SAND2006-5887P

Advanced Scanning Probe Microscopies

Research Interests

Primary research interests are in the area of kinetics and thermodynamics of nanoscale structures – bridging length scales from atoms to microns – with an emphasis on developing a fundamental understanding of mass transport processes and the stability of nanostructures.

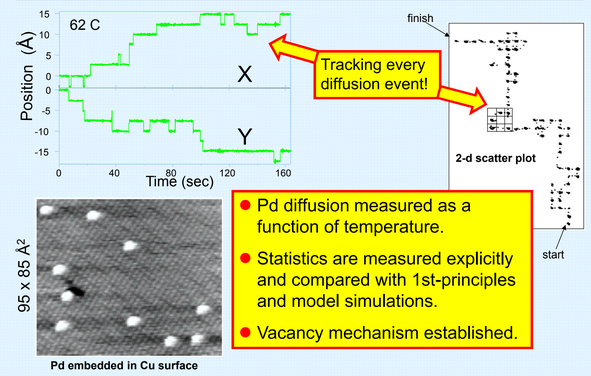
Current research activities focus on the determination of atom diffusion processes and their implications for the growth and mobility of larger structures. Examples include the initial stages of nucleation and growth of Ge/Si alloy structures and their pathway to 3-d quantum dot formation, and the atomic diffusion of Pb and Pd atoms in the copper alloy surface leading to a rich variety of concentration-dependent self-assembled surface structures on the nanometer length scale.

Additional research activities include developing novel implementations of scanning-probe-like instruments for direct and precise nanomanipulation for top-down construction of unique nanostructures, for 3d-electronics, sensor, and 'NEMS' applications.

Atom-Tracking Scanning Tunneling Microscopy

While atom tracking, the probe tip of the STM is locked onto a selected feature using two-dimensional lateral feedback. Once locked, the feedback electronics maintain the tip over the feature as it diffuses over the substrate tracking its coordinates. Because the STM spends all of its time measuring the diffusion, atom tracking increases the time resolution a factor of one thousand over conventional imaging.

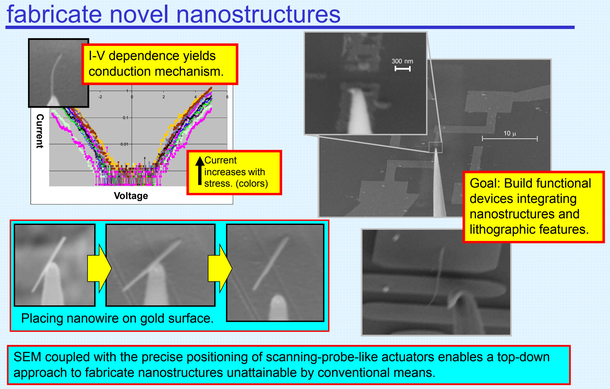
Diffusion of Pd in Cu(001) surface is determined to be vacancy mediated.



Scanning-Probe Based Nanomanipulation

We are building a scanning-probe based nano-manipulator inside of a scanning electron microscope for top-down construction and characterization of unique nanostructures. This tool enables not only direct and precise control over the placement of individual nanostructures, but also of their position with respect to each other – an ideal unattainable by present means.

Scanning-probe control to study, manipulate, and fabricate novel nanostructures

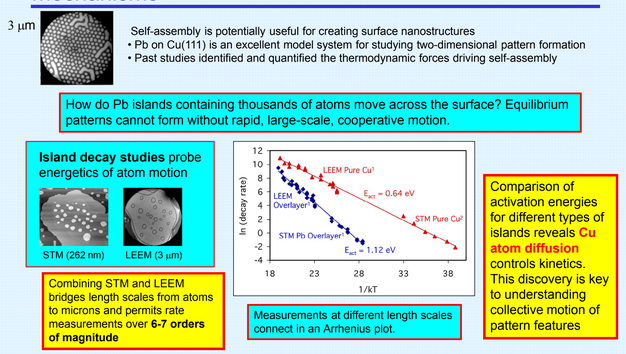


SEM coupled with the precise positioning of scanning-probe-like actuators enables a top-down approach to fabricate nanostructures unattainable by conventional means.

Combined Low-Energy Electron Microscope / Scanning Tunneling Microscope

LEEM is a parallel imaging (non-scanning) electron microscope used to study nanoscale phenomena on surfaces with a spatial resolution of 7-8 nm and a depth resolution of single atomic layers. STM is a scanning-probe microscope used to examine structural and electronic properties on an atomic scale. LEEM and STM are ideal complementary tools, accessing a wide span of time, temperature, and length scales. Their combination in a single instrument makes bridging of length scales a reality.

Bridging length scales to understand self-assembly mechanisms



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