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THE EFFECT OF THE GRADED BILAYER DESIGN ON THE STRAIN DEPTH PROFILES AND MICROSTRUCTURE OF CU/W NANO-MULTILAYERS

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The properties and thermal stability of thin films and nano-multilayers are generally governed by the in-depth stress (strain) gradients rather than the average stress state. In the present study, the effect of a variation of the strain gradient in Cu/W NMLs on the thermal stability in the range of 400–800°C was investigated. The strain distribution in the NML stacks was varied by combining Cu/W bilayers with different Cu and W nanolayer thicknesses of either 3 nm or 10 nm. The depth dependent strain profiles were experimentally derived by in-plane grazing X-ray diffraction with the relevant modelling approach. The mean residual stresses in Cu and W nanolayers in the as-deposited state and after annealing were found to be independent of the disposition of the different Cu/W bilayer substacks. On the contrary, the strain depth profile of the W nanolayers was found to strongly depend on the disposition of Cu/W bilayer substacks in the Cu/W NML, which resulted in different Cu outflow characteristics upon annealing. Thereby, combining different Cu/W bilayer units within the NML stack can be used to tailor the Cu outflow intensity. Moreover, the arrangement of bilayer units with various nanolayers thicknesses also provides a pathway for producing Cu/W nanocomposites with graded bulk microstructure by high-temperature thermal degradation.

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