Phase transitions and thermal defects in Bi/Cu(111): true hard hexagon behavior

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We have combined surface X-ray diffraction (SXRD) data [1] and low-energy electron microscopy (LEEM) movies to investigate the atomic structure and pattern formation in the Bi/Cu(111) system. Deposition of submonolayer amounts of Bi on Cu(111) leads to the formation of a two-phase system consisting of a surface alloy phase and an overlayer phase that forms patterns similar to those previously observed in the Pb/Cu(111) system [2-4]. In our LEEM movies, the patterns however exhibit several dramatic changes that are unseen in Pb/Cu(111).

The origin of the changes in the patterns can be pinpointed to changes in the atomic structure of the two phases. In this presentation, we will specifically focus on the creation of thermal defects and how the presence of these defects affects the morphology of the self-assembled structures. Critical behavior of the surface alloy phase leads to a spectacular change in the thermodynamic parameters that govern the pattern formation. The change in parameters is accompanied by an equally spectacular change in the appearance of islands in this system, as shown in the two figures to the side. The ensuing redistribution of Bi is imaged and the newly formed patterns are quantitatively analyzed using LEEM movies.

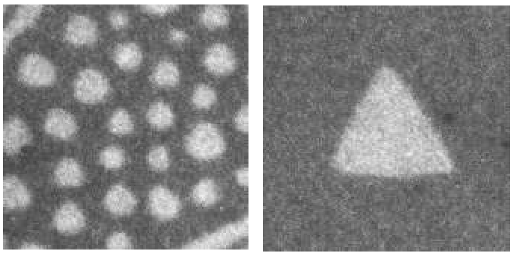

Figure: LEEM images of Bi overlayer islands (bright) on Cu(111). Left image shows a stable ensemble of circular islands formed at T = 632 K. The right image shows the triangular island that has formed after heating to T = 685 K. Field of view is 0.63 µm

We employ the hard hexagon model [5] to interpret the nature of the phase transition and the changes in the thermodynamic parameters. In our analysis we find that the Bi/Cu(111) system exhibits near-perfect hard hexagon behavior and the predicted value for the hard-hexagon critical coverage is recovered from our experiments.

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