Bioabsorbable zinc alloys – the effect of materials processing on microstructure, mechanical and corrosion properties

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Zinc-based materials are intensively studied in relation to the possible application like bioabsorbable medical devices including stents or various fixation devices like screws, and plates. Zinc is favourable due to its excellent biocompatibility and rather low corrosion rate with the absence of concomitant hydrogen release making him an interesting alternative to Mg-based bioabsorbable implants. To comply with the high requirements on mechanical and degradation properties, zinc has to be appropriately alloyed and thermomechanically processed enabling significant improvement in strength and also elongation. One of the remnant shortcomings is related to the pour mechanical strength at increased temperate (even body temperature at 37 °C) and low creep resistance, both these factors are related to the low recrystallization temperature of pure zinc. In the last years, powder metallurgy techniques have been suggested to overcome the issues of low strength and poor creep behaviour, further with the tendency to support a more homogeneous corrosion process preceding the onset of localized corrosion. In this work we try to insight into the behaviour of several materials consisting of key suggested alloying elements for zinc (Mg, Ag, Sr) and processed by various techniques including conventional casting and extrusion but also powder metallurgy methods including mechanical alloying (MA) and spark plasma sintering (SPS). Our results indicated a strong positive effect of thermomechanical processing (hot extrusion) on materials microstructure with a reduced grain size of up to 2 μm and increased mechanical properties (strength, elongation). However, these results were even overcome by the application of powder metallurgy methods resulting in grain and intermetallic particle size below 1 μm and slightly improved strength over conventionally processed materials attacking 400 MPa. Furthermore, a higher tendency for uniform corrosion has been observed. In sum, powder metallurgy products are suggested as highly competitive to conventionally processed alloys. The study has been funded by the Czech Science Foundation, project 21-11439K.