Anomalous Mass Transport in the Pb Wetting Layer on the Si(111) Surface


An exceptionally fast and unusual mass transport behavior has been discovered in the dense Pb wetting layer on the Si(111) surface. A convection-like mass transport has been observed, which is unprecedented at crystalline surfaces. Such anomalous mass transport is believed to facilitate the remarkably efficient self-organization of uniform height Pb quantum islands on Si(111) that was reported on widely in the past.

Mass transport is studied by observing non-equilibrium coverage profile evolution using low energy electron microscopy. The initial coverage step profile produced by laser induced thermal desorption (LITD) propagates rapidly at a constant velocity and with unperturbed shape. This differs significantly from the classical behavior which is characterized by profile broadening and gradual approach to equilibrium uniform distribution.

A model that attributes this nonclassical equilibration behavior to the diffusion of thermally generated adatoms on top of the wetting layer can account for the observed convection-like mass transport.

The profile equilibration time, $\tau$, exhibits (a) a dramatic coverage dependence, characterized by an exceptionally sharp divergence below a critical coverage and (b) a very weak temperature dependence corresponding to an activation energy of 0.15 eV. Model predictions are indicated by solid red lines.