DISLOCATION NETWORKS IN S/2ML Cu/Ru(0001): PHASE TRANSITIONS BETWEEN NANOSTRUCTURES IN ULTRA-THIN FILMS

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Elastic relaxations at surfaces can create ordered nanostructures. A classic example is misfit dislocations in ultra-thin films that occur to relieve the misfit between the in-plane lattice parameters of substrate and film. Such dislocation networks have been used as templates to pattern the growth of additional material. The dislocation networks can be modified by changing the film thickness: a model system is ultra-thin layers of Cu on Ru(0001) -- 2 ML Cu forms a striped pattern while 4 ML Cu forms a hexagonal (moiré-like) pattern. The experimentally observed patterns of the Cu/Ru system have been explained within rigid-substrate models (i.e., Frenkel-Kontorova) where lateral interactions die exponentially [1]. But the observed patterns can be completely modified by adsorption of additional elements such as sulfur [2] -- the precise dislocation network observed depends on a delicate equilibrium between the film's interaction with the substrate and within the film itself.

In this work, we have used Low Energy Electron Microscopy (LEEM) to explore the effect that sulfur has on the patterns formed by 2ML of Cu on Ru(0001) (see Fig. 1). When exposed to sulfur, the stripe pattern of clean 2ML Cu is sequentially transformed to two patterns with hexagonal symmetry (see Fig. 2 where the electron diffraction pattern of one of them is show). Upon heating, these hexagonal patterns convert back to a stripe pattern. We follow this transformation, which is reversible, with temperature in real time both in real space, using dark-field imaging, and in reciprocal space, using area-selected diffraction patterns. We will show how the high temperature stripe phase with Sulfur differs from the clean Cu phase. We propose that S changes the dislocation network by changing the overall surface stress of the film.

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[1] J. C. Hamilton and S. M. Foiles, *Phys. Rev. Lett.* **75** (1995) 882.
[2] J. Hrbek et al, *J. of Phys. Chem.* **48** (1999) 10557.

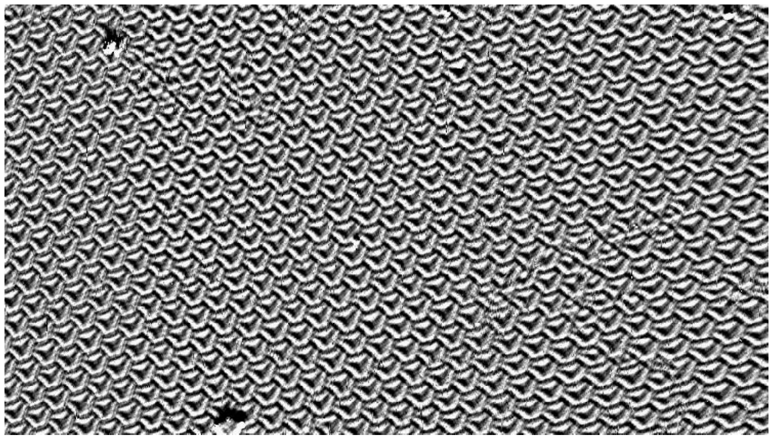

Fig. 1: 140 nmx200 nm STM image of an ordered S/2ML Cu/Ru(0001) structure

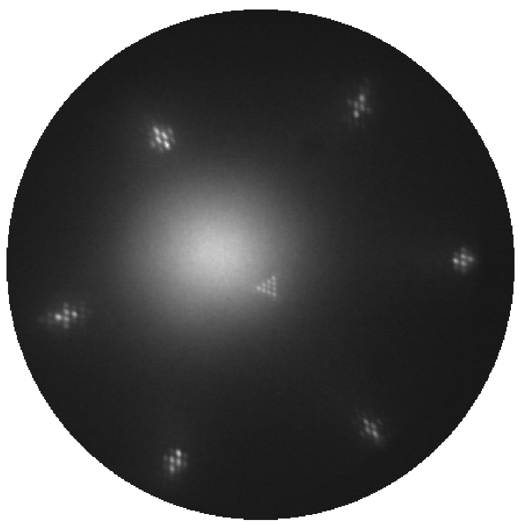

Fig. 2: Low Energy Electron Diffraction pattern of a S/Cu/Ru structure at 45.5eV, taken with LEEM.