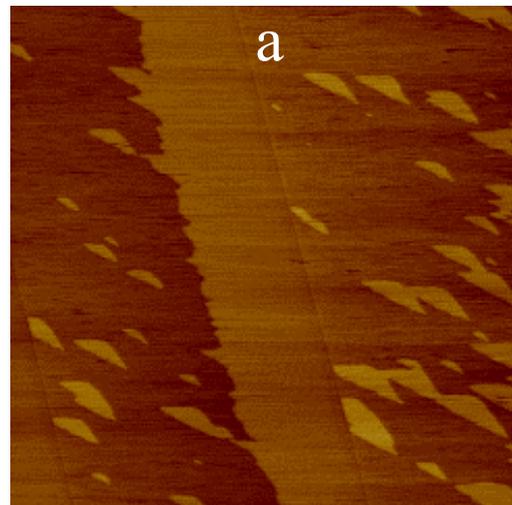


Discovering the Mechanisms of Liquid Phase Epitaxy and Bringing
Intermolecular Forces to the Physics Curriculum (2004)
Srinivas Manne, University of Arizona, DMR-0094385

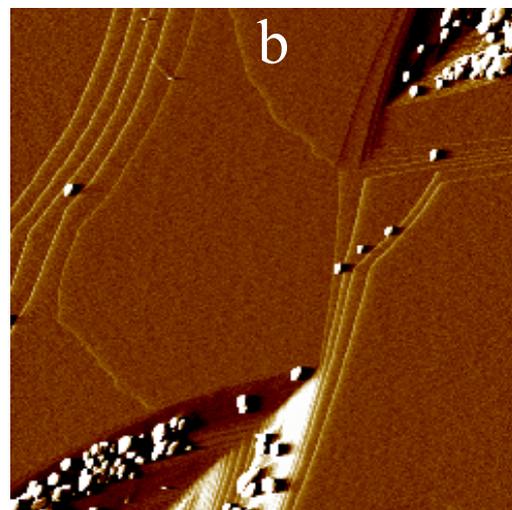
The aim of this research is to discover how solid surfaces cause molecular ordering in an adjoining liquid, and how this ordering affects the properties of the interface. An important special case is the trapping of metal pollutants by mineral surfaces in freshwater streams.

Atomic force microscope images show strikingly different growth patterns for two sulfate minerals: SrSO_4 on BaSO_4 (**a**) vs. the converse case BaSO_4 on SrSO_4 (**b**). In (**a**), the smaller overgrowth lattice can stretch to match the larger substrate lattice, resulting in 2D wetting growth that adheres to the substrate mineral. In the converse case (**b**), ion size limitations prevent the the larger overgrowth lattice from shrinking to match the substrate; the result is 3D non-wetting growth that can be easily dislodged by solvent flow.

The absorption of metal pollutants from water solutions is therefore best accomplished by solid lattices large enough to accommodate the pollutant ions.



5 x 5 micron AFM image showing 2D triangular islands of SrSO_4 growing on BaSO_4



5 x 5 micron AFM image showing 3D “chunks” of BaSO_4 (white spots) growing at SrSO_4 steps

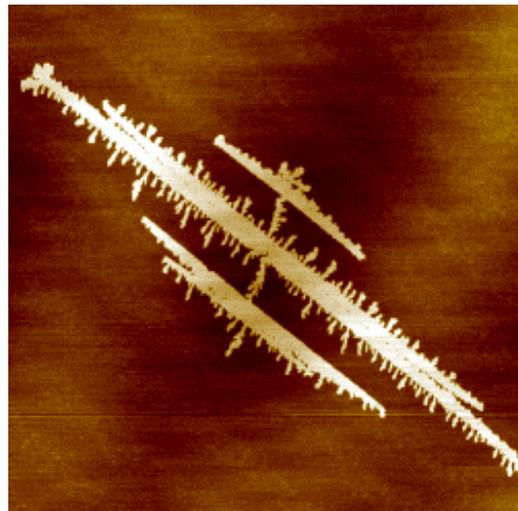
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Educational Activities:

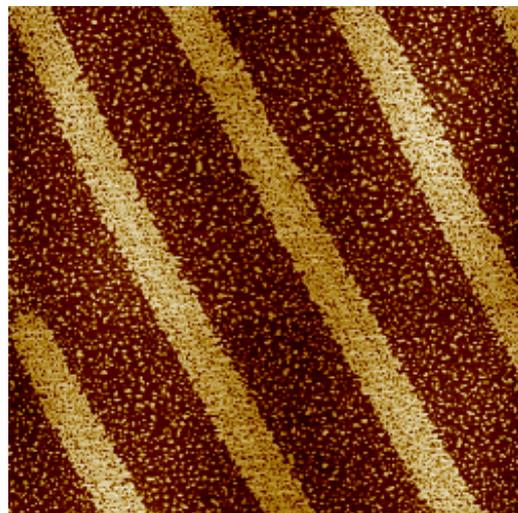
The PI taught an interdisciplinary graduate course on intermolecular forces and self-assembly, which attracted 24 students from four departments on campus. Student grades were based on independent experimental work, using an AFM purchased and installed for this purpose. Roughly half of these students were women.

NSF funds were used to train two undergraduate and two graduate students in the PI's research lab; three of the four researchers were women.

The figure at right shows AFM images of stamped monolayers on mica, obtained by an undergrad (Anneliese Schmidt) and a grad student (Rick Workman) from the PI's research group. **(a)** Long-chain molecules transfer along water menisci adjacent to stamp contact areas, resulting in "fingering" transport away from a single source. **(b)** Shorter-chain molecules transfer by vapor phase and surface diffusion, resulting in solid bars at the contact areas and island nucleation in between.



25 x 25 micron AFM
image of stamped
docosanol (C_{22})
monolayers on mica



10 x 10 micron AFM
image of stamped
stearic acid (C_{18})
monolayers on mica