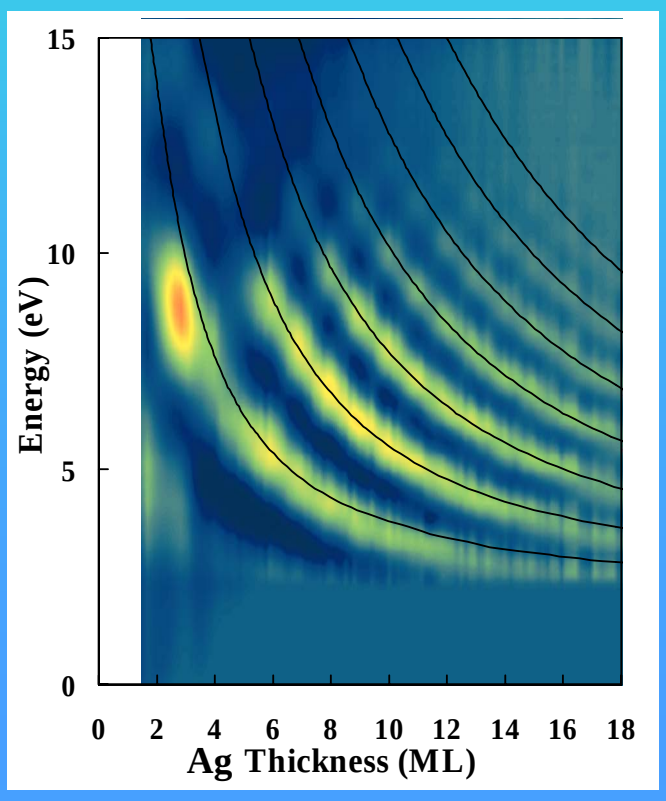
Metallic Quantum Well States and Resonances

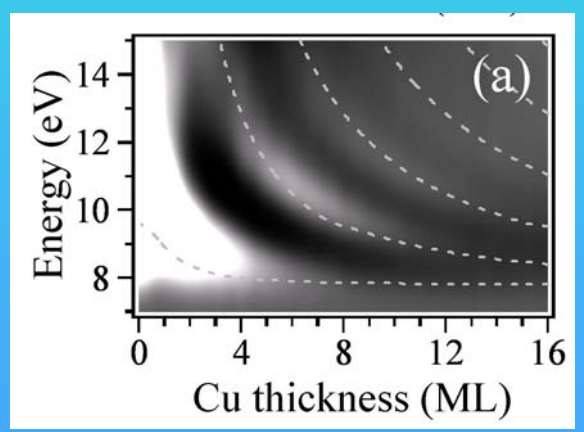
(★) K.L. Man, Z.Q. Qiu and M.S. Altman, Phys. Rev. Lett. **93**, 236104 (2004).
Y.Z. Wu, A.K. Schmid, M.S. Altman, X.F. Jin and Z.Q. Qiu, Phys. Rev. Lett. **94**, 027201 (2005).
(★) selected for the Virtual Journal of Nanoscale Science & Technology, vol. 10, issue 24 (2004), (http://www.vjnano.org/).

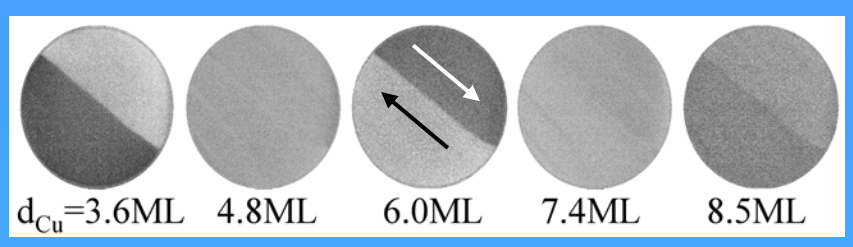
Quantum well (QW) states that are formed due to electron confinement in ultrathin metallic films can have a remarkable impact on film properties. Corresponding QW resonances involving electrons above the vacuum level have been identified and investigated with low energy electron microscopy (LEEM) and spin polarized LEEM.



