## Advanced Characterization Techniques for Coatings, Thin Films, and Small Volumes
## Room Town & Country A - Session H3-2-WeM

### Characterization of Coatings and Small Volumes in Extreme and Cyclic Conditions II

**Moderators: Prof. Dr. Peter Hosemann**, University of California, Berkeley, USA, **Prof. Dr. Barbara Putz**, Montanuniversität Leoben, Austria

8:00am **H3-2-WeM-1 Characterizing Interfacial Straining Mechanisms Using High Temperature *in situ* Tem*, Shen Dillon,*** University of California Irvine, USA **INVITED**

Thin film stress relaxation can depend strongly on interfacial strain mechanisms, particularly at grain boundaries within the film and at the film-substrate interface. Diffusion dependent strain, i.e that requiring atomic fluxes, is typically assumed to be diffusion rate limited, and in some cases, rate limited by the emission and absorption of point defects at sources and sinks. The process could also be rate limited by the nucleation of interfacial line defects that mediate climb during the atomic flux. This latter process has largely been ignored within the literature, since it is assumed to require large stresses. The nucleation rate limited kinetic mechanism can stabilize large stresses and exhibits discontinuous stress relaxation. The other mechanisms, diffusion and point defect emission/absorption limited, relax stress continuously. Appropriately identifying the correct mechanism is, therefore, of significant importance for understanding stress evolution in thin films. The work presented in this talk demonstrates the use of high temperature *in situ* transmission electron microscopy (TEM) based mechanical testing applied to characterizing the strain mechanisms active at bicrystal grain and phase boundaries. These experiments indicate that interfacial strain kinetics are nucleation rate limited up to large stresses, and that creep at low stresses in polycrystals results from stress concentration effects. Models for bulk and local interfacial creep are discussed. The strain behavior at and around metal-oxide interfaces is discussed as an example relevant to many thin film applications. These systems are interesting because metal-oxide tensile strain is extremely unfavorably, while interfacial sliding is facile. Such factors must be accounted for to understand microstructural changes occurring during interfacial stress relaxation.

8:40am **H3-2-WeM-3 Quantitative in Situ TEM Observations of a Grain-Boundary-Migration-Assisted, Radiation-Damage Healing Mechanism in Ultrafine Grained Au Thin Films*, Lina Daza,*** *S. Stangebye, K. Ding, X. Liu, T. Zhu, J. Kacher, O. Pierron,* Georgia Tech, USA

The plastic deformation mechanisms of ultrafine grained gold thin films (average grain size of 150 nm) irradiated with 2.8 MeV Au+ ions at three different levels (0.1, 1 and 5 dpa) have been studied using quantitative *in-situ* transmission electron microscopy (TEM) nanomechanical testing. This technique allows for the simultaneous observation and comparison of the active deformation mechanisms, measurement of mechanical properties and true activation volume.Some of the observed deformation mechanisms include dislocation nucleation at grain boundaries (GB), dislocation pinning/de-pinning at irradiation induced defects, and stress-induced GB migration. During the early stages of deformation, dislocation nucleation and GB migration occur simultaneously. However, the dense populations of irradiation-induced defects prevent transgranular dislocation motion. As the deformation levels increase, GB migration leads to defect-free zones which then provide avenues for unimpeded dislocation glide. The true activation volume increases from ~$10b^3$ in unirradiated specimens, to ~$22b^3$ in irradiated specimens at 1dpa, for flow stresses ranging from 400 to 550 MPa.

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