Alumina Precipitation in a-C:H Films by Plasma Immersion Ion Implantation and Deposition

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Abstract

A new plasma methodology for the deposition of films from aluminum acetylacetonate, AAA, is proposed. Instead of diluting the powder of AAA in isopropyl alcohol it was placed directly inside the reactor and sputtered by argon plasma. Once in the plasma phase, molecules and fragments of the AAA are activated and deposited upon ion bombardment. It was investigated the effect of the pulse magnitude, P, on the properties of the resulting layer. Depositions were conducted spreading 0.8 g of the compound directly on the lowermost electrode of a stainless steel vacuum chamber. Glass, polished stainless steel and carbon steel plates were attached to the upper electrode. The system pressure was lowered down to 4.0 Pa and argon was introduced (11 Pa). Argon plasma was then generated by the application of radiofrequency power (13.56 MHz, 150 W) to the lowermost electrode, while biasing the sample holder with high voltage negative pulses of different amplitudes. It was investigated the effect of the pulse magnitude (600 – 2800 V) on the properties of the films. All the five different depositions were conducted for 3.600 s. Thickness of the films was measured by perfilometry and their chemical structures were evaluated by infrared reflectance-absorbance spectroscopy. Roughness and wettability were determined by atomic force microscopy profiles and contact angle data, respectively. Surface morphology and chemical composition were analyzed by the association of scanning electron microscopy and energy dispersive spectroscopy. Thickness of the films increases as pulse magnitude is enhanced from 600 to 1200 V, and keeps practically constant after that. Infrared spectra reveal the presence of organic groups by the bands around 2920 (C-H), 1700 (C=O), 1550 (C=C), 1400 (C-H3) and 1300 cm-1 (C-CH3) as well as of the hydroxyl functional by the contributions around 3400 and 1160 cm-1. Incorporation of alumina was detected by the absorptions at 1030 (Al=O), 770 (Al-O) and 650 cm-1 (AlO6). As a general trend, the intensity of the bands related to alumina groups rises while those ascribed to organic functional falls with increasing P. Films are moderately hydrophilic with contact angles around 60◦. Roughness increases with P up to 2500 V but suddenly falls with further increasing P. As the concentration of alumina rises in the layer, cracks are generated in the structure. A discussion based on the total energy delivered to the film by ion bombardment is presented to interpret the results.

Keywords: alumina precipitation, PBIID

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