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How does alloying addition affect the mechanical stability of bioabsorbable zinc alloys subjected to hydrostatic extrusion?

Anna Jarzębska[a], Łukasz Maj[a], Magdalena Wróbel[a], Daniel Wojtas[a], Jakub Kawałko[b], Robert Chulist[a], Sylwia Przybysz[c], Jacek Skiba[c], Magdalena Bieda[a]

[a] *Institute of Metallurgy and Materials Science, Polish Academy of Sciences, Krakow, Poland*

[b] *Academic Centre for Materials and Nanotechnology AGH University of Science and Technology, Krakow, Poland*

[c] *Institute of High Pressure Physics, Polish Academy of Sciences, Warszawa, Poland*

a.jarzebska@imim.pl

Recently, growing popularity in the scientific community of zinc alloys is due to their tendency to dissolve in human body with the optimal corrosion rate. However, insufficient mechanical properties prevent Zn-based materials from the broad-scale application. Another concern is the fact that zinc alloys demonstrate strain-sensitivity, which could cause instability of mechanical properties. It has been already proven that the synergistic effect of alloying additions and hydrostatic extrusion can lead to improvement of mechanical properties, exceeding requirements for bioabsorbable stents. Nevertheless, the stability of the hydrostatically extruded materials was not taken into consideration so far and thus, it will be the aim of the present work.

In order to characterize the effect of alloying additions on strain-sensitivity, pure Zn and two different alloys i.e., Zn-Mg and Zn-Mg-Cu were prepared and subjected to multi-pass hydrostatic extrusion. The mechanical properties were assessed based on static tensile tests performed on Zwic/Roell Z250 with various strain rates, ranging from 10^{-2} to 10^{-4} s^{-1}. Microstructure investigations by means of Electron Backscatter Diffraction conducted on FEI Quanta 3D FEG/SEM were carried out to have an insight on deformation behavior of low-alloyed zinc. In order to support microstructure observation, crystallographic textures were determined.

The results showed that despite the beneficial effect of alloying additions on strength enhancement of zinc alloys, they also increase strain-sensitivity. Ternary zinc alloys exhibited the highest strain-sensitivity. The elongation to failure significantly increased with slower strain rates from 24% to 120%. The reason behind this can be the refined microstructure, supported with solution strengthening, which cause the deformation by grain boundaries sliding to be dominant during the tensile test, rather than dislocation slip.

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