Theoretical strength under multiaxial loading

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The theoretical strength represents an upper limit to the envelope of attainable stresses and its knowledge enables us to assess the gap remaining to upper strength values of advanced engineering materials. Another reason for the TS investigation is that it plays a crucial role in the fundamental theory of fracture. Most of the theoretical strength calculations were performed for simple loading modes, given by a single non-zero stress (or strain) tensor component as uniaxial or isotropic tension or simple shear. On the other hand, crystals and whiskers used in the industrial exploitation are usually subjected to multiaxial loading.

This talk will focus on two particular examples of a superposition of simple loading modes: a tensile loading along [001] axis in cubic crystals under superimposed transverse stresses and a shear loading under superimposed normal stress. A typical example of the former case is a stress induced by the matrix/reinforcement incompatibility strain on the reinforcing single crystal fiber (or whisker) in a composite material. The fibers are subjected to triaxial loading even in case of the remote (purely uniaxial) tension of the composite. The influence of stress applied perpendicularly to slip planes during shear deformation of a crystal on the shear strength is also important in many deformation processes. As an example, one can consider a nanoindentation process as a combination of shear and compressive deformations in the vicinity of an indentor.

Results of the above mentioned studies were obtained from atomistic modeling using first principles computational code based on pseudo-potentials and plane wave basis set.