Nano-grained Zinc Composite Materials Synthesized by Mechanical Alloying and Spark Plasma Sintering

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Zinc alloys are extensively researched due to their potential as promising materials for biodegradable medical devices. This is primarily because of their remarkable biocompatibility and reasonable corrosion rate, which prevents the formation of toxic byproducts and hydrogen release. However, they often exhibit suboptimal mechanical, corrosion, and biological properties, limiting their applications[1, 2, 3].

To address the limitations of zinc alloys, we developed a Zn–1Mg–1Si composite alloy, incorporating biologically compatible elements to potentially strengthen the zinc matrix. Utilizing powder metallurgy techniques, including mechanical alloying, spark plasma sintering, and extrusion, we produced alloys with uniquely fine-grained microstructures. Our systematic study demonstrated the possibility of achieving a homogeneous microstructure, enhanced by the intermetallic phase Mg_2Zn_{11} and Si particles, resulting in high tensile strength exceeding 400 MPa and hardness over 130 HV1. Furthermore, the selected chemical compositions and processing methods led to slightly reduced wear during tribology testing and corrosion rates, along with more uniform corrosion behavior in the simulated human environment compared to pure metal.

The authors would like to thank the Czech Science Foundation (project no. 21-11439K), the grant of Specific university research (grant A1_FCHT_2024_007), the Slovenian Research Agency ARIS (project N2-0182) and ARIS program P2 0132 for the financial support.

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