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Editorial for the focus issue on "Nanomechanics" in Extreme Mechanics Letters

Materials with nanoscale features exhibit different mechanical properties from their bulk counterparts. This holds true not only for nanostructures (surface-dominant structures such as 1D and 2D nanostructures), but also for nanostructured materials (e.g. nanocrystalline or nanotwinned materials) as well as biological materials with nanoscale components (e.g. DNAs, proteins and cells). Nanomechanics has received extensive interests in recent years, motivated by the emergence of materials with nanoscale features, novel mechanics phenomena at the nanoscale and mechanics-driven applications of such materials.

In this special issue, we present twenty papers including one perspective paper and nineteen research papers. It starts with the perspective paper by Wang and Mao that summarizes recent progress in *in-situ* transmission electron microscopy study of mechanical properties, deformation and failure of nanostructures and nanostructured materials. Future research needs and opportunities on *in-situ* nanomechanics were discussed.

The nineteen research papers can be grouped into four categories. The first category of papers focuses on nanostructures. Atomistic simulations such as molecular dynamics (MD) simulations have been playing a central role in revealing the deformation mechanisms of nanostructures. Bitzek and co-workers reported formation of wedge-shaped twins in face-centered-cubic (FCC) metal nanowires under bending, which might lead to pseudoelasticity upon removal of the bending depending on the bending direction. Godet et al. found that a hard amorphous shell can suppress the localized plasticity in a crystalline metal core, leading to a homogeneous plastic deformation in the core–shell nanowire. Ni et al. studied the effect of the stress anisotropy on evolution of the core–shell nanowire morphology, pointing out a possible way to tailor morphologies of core–shell nanostructures. It remains challenging to measure the mechanical properties of individual nanostructures. Innovative experimental methods have been developed recently, among which a promising one is based on microelectromechanical systems (MEMS). Gupta and Pierron developed a MEMS-based nanomechanical testing method for monotonic and stress relaxation tests of thin Au films. Yong Zhu and his group discussed the origin of the size-dependent Young's modulus of penta-twinned Ag nanowires. The authors developed a new experimental method, by conducting two experiments of different loading modes on the same nanowire, to decipher the relative roles of surface and interior on the nanowire elasticity. Using a MEMS-based testing platform, Shroff and de Boer investigated the velocity dependence of friction in a micromachined interface consisting of nanometer-scale asperities. Galiotis and co-workers presented a combined theoretical and experimental study on the compression behavior of simply-supported and fully-embedded monolayer graphene.

The second category of papers centers on nanostructured materials. Deng and Sansoz reported a new form of pseudo-elasticity in small-scale nanotwinned metals when twin boundaries are oriented at a special angle. Xu and Demkowicz demonstrated crack healing under external mechanical loading in nanocrystalline Pd, which was attributed to microstructurally-induced internal stresses. Gradient nano-grained metals are emerging recently with spatial gradients in the grain size. Ting Zhu and co-workers found both gradient stress and gradient plastic strain in the cross section of gradient nano-grained Cu under axial tension, which arise as a result of progressive yielding of grains with different sizes. Greer and co-workers investigated the microstructure and mechanical properties of a type of high entropy alloy that consists of both body-centered cubic (BCC) and FCC phases. Spolenak and colleagues discovered that plastic anisotropy in decagonal quasicrystales can be considerably reduced and even eliminated at sub-micrometer scale and room temperature. Kiener and co-workers performed miniaturized fracture experiments *in-situ* in a scanning electron microscope, coupled with finite element simulations, to determine the fracture toughness of individual films in a trilayer thin film system. So et al. reported a strategy to significantly enhance plastic flow strength while retaining tensile ductility in a nanocomposite — uniformly dispersing carbon nanotubes in the metal matrix.

In addition to engineered materials, nanomechanics also plays a key role in biological materials. The third category of papers showcases two examples where nanomechanics governs the biological properties and functions. Park and his group reported force-dependent unfolding pathways and intermediate configurations of the green fluorescence protein using novel atomistic simulations based on potential energy surface exploration. Knoll and Saif investigated the cell force relaxation excited by light, which was found to consist of short, sudden relaxation events.

The last category of papers deals with mechanics-related applications of nanostructures and nanostructured materials. Han and co-workers reported a study on the bending fatigue of Ag nanowire network, which provides valuable insights to the reliability of Ag nanowire based stretchable electronics. Jia and Li reported a comprehensive study on the formation and morphologic evolution of the charging/discharging induced

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wrinkling in a substrate-supported thin film anode, which can provide design guidelines for material selection and service condition towards optical anode performances. Kraft and co-workers investigated the influence of annealing on the mechanical properties of polymer micro-truss structures and suggested insights for optimizing their mechanical properties including stiffness, strength and toughness.

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