial application of RF PACVD processes difficult. From this point of view it is more advantageous to use impulse bipolar plasma technologies, because they allow working at higher power, compared to RF discharge and without matching networks.

The present work is devoted to the study of the effect of precursor (polyphenylmethylsiloxane, PPMS) flow rate on the physical and mechanical properties of a-C:H:SiO_x films formed by plasma-chemical deposition using the bipolar bias voltage applied to the substrate. The deposition method is described in detail in [8]. Deposition of a-C:H:SiO_x films was carried out on single-crystal silicon substrates. The surface morphology of the obtained films was studied using atomic force microscopy; the semi-quantitative ratio of sp^3- and sp^2-hybridized carbon atoms in the film was determined by Raman spectroscopy and FTIR spectroscopy. It is shown that an increase in the PPMS flow rate from 35 to 287 μl/min leads to an increase in the film growth rate from 17 to 220 nm/min, while the hardness of the obtained films varies slightly and is 14±0.8 GPa. The elastic recovery of thin films under a normal load applied during nanoindentation is evaluated and it is equal to 90-96% at a load of 2 mN, and 71-75% at a load of 20 mN. Using a-C:H:SiO_x film on the stainless steel substrate and on the substrate made of VT1-0 titanium alloy allowed to reduce the friction coefficient from 0.55 to 0.095 and from 0.37 to 0.097, respectively. At the same time, the wear rate decreased from $0.6\cdot10^{-3}$ to $4.9\cdot10^{-6}$ $mm^3/N\cdot m$ and from $1.3\cdot10^{-3}$ to $6.6\cdot10^{-6}$ $mm^3/N\cdot m$, respectively.

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