

Atomic-resolution understanding of multilayers deformation triggered by nanoindentation

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Mechanical properties of nanoscale multilayer coatings are governed mainly by the number of interfaces and their characteristics. While increasing strength and toughness values have been reported for a reduced layer thickness, properties degrade for layer thicknesses of just several nanometers. Here, we report on an entirely overlooked phenomenon occurring during the indentation of nanolayers, presumably explaining the degradation of properties. Nanoindentation disrupts and intermixes the multilayer structure due to the imposed deformation. Detailed electron microscopy studies, supplemented by atomistic simulations, provide evidence for intermixing in epitaxial transition metal nitride superlattice films induced by nanoindentation. The formation of a solid solution reduces the interfacial density and leads to a sharp drop in the dislocation density. Our results confirm that plastic deformation causes the microstructure instability of nitride multilayer, which may further improve our understanding of multilayer strength mechanisms.

Keywords: HRTEM, EELS, deformation, nanoindentation, multilayers

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References:

[1] Zhuo Chen, et al, Atomic insights on intermixing of nanoscale nitride multilayer triggered by nanoindentation, *Acta Materialia.*, 214 (2021)117004