17: Local deformation and mechanical properties by nano-indentation

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Objectives :

To study quantitatively local mechanical properties and to interpret the load / displacement / stiffness data of the contact in relation with the material. Experiments are carried out on a dedicated nanoindenter and an AFM under ambient conditions.

Access to SEM-FEG and TEM is provided for complementary observations.

Various materials are studied: ionic crystals, metals, semiconductors and amorphous solids (metallic and oxyde).

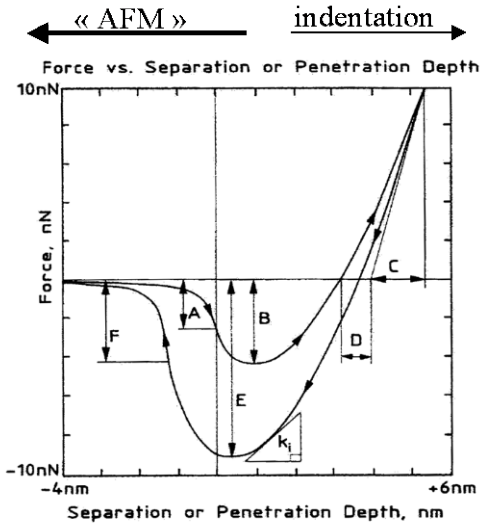
Different boundary conditions are proposed : indentation size effect, thin film (metallic and nanoporous dielectric (Ultralow k), multilayer geometry, patterned lines ...)

Content :

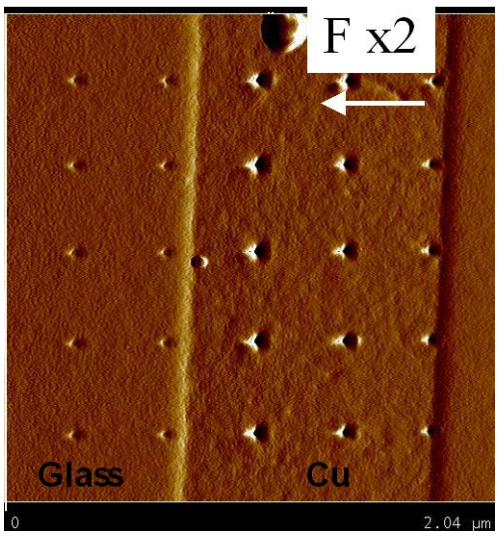
- Phenomenology of contact mechanics, reversible and irreversible processes.
- Measurements principle: elastic contact modelling, indenter tip geometries, defects generations
- Frame, tip and lever calibration and coupling Nanoindenter, AFM
- Case studies *(à la carte*):

  « Bulk material »: elastic contact, threshold for defect nucleation, plastic deformation (effect of creep), phase transformation, fracture. (NaCl, MgO ; Au, Al, Cu, Zn; Si, SiC; SiO2, Zr-bulk metallic glasses)

  « Boundary conditions »:
  thin film of variable thickness, patterned lines (300nm-3µm) Cu/SiO2, metallic multilayers (2-100nm period), ULK nanoporous films, free standing beam.



Force-Distance scheme



Cu / SiO2 patterned lines and matrix of increasing loads.