THE INFLUENCE OF 3-D INTERFACIAL STRUCTURE AND MORPHOLOGY ON THE MECHANICAL BEHAVIOR OF NANOCOMPOSITES

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2-dimensional (2D) sharp interfaces with distinct boundaries demarcating an abrupt discontinuity in material properties in nanolayered composites have been studied for almost twenty years and are responsible for enhanced behaviors such as strength, radiation damage tolerance, and deformability. However, 2-D interfaces have their limitations with respect to deformability and toughness. 3D interfaces are defined as heterophase interfaces that extend out of plane into the two crystals on either side and are chemically, crystallographically, and/or topologically divergent, in three dimensions, from both crystals they join. Here, we present the mechanical behavior of two different classes of nanocomposites: 1.) nanolayered Cu/Nb containing interfaces with 3D character and 2.) Tungsten-based 3D ordered mesoporous composites consisting of a porous W scaffolding with silicon carbide or silicon nitride infill. Micropillar compression results show that the strength of Cu/Nb nanocomposites containing 3D interfaces is significantly greater than those containing 2D interfaces. Shear banding in 3D Cu/Nb is observed during pillar compression with retention of continuous layers across the shear band. We will present our recent results on deformation of such 3-D interfaces and structures, and describe this evolution mechanistically through the use of atomistic simulations.

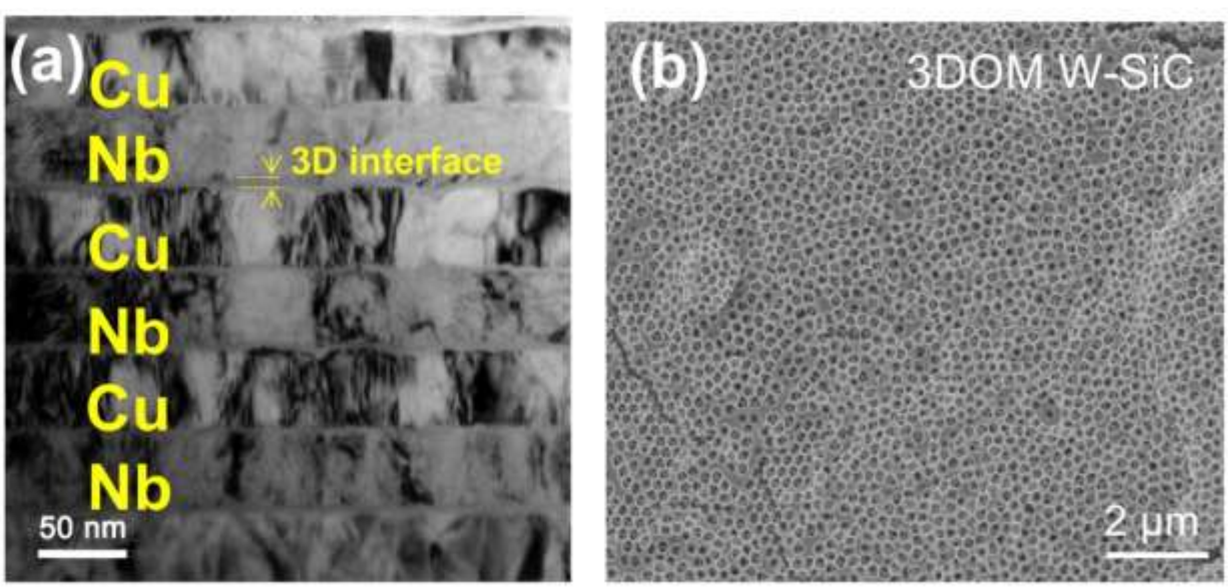

Figure 1 – (a) Bright Field TEM micrograph of Cu-Nb vapor deposited nanocomposite containing 3-D interfaces of chemically intermixed character. (b) SEM micrograph of 3D-ordered mesoporous structure consisting of W ligaments coated with SiC.