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Deformation Mode Transitions in Amorphous-Cu45Zr55/Crystalline-Cu Multilayers

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Abstract:

A transition of deformation modes from shear banding to co-deformation subject to nanoindentation was revealed by a systematic experimental study of multilayers of amorphous-Cu45Zr55 (at/%)/crystalline-Cu. The Cu45Zr55 was fixed at 150 nm where the Cu layers varied from 5 nm to 150 nm. At the 5 nm Cu layer thickness, the shear bands propagated through both layer types physically splitting the Cu layers. Upon increasing the Cu to 25 nm, the shear bands were able to propagate through the amorphous layer but only locally bend the Cu layers. At the 150 nm Cu layer thicknesses, the two phases co-deformed without clear evidence of shear propagation through the multilayer structure. Using molecular dynamics simulations, the spatial correlation of the shear transformation zones in the amorphous layers as a function of various Cu thicknesses was investigated. The simulations revealed a percolation created by the indent impression of the strain localization initiated in the amorphous layers above and below the Cu layer prior to shear banding. This spatial correlation condition was suspected to shear the Cu layer from both sides if the Cu layer is sufficiently thin.

Key words:

amorphous/crystalline multilayers, metallic glass, shear banding, co-deformation, shear transformation zone

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