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Geometric structure of strained Cu and Ag films on Ru(0001)

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We present an x-ray scattering study of the interfacial structure of thin Cu and Ag films on Ru(0001) surfaces. Our results give new insight into the mechanisms of strain accommodation at these bimetallic interfaces. The origin of the strain arises from a lattice mismatch accompanying epitaxy with a 5.8% tensile stress for Cu and a 6.3% compressive strain for Ag. For the bilayer stripe phase of Cu on Ru, we provide the first detailed crystallographic description in terms of a set of 3D modulation functions [1]. Our analysis shows that both Cu layers consist of Cu chains which are approximately sinusoidally displaced transverse to the [100] direction thereby producing stripes of faulted hcp and fcc stacking. The resulting model shows that strain in Cu films is strongly inhomogeneous and that the top Cu layer appears to be less strained than the interfacial Cu layer. Ag accommodates the strain through a 2D reconstruction that consists of a hexagonal network of dislocations which separate patches of hcp and fcc stacking on the surface. In both cases, the strain relaxation is accompanied by an increased ad-layer density. For Cu, we find that the stripe phase is 6.3% denser than a pseudomorphic Cu layer but is still 5% less dense than in Cu bulk. In contrast to this, the reconstructed Ag film differs only 1.5% in its density in comparison to an equivalent layer in Ag bulk.

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