

UNH Materials Science Seminar

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DeMeritt Hall 238

University of New Hampshire

Dependence of Fiber Texture on Composition in Au-SiO₂ Composite Thin Films

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As an integral part of electronic, magnetic and optical devices, thin films control the performance of these devices through their properties. Numerous studies have explained that the microstructure of thin films holds the key answer for the mechanical and physical properties that thin films might exhibit. We explored characterization of thin film microstructure on gold-silica composite thin films through x-ray diffraction pole figures, which represents an effective non-invasive method. Development of crystallographic texture in Au-SiO₂ metal-insulator composite materials consisting of crystalline grains (Au metal) and an amorphous matrix (SiO₂ insulator) has a strong dependence on composition. Changing composition across a metal-insulator thin film results in changing microstructure and changing resistivity.

For very low SiO₂ volume fractions less than 0.05, the Au has low resistivity and a strong (111) fiber texture similar to that of pure Au. For higher SiO₂ volume fractions up to 0.3, the strength of the fiber texture decreases rapidly with increasing volume fraction of SiO₂ second-phase particles, and the resistivity increases. For SiO₂ volume fractions greater than 0.3, the fiber texture is lost as the Au becomes discontinuous and the microstructure changes to randomly oriented Au islands within an insulating matrix of SiO₂, confirmed by resistivity and transmission electron microscopy measurements. We show that the rapid decrease in Au (111) fiber texture strength is consistent with a reduction in Au grain size caused by Zener pinning of Au grains by second-phase SiO₂ particles. Grain boundary pinning by second-phase particles prevents the development of (111) fiber texture that usually occurs during normal grain growth. The result is a more rapid loss of fiber texture as a function of composition than can be explained only by the decreasing Au volume fraction.