Influence of Grain Boundary Chemistries in Mix-mobility Thin Film Growth

B. Fu, W. An, C. H. Turner and G.B. Thompson

Thin films exhibit compressive-tensile-compressive stress states during the nucleation of islands, coalescence of islands and post-coalescence stages of growth. Using an in situ wafer curvature measurement technique, the stress evolution in Fe-Pt alloy thin films has been investigated. The stresses were shown to be compositionally dependent. In general, the tensile or compressive stress for the various binary compositions was associated with whichever element enriched the grain boundaries. Under specific growth conditions, a 'zero-stress' state could be achieved. The as-deposited alloy stress states do not show significant stress recovery upon ceasing the deposition. Upon annealing, the magnitude of the compressive stress state is reduced with increase in order parameter and is explained in terms of reduced adatom surface migration. Density functional theory calculations were performed to quantify the possible diffusion pathways and binding energies for Fe and Pt on a {111} $L1_0$ surface. Upon ceasing deposition, the post-growth stress relaxation rate increased with order parameter and is explained in terms of an increase in interfacial energy contribution at the grain boundaries formed by chemically ordered grains. XRD, TEM, and atom probe tomography have been employed to quantify the phase, grain size and grain boundary chemistries, respectively, as they relate to the preferential segregation and thin film stress measurements.