ICSMA19 Metz, France, June 26 - July 1, 2022
International Conference on Strength of Materials

Experimental measurements of critical resolved shear stress in pure Zn and Zn-Ag alloys using micropillars compression

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Zinc (Zn) has been recently gaining increasing attention as a promising novel material for biomedical applications. Many attempts have been performed to improve the mechanical properties of Zn by introducing other elements and by inducing grain size refinement [1]. In this research, we systematically investigated the micro-scale deformation behavior of Zn and Zn alloys. The samples with increasing Ag content up to 2.2 at. % were fabricated by casting and annealing. After an SEM-EBSD analysis different-sized micropillars were prepared by FIB milling within the grains having orientations favoring the activation of a single slip system. The micropillars were compressed using an *in situ* nanoindenter with a diamond flat punch at room temperature and different strain rates. It allowed for measuring the critical resolved shear stresses (CRSS) of basal and prismatic slip systems. The deformed micropillars were also carefully examined using SEM to determine the orientation of the appeared slip traces. The results showed that the strength of Zn depends on the micropillar size, which is commonly termed as the *size effect*. It was also shown that Ag solute atoms provide more effective strengthening during deformation in the prismatic than basal slip system. Overall, the obtained results can be further implemented in crystal plasticity models as input data, for designing fabrication processes of bioresobable implants requiring specific mechanical properties.

Keywords: zinc, micropillars compression, size effect, slip systems, strain rate

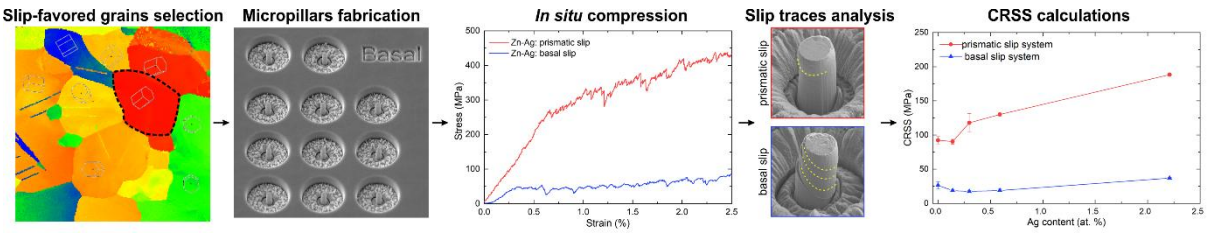

Fig.1 Systematic Zn-based micropillars compression tests and data analysis procedure

References:

[1] M. Wątroba, W. Bednarczyk, J. Kawałko, P. Bała, Fine-tuning of mechanical properties in a Zn–Ag–Mg alloy via cold plastic deformation process and post-deformation annealing, Bioact. Mater. 6 (2021) 3424–3436.