Plasticity in nanometallic laminates: unraveling the mechanism of kink banding

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Nanometallic laminates (NML) are composite materials consisting of alternating stacks of dissimilar metals. These are known to exhibit high yield strength, in part due to dislocation slip confinement, as well as a ductile behavior. Overall though, one expects the mechanical response of NML to exhibit a complex dependence on layer thickness, constituent and intrinsic properties of the interface. The work to be presented aims at rationalizing the separates effects of all these features on both yield strength and ductility. To this end, we investigate four types of NMLs using small scale micro-mechanical testing and EBSD,TKD and TEM characterization accompanied by multiscale modeling efforts. Our results demonstrate that the deformation behaviors of NMLs are greatly affected by interface attributes such as interface orientation, interface morphology, and interface strength in addition to interface spacing. Interestingly we show that depending on the loading direction vis a vis interface orientation, NMLS can fail either via kinking, interface shearing/sliding, and barreling. Multi-scale modeling efforts allowed us to rationalize these failure processes in terms of both internal stress developments, secondary slip activation and interface strength.

Bio

Laurent Capolungo is a Scientist 5 and team leader at Los Alamos National Laboratory (LANL). Prior to this, he was an associate Professor at the Georgia Institute of Technology where he obtained his PhD in 2007.

Dr. Capolungo has 20 years of experience in computational mechanics. Laurent is an expert in multiscale modeling of metals subjected to extreme environments. He and his colleagues have developed several advanced numerical tools allowing for: (i) automated microstructure data analysis, (ii) simulations of the collective behavior of dislocations (discrete dislocation dynamics), (iii) simulations of the mechanical response of polycrystal using mean-field and full-field methods and, (iv) simulation of radiation induced damage in polycrystals. In recent years, Laurent co-developed LAROMance; a suite of data driven constitutive finite element level models sensitive to the underlying microstructure of metals which was a R&D100 award finalist in 2022.

Dr. Capolungo is the co-author of more than 150 journal articles that have been cited more than 6600 hundred times (h-index 43). Dr. Capolungo officiates as a referee for more than 10 international journals including JMPS, Acta Mater Scripta Mater (for which he received an outstanding performance award in 2016). He is also a member of the editorial board of the international journal of plasticity, Frontiers in materials.

Over his career Dr capolungo has co-lead more than 10 research projects support by the European commission, NSF, DoE NE, DoE FECM, DoE BES etc.. Currently, Dr Capolungo is the PI or co-PI of several large-scale programs. Among others Dr Capolungo is national deputy director of consortium ExtremeMAT and the PI of a recently awarded project supported by SciDAC on the topic metals subjected to molten salt reactor environments.