PRINCETON
Mechanical & Aerospace Engineering

Wednesday, March 15, 2017
EQUAD Rm J223
12:30 PM

# Advanced Instrumentation and Fabrication Techniques for Understanding the Mechanical Behavior of Thin Films

*Thin films are widely used as functional and structural elements in micro-electronic devices, large-scale integrated circuits, thin-film solar cells, electrical sensors, and electronic textiles. Therefore, understanding the mechanical behavior of thin films at different length scales and environmental conditions is essential for the design of reliable devices. However, it is difficult to precisely measure the properties of small-scale materials with the methods that are employed for bulk materials; probing micro/nano scale samples is challenged by the inherent difficulties associated with fabricating and handling of extremely small specimens. Advanced instrumentation and manufacturing techniques with enhanced characterization capabilities are required to better understand the properties and deformation mechanisms of technologically relevant materials.*

*In this presentation, I will introduce experimental studies utilizing micro/nano scale manufacturing to understand the mechanical behavior of thin films and to develop metallic alloys for metal MEMS applications. Measurements at elevated temperatures are performed through use of a custom-built in-situ SEM mechanical tester and two silicon-based micro heaters that support the sample and allow us to study the mechanical behavior of Cu, Au, ZrB2, and Pd-based metallic glass thin films at temperatures up to 740°C. The second topic is on the mechanical behavior of sputter deposited NiMoW alloy thin films annealed at various temperatures. NiMoW alloy thin films will be shown to be linear elastic to 3.1 GPa as-deposited, and can be heat-treated to result in 9% plasticity while maintaining a yield strength of 1.25 GPa. This brittle to ductile evolution suggest that sputtering and subsequent heat treatment offers an attractive route for developing metallic MEMS materials with tailorable mechanical properties, e.g. linear-elastic with ultra high strength or ductile with high strength and superior toughness.*

*Gi-Dong Sim is a research scientist at Johns Hopkins University working under guidance of Professors Kevin Hemker and Jaafar El-Awady. Before joining JHU, he studied at Harvard University and KAIST under guidance of Professor Joost Vlassak and Professor Soon-Bok Lee. His research is focused on developing experimental techniques and fabricating devices (nanocalorimetry, microheaters, etc.) to test the thermal mechanical behavior of materials at small-scales and in different environments, on the development of advanced metallic alloys and devices for high temperature metal MEMS applications, and on elucidating high temperature deformation mechanisms of single crystalline and polycrystalline materials.*