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Structure and density profile of diamond-like carbon films containing copper: study by X-ray reflectivity, transmission electron microscopy, and spectroscopic ellipsometry

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Abstract

Diamond-like carbon nanocomposite thin films containing Cu (DLC:Cu) were deposited employing high power pulsed magnetron sputtering. A mixture of argon and acetylene gases was used. Deposition conditions were varied to produce DLC:Cu nanocomposite films with different Cu content, ranging from 13.6 to 48.8 at.%. The films demonstrated multilayered structure that was characterized by energy-dispersive X-ray spectroscopy (EDS), X-ray reflectivity (XRR), transmission electron microscopy (TEM), spectroscopic ellipsometry (SE) and optical spectroscopy. The results show that tandem analysis of the results obtained by different methods for DLC:Cu nanocomposite films can be modeled as a structure having ten distinct layers. This ten-layer model was used to fit the measured SE and XRR data. The roughness and thickness of the films were measured. Information about copper content, material density, refractive index, extinction and copper volume concentration profiles in a direction normal to the surface of DLC:Cu films was obtained. The thickness values and Cu distribution along the film agreed with were found to agree well with the results obtained employing TEM, EDS and XRR, SE methods.