Bulk nanostructured materials, with structural units (e.g., grains) falling in the nanometer range, have emerged as a new class of materials and received world-wide attention. They are structurally characterized by a significant volume fraction of grain boundaries, which significantly enhances their mechanical and physical properties (e.g., irradiation tolerance) in comparison with those of their conventional coarse-grained counterparts. Nano science and engineering can be utilized to improve performance of materials to enable them for extreme environments such as neutron irradiation and ballistic impact. In this talk, research projects will be discussed involving nano science and engineering in an effort to develop, manufacture and evaluate nanostructured materials with enhanced mechanical properties and irradiation resistance. Ultrafine-grained or nanocrystalline Cu and Al alloys with dramatically higher strength than their coarse-grained counterparts were fabricated and thoroughly characterized. Bulk nanostructured steels and high-entropy alloys are fabricated using advanced manufacturing techniques (e.g., equal-channel angular pressing, and additive manufacturing) and assessed for mechanical properties and irradiation performance. The structures of the materials are tailored on the nanometer scale in order to achieve desired properties and performance. Characterization of neutron irradiated nuclear fuels will also be discussed. Furthermore, a nanostructured Al alloy – ceramic particle composite will be described for ballistic impact applications.

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