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Self-Assembly of Nanoscale Hexagons in S/Cu/Ru(0001)[1]

A. P. Baddorf
Oak Ridge National Laboratory
H. Zajonz and Doon Gibbs
Brookhaven National Laboratory

Periodic structures on a nanometer length scale exhibit unique dynamics and forces, and offer a template for ordering of quantum dots. Recently, Hrbek, et al.,[2] have shown that small quantities of S adsorbed on the two layer Cu/Ru stripe phase react at dislocations, shorten stripes, and produce a quasi-hexagonal structure. We have examined the growth of this structure and its dependence on temperature with synchrotron x-ray diffraction.

Deposition rates were determined by monitoring the intensity at the specular anti-Bragg position (similar to RHEED oscillations). After S deposition of up to 0.2 ML at room temperature, no new diffraction was observed, even after annealing. This is consistent with the results of Hrbek, et al., who found poor order in STM images. For deposition between 100 and 200°C, additional reflections were observed corresponding to a quasi-hexagonal lattice with a periodicity of approximately 44 Å. This structure persisted when the sample was cooled to room temperature. Long range order was indicated by narrow peak widths, 0.009 $Å^{-1}$ FWHM, corresponding to a correlation length of over 700 Å. Heating above 200°C reduced and broadened the diffraction wavevector, indicating a larger, less ordered lattice. Above 300°C, the quasi-hexagonal diffraction pattern disappeared leaving only diffraction from the linear Cu/Ru stripe phase. This process was reversible, so that cooling below 300°C returned the hexagonal pattern. We interpret this as a melting of the S induced structure.

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2. J. Hrbek, J. de la Figuera, K. Pohl, T. Jirsak, J. A. Rodriguez, A. K. Schmid, N. C. Bartelt, and R. Q. Hwang, J. Phys. Chem. B 103, 10557 (1999).