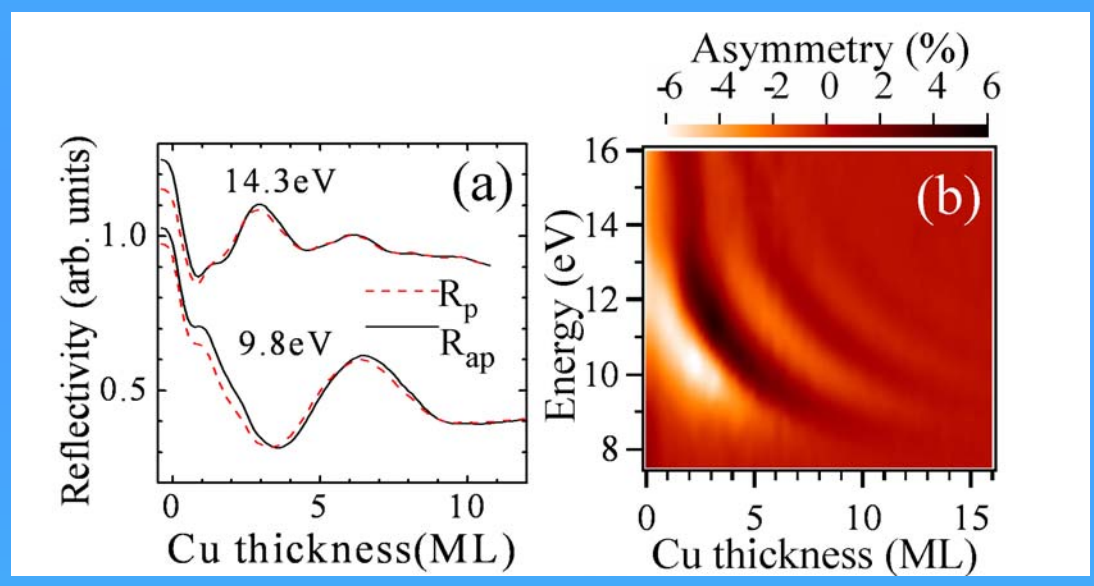
QW resonance conditions (energy, thickness) for Ag/Fe(100) (left) and Cu/Co/Cu(100) (right) are understood by the phase accumulation model.

Spin-dependent electron reflectivity at the Cu/Co interface leads to spin-dependent Fabry-Pérot electron interference in the Cu film.

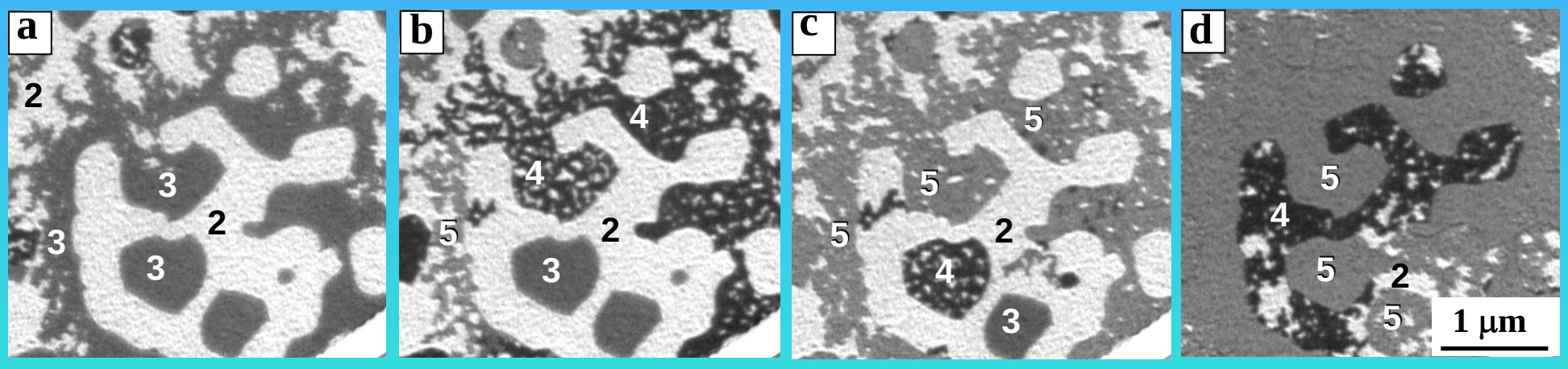




SPLEEM images of Cu/Co(5ML)/Cu(100) at 11.3 eV demonstrate the spin-dependent Fabry-Pérot interference of the Cu film. (Arrows indicate magnetization direction)



(a) Spin-dependent electron reflectivity from Cu/Co(5ML)/Cu(001). (b) Spin-asymmetry of the spin-dependent electron reflectivity.



QW resonances are used to monitor film morphology with LEEM during annealing and growth of Ag films on an Fe(100) surface. The equilibrium morphology is dominated by thicknesses that are stabilized by QW states at the $\bar{\Gamma}$ point. Novel growth morphologies are also observed that highlight the competition between kinetic limitations and the QW state energetics that dictate the equilibrium morphology. (Figure: Morphological evolution of Fe/Ag(100) during growth at 455K; integer atomic layer thicknesses are indicated.)