

Dislocation and back stress dominated viscoplasticity in freestanding sub-micron Pd films

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ABSTRACT

Thin films ("thin" meaning thinner than $1\mu\text{m}$) are nowadays present everywhere such as in MEMS. The mechanical integrity of the films is the key for the reliability of the devices under interest. Compared to their bulk counterparts, thin films involve, owing to the very fine microstructure, high strength, long elasto-plastic transition and moderate to high strain rate sensitivity, which can lead to detrimental creep.

A dislocation-based crystal plasticity model is developed in order to study the mechanical and creep/relaxation behaviour of polycrystalline metallic thin films [1]. The model accounts for the confinement of plasticity due to grain boundaries and for the anisotropy of individual grains, as well as for the significant viscoplastic effects associated to dislocation dominated thermally activated mechanisms. Numerical predictions are assessed based on experimental tensile test followed by relaxation on freestanding Pd films, gathered using an on-chip test technique [2]. The dislocation-based mechanism assumption captures all the experimental trends, including the stress-strain response, the relaxation behaviour and the dislocation density evolution, confirming the dominance of a dislocation driven deformation mechanism for the present Pd films with high defects density. The model has also been used to address some original experimental evidences involving back stresses, Bauschinger effect, backward creep and strain recovery.

References

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