Identifying the Origins of Heterogeneity in Ultra-thin Films by LEEM-IV Analysis*

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Thin films play a key role in many technologies. Applications range from promoting chemical reactions at surfaces, preventing interdiffusion, and electrical isolation to more exotic ones in nanotechnology, where reduced dimensionality gives rise to unique electronic or magnetic properties. One particularly important issue in the growth of ultra-thin films is controlling compositional heterogeneity. It is well known that films can be inhomogeneous, but determining exactly *how* and *why* heterogeneity develops is extremely difficult. In general, understanding how the three-dimensional composition profile of the film evolves with time is required. Historically, this information has been difficult to come by. Techniques that are capable of accurately determining subsurface structure and composition -- electron and x-ray diffraction -- implicitly assume a laterally homogeneous film. Techniques with high spatial resolution, e.g. scanning probe microscopies, typically have poor chemical sensitivity. In this talk I will describe spatially resolved electron diffraction measurements that overcome these limitations. Using this "LEEM-IV" approach we have measured the time evolution of the 3D composition profile of a generic miscible surface alloy: Pd/Cu(001) [1]. We show that heterogeneity during the growth of Pd on Cu(001) arises naturally from a generic step-overgrowth mechanism that should be relevant in many thin-film growth systems.

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