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# Measuring surface dislocation nucleation in defect-scarce nanostructures

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# MEASURING SURFACE DISLOCATION NUCLEATION IN DEFECT-SCARCE NANOSTRUCTURES

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Linear defects in crystalline materials, known as dislocations, are central to the understanding of plastic deformation and mechanical strength, as well as control of performance in a variety of electronic and photonic materials. Despite a thorough understanding of dislocation structure and their interactions, measurements of the energetics and kinetics of dislocation nucleation have not been possible, as synthesizing and testing pristine crystals absent of defects has been prohibitively challenging. In this talk, experiments that directly measure the surface dislocation nucleation strengths in high quality <110> Pd nanowhiskers subjected to uniaxial tension will be presented. We find that, whereas nucleation strengths are weakly size- and strain-rate-dependent, a strong temperature dependence is uncovered, corroborating predictions that nucleation is assisted by thermal fluctuations. We measure atomic-scale activation volumes, which explain both the ultrahigh athermal strength as well as the temperature-dependent scatter, evident in our experiments and well captured by a thermal activation model. Modeling of the probabilistic nature of surface dislocation nucleation suggests activation energies consistent with surface self-diffusion as the rate-limiting step needed to promote displacive activity. In this context, approaches allowing for modification of the surface chemistry and structure of metallic nanostructures to either inhibit or enhance surface diffusion will be discussed.