XPS and nano-mechanical properties of hybrid a-C:H and a-C:H:Si films

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Abstract

In this study hydrogenated amorphous carbon (a-C:H) and silicon doped hydrogenated amorphous carbon (a-C:H:Si) films were deposited onto Si wafers. The deposition was carried out using a combination of closed field unbalanced magnetron sputtering ion plating (CFUBMSIP) and plasma enhanced chemical vapour deposition (PECVD) in Ar/C_4H_{10} plasma at low bias voltage (-30V). The films were characterised by x-ray photoelectron spectroscopy and nano-indentation methods. XPS survey scans for the films showed the contributions from C 1s (~285 eV), O 1s (~531 eV), Si 2p (~100 eV) and Si 2s (~151 eV). C-Si (C 1s) and Si-C (Si 2p) configurations corresponding to bonding between carbon and silicon atoms in SiC were observed. The sp^3/sp^2 ratio was higher for the a-C:H:Si film compared to a-C:H film. Nano-indentation results show that all of the films tested had the same order of properties with hardness values of approximately 3.6GPa and Elastic modulus of 35GPa. The low hardness values were attributed to the use of butane gas as a precursor and CFUBMSIP at low bias voltages (-30V) resulting in a-C:H and a-C:H:Si films with polymer like chains.

Keywords: *a-C:H; a-C:H:Si; X-ray photoelectron spectroscopy; Nano-hardness; Elastic modulus*