Deformation and Failure Behavior of Nanowires and Nanolattices

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Nanolattice, an architected structural meta-material, is instrumental in creating lightweight, strong, and damage-tolerant engineering materials. The reliability of nanolattice is often dictated by the mechanical properties of its truss components such as nanowires and nanopipes and its defects, such as notches and voids. An in-depth understanding on the effects of intrinsic factors such as grain boundaries and surface roughness and extrinsic factors such as size, shapes and man-made notches of its components on the plastic deformation mechanisms and failure patterns is of great importance in fabricating nanolattice with high reliability. In addition, the effects of defects such as notches and voids and also testing temperature on the failure behavior of nanolattices remain unexplored. In this talk, we will report our recent progresses in the study of the effects of intrinsic factors such as grain boundaries and surface roughness and extrinsic factors such as sizes, shapes and man-made notches, on the plasticity and failure of nanowires using both nanomechanical testing and molecular dynamics simulations. We will then report our recent work on the effect of temperature and component size on the deformation and failure of nanolattices under compression using both nanomechanical testing and molecular dynamics simulations. Finally, we discuss the effect of notch on the failure behavior of nanolattices under tension using both nanomechanical testing and finite element modeling. These works explore the size effect, testing conditions and flaw sensitivity of nanolattices and their components, using both experiments and simulations, and demonstrates various interesting and unique features of the architected structural meta-materials.