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Mechanical properties of faceted nanoparticles – A comparative experimental and simulation study

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In recent years, several experimental schemes were suggested to study the mechanical properties of nanometric metallic structures, which are found to be very different from those of bulk samples. In this talk I will present a new experimental scheme, in which we study by nanoindentation the mechanical properties of defect-free single crystalline metallic nanoparticles, obtained employing the dewetting process of thin metal films deposited on sapphire. Nanoindentation experiments reveal that the deformation compliance of the larger nanoparticles increases with decreasing particle size, i.e. the strength is size dependent. With the aid of molecular dynamics (MD) simulations, we show that the deformation is controlled by dislocation nucleation near the tip, followed by fast dislocation glide toward the surface. The nucleation and evolution of dislocations within the particle, as well the force acting on the indenter, is analyzed during the indenter penetration into particle. In the case of a cubic-corner punch, no strain hardening was observed in the simulations, as opposed to the case of thin film indentation. This is explained by the confinement of nucleated dislocations within the specimen, and their interactions close to the substrate.

Mercredi 30 juin 2010 à 10h30

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