Three-Dimensional Concentration Profiles at Surfaces Measured Using LEEM

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Heterogeneity is a serious problem encountered in almost every heteroepitaxial growth system. Controlling heterogeneity requires understanding alloying at an atomic scale. However, in order to determine the key kinetic processes responsible, it is necessary to accurately measure surface structure and composition with high temporal and spatial resolution. This is a difficult proposition, even for modern surface analytical techniques such as STM. We have developed a novel analysis approach [1-2] that allows us to measure the evolution of the 3D composition profile of an alloy surface in real time. We do this by quantitatively analyzing the image intensity in low-energy electron microscopy (Fig. 1). We have measured the composition of a CuPd surface alloy, during growth, with 8.5 nm lateral resolution and monolayer depth resolution. From the 3D composition profiles, we have identified a generic step-overgrowth mechanism that leads to inherent alloy heterogeneity at steps. Heterogeneity is traced to the difference between bulk and surface diffusion of Pd. Furthermore, Monte Carlo simulations are described to reproduce the time evolution of the compositional heterogeneity and give support to the step-overgrowth model.

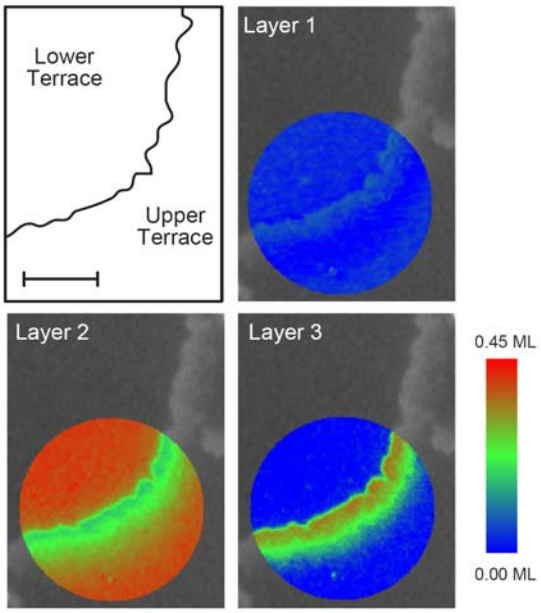

Fig. 1. Three-dimensional map of the Pd concentration near a surface step. The images were constructed from the analysis of 17,665 individual pixels and show the concentrations in the first three surface layers after deposition of 0.45 ML of Pd (27 min) at 200 °C. The spatial resolution is 8.5 nm. The maps are superimposed on the corresponding LEEM image at 13.1 eV. Scale bar, 500 nm.

References:
[1] Sun, J., Hannon, J. B., Kellogg, G. L. & Pohl, K., Phys. Rev. B **76**, 205414 (2007).
[2] Hannon, J. B., Sun, J., Pohl, K. & Kellogg, G. L., Phys. Rev. Lett. **96**, 246103 (2006).

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