

Bi-continuous Mg-Ti interpenetrating-phase composite as a partially degradable and bioactive implant material

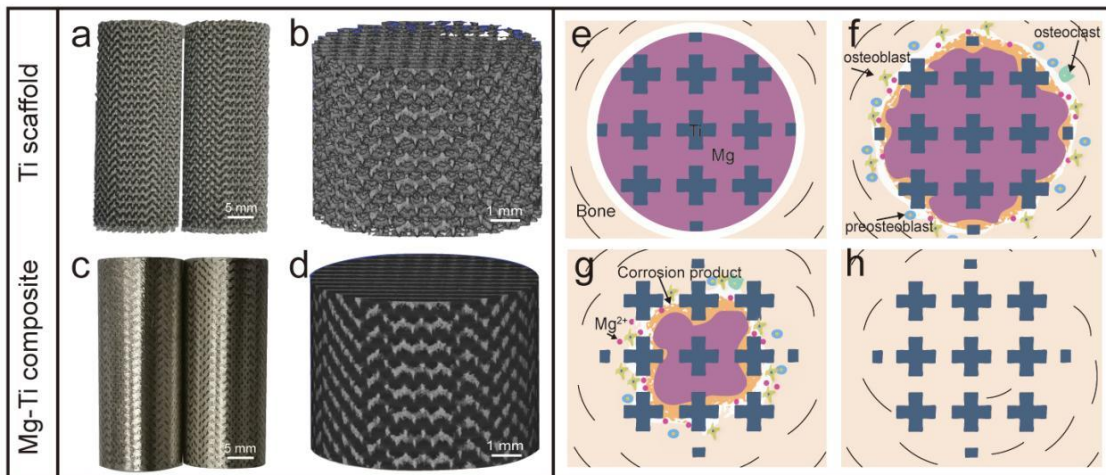
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Abstract Magnesium and its alloys possess the ability to degrade in physiological environments and promote new bone formation. Nonetheless, the rapid deterioration of their mechanical properties during the degradation process poses a significant limitation to their clinical application as bone repair materials. Titanium and its alloys exhibit superior biocompatibility and exceptional mechanical properties, yet their bioactivity remains suboptimal. Making composites composed of them offers the promise for combining their property advantages for bone repair. Here, we present a Mg-Ti composite fabricated by pressureless infiltration of pure Mg melt into 3D printed Ti scaffold, and demonstrate a potential of the composite for use as new partially degradable and bioactive implant materials. The composite has such architecture that the Mg and Ti phases are topologically bicontinuous and mutually interspersed in 3D space, and exhibits several advantages over its constituents, such as higher strengths than as-cast pure Mg and Ti scaffold along with lower Young's modulus than dense Ti. Additionally, the degradation of Mg phase may induce the formation and ingrowth of new bone tissues into the Ti scaffold to form mechanical interlocking between them; in this process, the Ti scaffold provides constant support and Young's modulus adaptively decreases toward that of bone. Despite the accelerated corrosion than pure Mg, the composite remains non-cytotoxic and does not cause obvious adverse reactions after implantation as revealed by in vitro and in vivo experiments. This study may offer a new possibility for combining mechanical durability and bioactivity in implant materials, and allow for customized and targeted design of the implant.



(a, c) Overall appearances of (a) the 3D printed Ti scaffold and (c) the Mg-Ti composite after infiltration of the scaffold with Mg. (b, d) XRT volume renderings of the (b) Ti scaffold and (d) Mg-Ti composite. (e-h) Degradation process of the Mg phase in the Mg-Ti composite implant after implantation.

Keywords 3D printing; Mg-Ti composite; Mechanical properties; Biomechanical property; Partially degraded materials