

Multifunctional nanomaterials and supra-nanomaterials: concept, processing and applications

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To develop high efficient and advanced mechanical system, the creation of new materials and associated systems is one of the key directions. This presentation will feature recent development of structural nanomaterials and high mechanical properties of functional nanomaterials for the potential applications in mechanical and energy systems. The mechanisms of nanomaterials processing with different nano-structures by high efficient physical methods will firstly be reported by illustrating our latest findings / research progress on the nanomaterials with high strength and high ductility, nanostructure materials with gradient structure, hierarchical nano-twinned materials, nanomaterials with multiphase embedded structure and the supra-nanostructured materials. We will also present our recent work on an approach that combines the strengthening benefits of nanocrystallinity with those of amorphization to produce a dual phase material that exhibits near-ideal strength at room temperature and without sample size effects. The magnesium-alloy system consists of nanocrystalline cores embedded in amorphous glassy shells, and the strength of the resulting dual-phase material is a near-ideal 3.3 GPa—making this the strongest magnesium alloy thin film yet achieved. This work demonstrates a new way of producing a supra-nanostructure in a controllable manner. The feasibility of applying different nanomaterials on various advanced robotics, light-weight vehicle and energy systems; such as soft robotics, robotics in challenging environment (nuclear plant), ocean exploration and thermal energy conversion will be discussed. The application of new nanomaterials on the newly designed light-weight automotive parts and the development and research direction of the biomimetic morphing nanostructured materials on advanced aerospace and underwater vehicles systems will be presented. Lastly, the new technology for 3D/4D printing of complex shape nanostructured ceramic and their applications will be introduced.

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