Frontiers in Applied Mechanics

TRANS-SCALE MECHANICS OF SOLIDS AND STRUCTURES

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Dr. Yueguang Wei is a Professor at the State-Key Laboratory of Nonlinear Mechanics (LNM), Institute of Mechanics, Chinese Academy of Sciences (CAS). He received his Ph.D. degree from Tsinghua University. He then joined the Institute of Mechanics, CAS, and Harvard University as Post-Doctoral Research Fellow. He has held faculty positions at LNM, Institute of Mechanics, CAS. He also had stints as visiting scientist at Harvard University, University of California at UCSB and Riverside.

Research Interests

Trans-scale Mechanics of Solids and Structures; Micro-scale Mechanics of Materials and Size Effect; Mechanics of Thin Film Delamination; Surface and Interface Mechanics; Strain Gradient Plasticity; Multi-scale Computational Mechanics; Composite Mechanics; Elastic-plastic Fracture Mechanics; etc.

Achievements & Honors

Dr.Wei has obtained several national science awards for his research achievements: Two Second Grade Awards of the National Natural Sciences of China, One Third Grade Award of the National Natural Sciences of China. Dr. Wei is a "Bai-Ren Plan" Scholar of the CAS and an Outstanding Young Scholar of the National Science Foundation of China. He obtained several honorable awards including the Young Scientist award of CAS and the Young Science and Technology award of China. He is on the editorial board of a few journals: Engineering Fracture Mechanics; International Journal of Applied Mechanics; Acta Mechanica Sinica; Acta Mechanics Solida Sinica; Chinese Physics Letters; Multidiscipline Modeling in Materials and Structures; etc.

Trans-Scale Mechanics of Solids and Structures

Dr. Wei has been working on the trans-scale mechanics of solids and structures. Advanced materials are usually designed and made based on the microscopic structures, and their mechanical behaviors at macroscopic scale are closely depended on the status of the microstructures. This phenomenon of the mechanical behaviors is called the trans-scale mechanics. Regarding the research on the trans-scale mechanics, there exist two methods, called "Top-Down Method" and "Bottom-Up Method", respectively. Dr. Wei has been adopting both methods in his research on the trans-scale mechanics problems. In the following we introduce Dr. Wei's achievements in his research.

i) Built a theoretical framework of the trans-scale mechanics based on the "Top-Down Methods"

In this study, the transient deformatio and numimplementation for large deformation kinetics of polymeric gels has been studied using the finite element method (FEM). The neutral and environmental sensitive hydrogels are investigated. Depending on the constituents, the polymeric gels are able to deform under the excitation of various external stimuli, such as temperature, Solved two key puzzles of both “negative fracture strength” and “no finite element methods which can be used” encountered in establishing strain gradient plasticity theories. Established a compressible Fleck-Hutchinson-type strain gradient plasticity and for the first time proposed a new finite element method which takes the pure derivatives of displacements as the basic variables and is suitable for the strain gradient plasticity theories. This new finite element method was evaluated “very well” by other authors in their citations. The achievement has played a central promotion role for successfully establishing strain gradient theories and making them widely used. Put forward a concise Taylor-type relation of micro-hardness for microstructured materials through systematically experimental research, and successfully characterized microindentation size effects for this kind of materials. The presented Taylor-type relation was evaluated by Singapore researchers as “elaborated functions covering surface-nanocrystallized materials” compared with Nix-Gao function, and is adopted worldwide.

ii) Carried out a systematical research on the trans-scale mechnicas based on the “Bottom-Up Methods”, and displayed the mechanisms of interaction between partial dislocations with twin and grain boundaries

The details of the formation of stacking faults and deformation twins were unveiled via systematic MD simulations to clarify the mechanical behavior in NC- and nano-twinned metals as well as in nanowires. We obtained several new findings on the strengthening and toughening of nanostructured metals, which include (1) the mechanism of formation and evolution of twin partial and stacking faults as well as their interplay with the surface, grain boundary, and twin boundary, (2) the *first* explanation of formation mechanism of five-fold deformation twin under uniaxial testing, and (3) the mechanism of work hardening due to deformation twinning and partial dislocations. The above results provided the physical basis, from the microscopic view, to substantiate the dominant role of partial dislocation mechanism on strengthening and toughening in NC materials. The main results were highly cited.

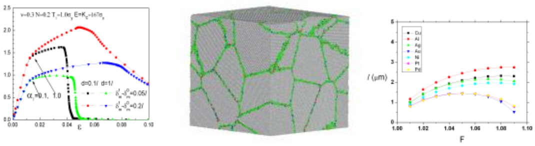

Fig. 1. (a) Solutions based on “Top-Down Method” for NC metals; (b) Computational model for “Bottom-Up method”; (c) Length scales based on linkage of “Top-Down” with “Bottom-Up”

References

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