

Modelling Contact between Metal Surfaces

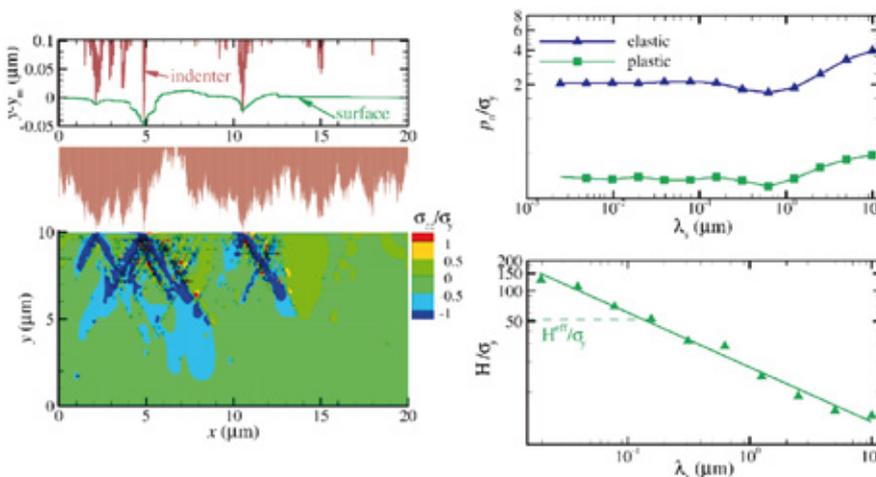
Metal surfaces, even when visually flat, have a self-affine rough character, with roughness spanning several decades in length scales. When metal bodies are pressed against each other, they touch only at the summits of surface asperities. The contact stresses are therefore very large even at moderate applied load and give rise to plastic deformation.

Keeping track of the deforming contact area and of the consequent change of contact stresses during loading is of great technological importance because it allows to understand and control phenomena such as friction, wear, adhesion, fretting, and contact fatigue. However, experimentally, it is very challenging to measure local changes in contact area, given that metal surfaces are non-transparent.

While there is an abundance of numerical models to study contact between elastic bodies, little attention was so far devoted to plasticity. The Computational Materials Science group has developed a novel computational technique called Green's Function Dislocation Dynamics that can be used to study the plastic deformation of metal bodies with self-affine rough surfaces. Plasticity in the body is modeled considering the collective motion of the individual dislocations in the bodies, described analytically. The image fields of the dislocations are calculated using Green's Function Molecular Dynamics, a boundary element method, which relies on damped dynamics in Fourier space to find the static equilibrium solution of elastic contact problems.

Simulations are performed while changing the main parameters of the surface roughness, i.e., root-mean-square height, Hurst exponent, fractal discretization. The aim of the work is to gain understanding in how plastic deformation affects the contact area, contact pressure and hardness, gap profile and subsurface stresses, while the roughness of the surface is changed.

Plastic deformation is found to be more pronounced for surfaces with larger root-mean-square height and/or Hurst exponent, and to be size dependent. Contact hardness is found to be much larger than what reported by classical plasticity studies. Primarily, this is caused by limited dislocation availability.



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There are currently several vacancies in the group.



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Main research topics:

- Multi-scale Modeling
- Mechanics of Materials
- Computational Methods
- Modeling of Failure for Brittle and Ductile Materials
- Micromechanics of Defects
- Phase Transformations
- Contact and Friction
- Structural Batteries