Materials Science & Engineering Thesis Defense

Synthesis and Characterization of Sputter Deposited BN and Cu/BN Multilayer Thin Films

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Abstract

"This thesis presents a study of the Boron Nitride (BN) and Copper (Cu)/BN multilayer thin film in terms of synthesis, chemical, structural, morphological, and mechanical properties characterization.

In this study, the influence of Ar: N2 flow rate in synthesizing stoichiometric BN thin films via magnetron sputtering was investigated initially. Post magnetron sputtering, the crystalline nature and B: N stoichiometric ratio of deposited thin films were investigated by X-ray diffraction (XRD) and X-ray Photoelectron Spectroscopy (XPS) respectively. Thicknesses revealed by ellipsometry analysis for stoichiometric B: N thin films and their corresponding deposition times were used for estimating BN inter layer deposition times during the deposition of Cu/BN multilayer thin films. To characterize the microstructure and chemical composition of the synthesized Cu/BN multilayer thin films, XRD and scanning electron microscopy/energy dispersive spectroscopy (SEM/EDS) have been used. Finally, a comparison of nanoindentation measurements on pure Cu, Cu/BN multilayer thin films having different number of BN interlayers were used for studying the influence of BN interlayers on improving mechanical properties such as hardness and elastic modulus.

The results show that the stoichiometry of BN thin films is dependent on the Ar: N2 flow rate during magnetron sputtering. An optimal Ar: N2 flow rate of 13: 5 during deposition was required to achieve an approximately 1:1 BN stoichiometry. Grazing incidence and powder XRD analysis on these stoichiometric BN thin films deposited in room temperature did not reveal a phase match when compared to hexagonal boron nitride (h-BN) and cubic boron nitride (c-BN) reference XRD patterns. For a BN thin film deposition time of 5 hours, a thickness of approximately 40 nm was achieved, as revealed by ellipsometry. XRD and microstructure analysis using scanning electron microscopy (SEM) on pure Cu and Cu/BN thin films showed that the Cu grain size in Cu/BN thin films is much finer than pure Cu thin films. Interestingly, nanoindentation measurements on pure Cu and Cu/BN thin films having a similar overall thickness demonstrated that hardness and young's modulus of pure Cu was improved by several folds when BN interlayers are present. "

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