SIZE EFFECT IN THE PLASTICITY OF MULTISCALE NANOFILAMENTARY CU/NB COMPOSITE WIRES DURING IN-SITU TENSILE TESTS UNDER NEUTRON BEAM

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Nanocomposite wires composed of a multiscale Cu matrix embedding Nb nanofilaments exhibit a high strength that results from a size effect in the finest Cu channels (single dislocation regime) and whisker-like behavior of the Nb nanofilaments (PMA 82 (2002) 925). In-situ tensile tests under neutron beam were performed at POLDI, PSI on nanocomposite wires composed of Nb nanofilaments with a diameter of 267nm and spacing of 45nm. The evolution of elastic strains and peak profiles versus applied stress evidenced the co-deformation behavior with different elastic-plastic regimes: size effect is confirmed in the finest channels while the Nb nanowhiskers remain elastic up to the macroscopic failure, with a strong load transfer from the Cu matrix onto the Nb filaments. The measured yield stress in the finest Cu channels is in agreement with calculations based on a single dislocation regime (APL 88 (2006) 191906).
Furthermore the temperature dependence of the residual stress in the as-drawn wires was studied. We find that at room temperature the Nb filaments are in axial tension whereas the Cu channels are in axial compression. Since Cu and Nb exhibit very different thermal expansion coefficients this residual stress signature changed drastically at 77K and is expected to have an important influence on the mechanical properties of the wires.