From design to functionality: Engineering biodegradable metals as durable implants through powder bed fusion – laser beam processing

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Additive manufacturing through Powder Bed Fusion—Laser Beam (PBF-LB) allows tailored fabrication of biodegradable alloys for bone implants, but challenges remain in printability, microstructure control, and in achieving optimal material properties for clinical use. This study provides an overview of printability, microstructure, and material properties of degradable Mg and Zn alloys produced by PBF-LB. Magnesium and Zn are both essential nutrients in the human body, playing vital roles in bone and tissue regeneration, and in some instances, also boasting antibacterial properties. Nevertheless, despite clinical usage, full-scale implementation of degradable Mg alloys is hindered by an overall rapid degradation, particularly for alloys produced by AM. Zinc alloys, meanwhile, are yet to be clinically implemented, and suffer from unsuitable mechanical properties largely attributed to a low recrystallization temperature and a tendency for natural ageing. Material synthesis, PBF-LB process optimization and component design are used as attempts to tackle these issues. Microstructure characterization, along with mechanical and corrosion testing reveal alloy-specific differences, including distinct sub-grain structures, that heavily influence key material properties, while a clear dependence of component geometry is also demonstrated. Indeed, AM provides numerous opportunities for fabricating durable biodegradable implants, yet distinct challenges need to be overcome before full-scale clinical implementation.