Incipient Plasticity During Indentation of a Well Characterized 3 Nanometer Radius Tip

GRAHAM CROSS, SFI Trinity Nanoscience, ANDRE SCHIRMEISEN, Universitat Munster, PETER GRUETTER, McGill University, URS DUEBIG, IBM Research Zurich — We present the results of nanoindentation testing of a well characterized tip geometry with a spatial scale easily matched by existing atomistic simulation. The atomically defined tungsten asperity of 3 nm radius was fabricated and imaged by field ion microscopy and brought into contact with a Au(111) terrace in ultra-high vacuum conditions. The mechanical evolution of the asperity contact under cyclic indentation testing was monitored by a simultaneous load-displacement and electrical current-displacement measurement. Load displacement curves of the pristine surface showed multiple discrete plastic (“pop-in”) events during loading, with energies consistent with the nucleation of individual defects. During unloading, we observe reverse plasticity and complete self-healing of the induced defect. Both the qualitative behaviour and measured energy dissipation values are in agreement with recent molecular dynamics simulations of incipient plasticity in metallic asperity contacts.

Graham Cross
SFI Trinity Nanoscience

Date submitted: 01 Dec 2004