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Measuring 3D Alloy Composition Profiles at Surfaces

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A key challenge in thin-film growth is controlling structure and composition. Of particular importance is understanding how and why atomic-scale heterogeneity develops during growth. We have used low-energy electron microscopy (LEEM) to measure how the three-dimensional composition of an alloy film evolves with time at the nanometer length scale. By quantitatively analyzing the reflected electron intensity in LEEM, we determine the alloy composition and structure, layer by layer near a surface, with 9 nm lateral spatial resolution. As an example, we show that heterogeneity during the growth of Pd on Cu(001) arises naturally from a generic step-overgrowth mechanism that is likely to be relevant in many growth systems. This work was performed in collaboration with Jiebing Sun (UNH), Karsten Pohl (UNH), and Gary Kellogg (Sandia Labs).