Deformation Physics of Ultrafine Scale Materials

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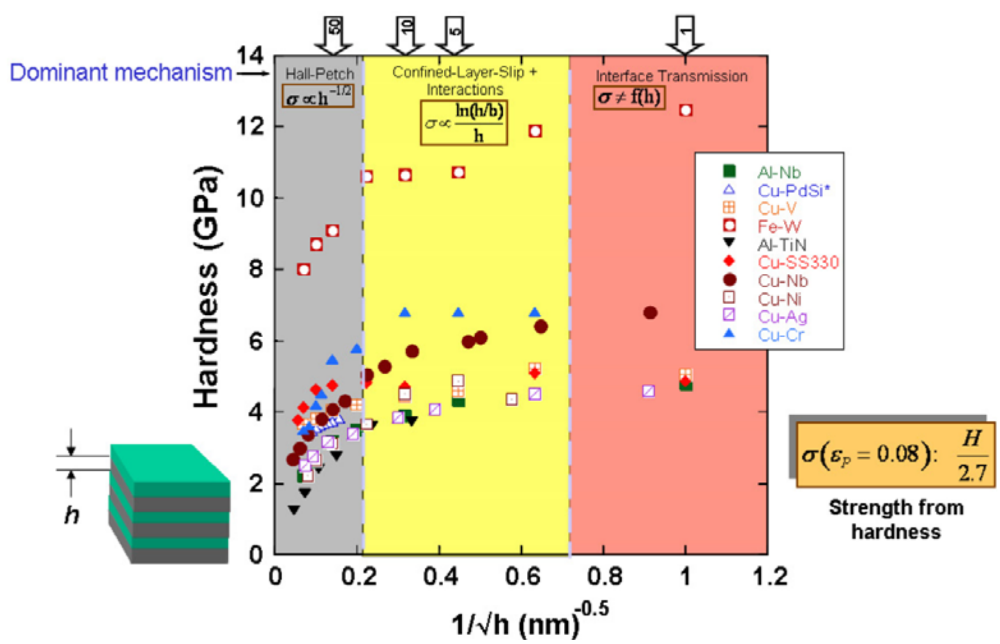
Past research has shown that nano-grained materials are stronger than their large-grained counterparts, but the random nature of the interfaces in those fine-grained structures make it difficult to unravel the reasons for this. To better elucidate the role of interfaces and nanostructures in the strength increases of metals, nanolayered composites have been fabricated with well-defined planar interfaces. It has been demonstrated[1] that certain nanolayered composites display both ultra-high strength and extreme tolerance to damage in under irradiation, making these composites potential structural materials and coatings for advanced nuclear energy systems. As the layers were made thinner the strength increased dramatically, and the radiation damage tolerance increased. Atomistic simulations have revealed that the structure of the interfaces between the layers plays a key role in both the resistance to irradiation and the increase in strength. It was discovered that they key to these remarkable behaviors was that the interfaces can adopt a number of configurations with nearly equal energy. That results in a "mushy" interface structure that can incorporate defects by locally restructuring without raising the energy of the interface and therefore breaking down the structure. This not only increases the stress necessary to move a dislocation through the interface (thereby increasing strength), it also increases the annihilation of radiation-induced defects (thereby increasing radiation tolerance). This work provides insights on how the atomic structure and energetics of interfaces can be tailored to design radiation damage tolerant composites.



References/Publications

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