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PROCEEDINGS

Microstructural Evolution, Mechanical Properties and Corrosion Behaviors of Additively Manufactured Biodegradable Zn-Cu Alloys

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ABSTRACT

Biodegradable metal implants that meet clinical applications require good mechanical properties and an appropriate biodegradation rate. Additively manufactured (AM) biodegradable zinc (Zn) alloys constitute an essential branch of orthopedic implants because of their moderate degradation and bone-mimicking mechanical properties. This paper investigated the microstructural evolution and corrosion mechanisms of zinc-copper (Zn-Cu) alloys prepared by the laser-powder-bed-fusion (L-PBF) additive manufacturing method. Alloying with Cu significantly increases the ultimate tensile strength (UTS) of unalloyed Zn, but the UTS and ductility of unalloyed Zn and Zn-2Cu decrease with increasing laser energy density. Unalloyed Zn has a dendritic microstructure, while Zn-2Cu alloy has a peritectic microstructure. The formation of round peritectic grains is due to the low-temperature gradient of unalloyed Zn during the AM. The Zn-2Cu samples exhibited higher corrosion rates, addressing the problem of slow degradation of unalloyed Zn. The grain size distribution influences the corrosion behaviors of the material. It enhances the corrosion rates of materials with refined grains in a non-passivating environment. However, the 100% extracts of Zn-2Cu samples exhibited greater cellular activity values than unalloyed Zn samples, thus confirming their better cytocompatibility. This work demonstrates the great potential of designing and modulating biodegradable Zn alloys to fulfil clinical needs using AM technology.

KEYWORDS

Additive manufacturing; Zn-Cu alloy; microstructure; mechanical property; corrosion behavior

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