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Improving Biodegradation Behavior of Fabricated WE43 Magnesium Alloy by High-Temperature Oxidation

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Abstract : WE43 magnesium alloy can be additively manufactured via laser powder bed fusion (LPBF) for biodegradable applications, but the as-built WE43 exhibits an excessively rapid corrosion rate. High-temperature oxidation (HTO) was performed on the as-built WE43 to improve its biodegradation behavior. A sandwich structure including an oxide layer at the surface, a transition layer in the middle, and the matrix was generated influenced by the oxidation reaction and diffusion of RE atoms when heated at 525 ℃for 8 hours. The oxide layer consisted of Y_2O_3 and Nd_2O_3 oxides with a thickness of 2-3 μm. The transition layer is composed of α-Mg and Y_2O_3 with a thickness of 60-70 μm, while Mg24RE5 could be observed except α-Mg and Y_2O_3. The oxide layer and transition layer appeared to have an effective passivation effect. The as-built WE43 lost 40% weight after the in vitro immersion test for three days and finally broke into debris after seven days of immersion. The high-temperature oxidation samples kept the structural integrity and lost only 6.88 % weight after 28-day immersion. The corrosion rate of HTO samples was significantly controlled, which improved the biocompatibility of the as-built WE43 at the same time. The samples after HTO had better osteogenic capability according to ALP activity. Moreover, as built WE43 performed unqualified in cell adhesion and hemolytic test due to its excessively rapid corrosion rate. While as for HTO samples, cells adhered well, and the hemolysis ratio was only 1.59%.

Keywords : laser powder bed fusion, biodegradable metal, high temperature oxidation, biodegradation behavior, WE43
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