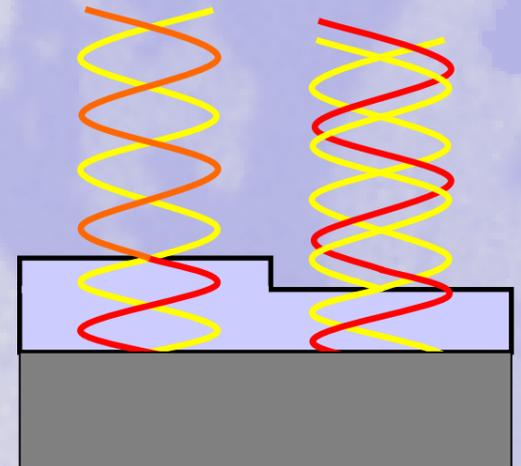


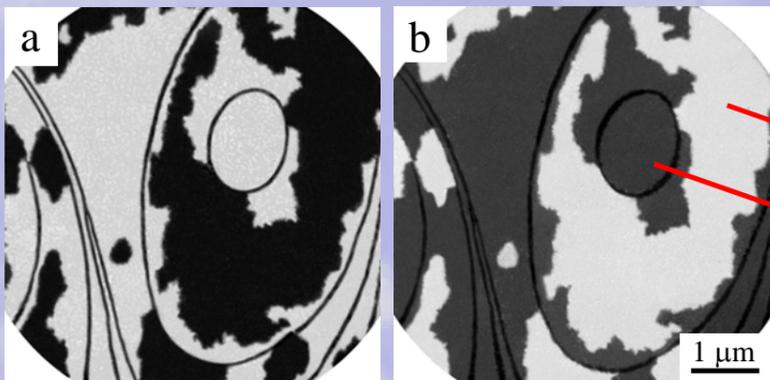
Quantum Effects in Low Energy Electron Microscopy:

A 3D View of Nanostructure

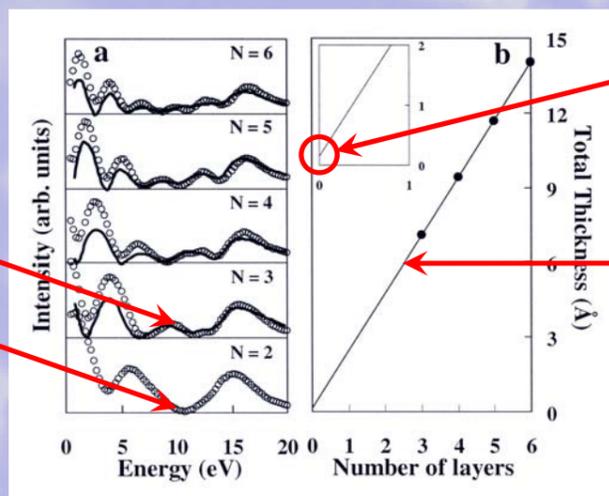
The properties of thin films exhibit remarkable quantum size effects (QSE) due to the discrete quantum well (QW) states that are caused by electron confinement. Measurements of the elastically reflected electrons from thin films also often reveal intensity peaks at very low energy that are associated with quantum well resonances above the vacuum level. Lateral resolution of this QSE with low energy electron microscopy (LEEM) provides a three-dimensional view of thin film nanostructures.



Layer Spacings in Coherently Strained Epitaxial Metal Films



The QSE in electron reflectivity is manifested vividly in LEEM as **quantum size contrast** between regions of different film thickness. Strained Ag films on a W(110) surface are shown at (a) 5.8 eV and (b) 9.8 eV.

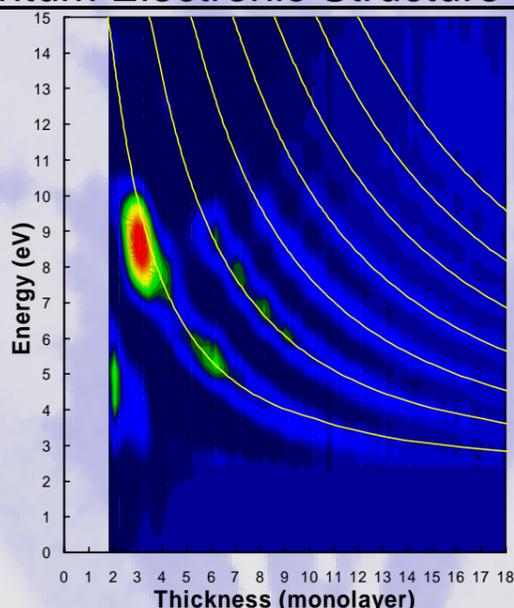


Buried interface spacing
 $a_{\text{int}} = 2.47 \pm 0.05 \text{ \AA}$

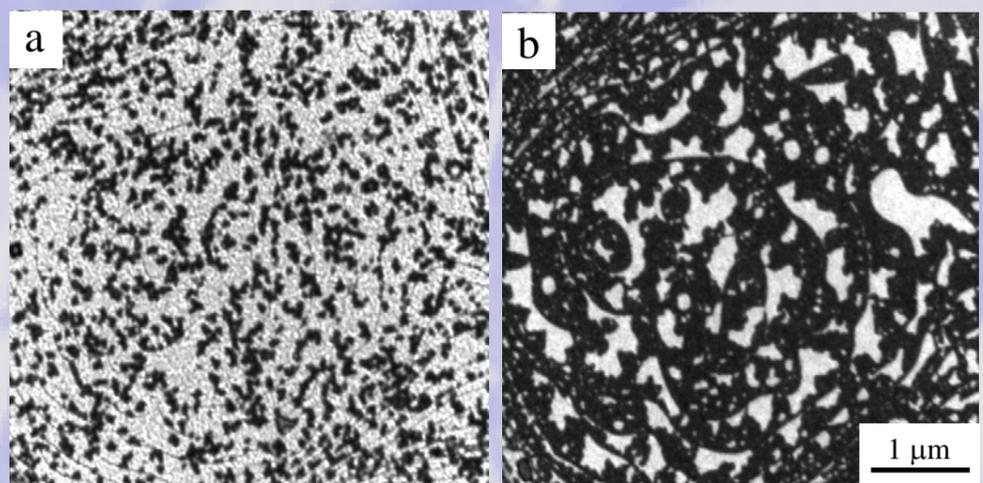
Strained layer spacing
 $a_{\perp} = 2.32 \pm 0.05 \text{ \AA}$

A non-destructive probe of buried interfaces: (a) The reflected intensity is determined experimentally (o) and by dynamical multiple scattering calculations (solid lines) for N-layer thick films. (b) This analysis provides information on the total film thickness, the strained layer spacing and the buried interface layer spacing.

Quantum Electronic Structure and Thermal Stability of Ag/Fe(100)



A **phase accumulation model** analysis (solid lines) of QW resonance intensity peaks for Ag films on the Fe(100) surface provides information on unoccupied band structure above the vacuum level.



The morphology of Ag films on Fe(100) is dominated by 2 layer (bright) and 5 layer (dark) regions following thermal decomposition of an initially uniform (a) 3 layer film, (b) 4 layer film. The stability of these thicknesses is governed by minima in the global energy landscape that are defined by QW states at the belly of the Ag Fermi surface in the [100] direction.

References

1. W.F. Chung, Y.J. Feng, H.C. Poon, C.T. Chan, S.Y. Tong and M.S. Altman, Physical Review Letters **90**, 216105 (2003).
2. "Quantum Effects in Low Energy Electron Microscopy: A 3D View of Nanostructure", Invited Talk at the March Meeting of the American Physical Society, 2004.