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Nanocrystalline/amorphous Biphase Enhanced Mechanical Properties in Multilayer Carbon Films

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Abstract

This study reports the nanostructure evolution and mechanical properties improvement in the nanocrystalline/amorphous multilayer carbon films. Electron cyclotron resonance sputtering and electron/ion alternative irradiation techniques were used to deposit the multilayer carbon films with the total film thicknesses ranging from 130 to 10 nm and the single layer thicknesses ranging from 4 to 1 nm. The high resolution transmission electron microscopy observation showed that the interface between nanocrystalline layer and amorphous layer evolved from an original toothed structure to a mixed biphase structure, and the nanocrystallite size in nanocrystalline layer decreased when layer thickness was reduced from 4 to 1 nm. The nano-indenter tests showed a significant improvement in hardness of multilayer film when single layer thickness was reduced from 4 to 1 nm. The scratch tests revealed that good scratch resistance could be preserved in the multilayer film with 1 nm single layer thickness when total film thickness was only 10 nm. This work may shed light on the ultrathin multilayered coating technology.

Keywords: multilayer carbon film; ultrathin single layer; interface structure; mechanical properties