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Structural-elastic relationships of Zr-TL (TL = Cu, Co, Ni) thin films metallic glasses

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Abstract

In this study, we investigated the structural and elastic properties of Zr-TL (late transition metal TL = Cu, Co, Ni) thin films metallic glasses (TFMG) deposited by dc magnetron co-sputtering from pure TL targets in Ar plasma discharge. The influence of the deposition parameters on the microstructure, chemical composition and elastic properties of the thin films has been explored. Advanced non-destructive techniques such as the picosecond ultrasonics and the Brillouin light scattering were employed to selectively measure the longitudinal V_L and the transversal V_T sound velocities, leading to the determination of the elastic constants C_{11}, C_{44}, respectively. From these data sets, the elastic constants of metastable amorphous single elements *a*-Zr, *a*-Cu, *a*-Co and *a*-Ni have been extrapolated. Some relationships between elastic moduli (Young's modulus E and shear modulus $G = C_{44}$) and the structural state either crystalline or amorphous are established. Predicted ductility/brittleness character was emphasized based on the Blackman's diagram, Pugh's ratio and the Pettifor criteria. Equivalently, the newly introduced δ parameter termed as 'the cooperation parameter' and related uniquely to the Poisson's ratio ν, confirmed the improvement of ductility with TL alloying.

Keywords:
Thin films, metallic glasses, ultrasonics, elasticity, mechanical properties