University of Maryland NSF-MRSEC Highlight:

Capturing Atomic Spirals

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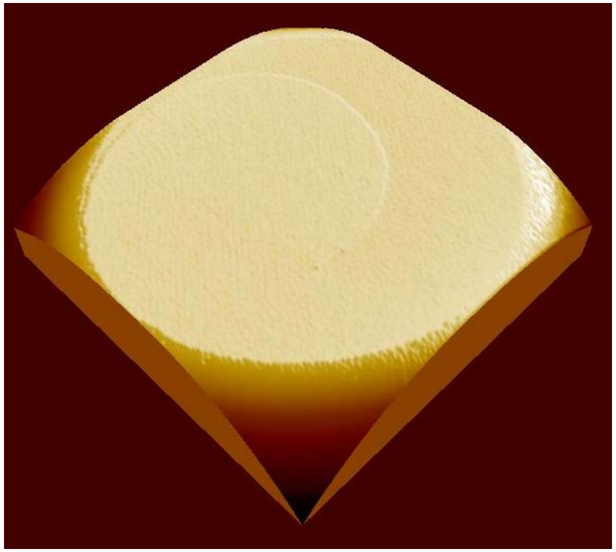
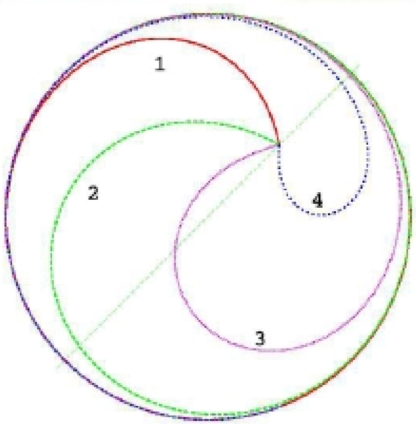
Defect structures serve as nucleation sources that allow growth and evolution of structure at temperatures far lower than perfect crystalline structure would allow. Screw dislocations, which form spiral growth/etch patterns when they evolve freely on a thin film surface, are the classical example of this behavior. Nanoscale crystalline structures provide a mechanism for capturing the spiraling dislocation within the boundaries of the nanostructure. Such a trapped trapped structure no longer can spiral freely, and instead develops a periodic structure with a highly non-uniform angular frequency. Very simple physical phenomena - the free energy of a curved interface, and the Brownian motion of atoms at the dislocation edge, suffice to model the behavior quantitatively.





Evolution of structure

Top right: Top facet of a micron-diameter lead crystallite contains a screw dislocation that unwinds with a period of about 23 minutes to merge with the crystallite walls.

Bottom left: Time lapse images (t = 0, 9, 17 and 21 minutes) of the unwinding spiral are superimposed to show the pattern evolution. The calculated evolution of the structure matches quantitatively, including the near-discontinuous jump from position 4 to position 1.