WPI MATERIALS SCIENCE & ENGINEERING

Yangzi Xu
PhD Dissertation

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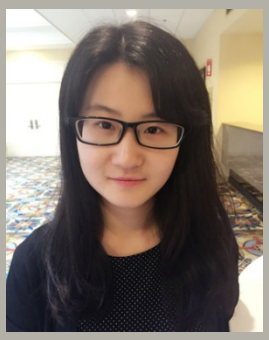

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Corrosion Behavior of Direct Metal Laser Sintered Ti6Al4V for Orthopedic Applications

Abstract

Ti-6Al-4V alloy has been used as biomedical implants for decades because of its superior mechanical properties, good biocompatibility, lack of allergic problems and good corrosion resistance. It is widely used as the tibial components in total knee arthroplastry and hip cup in total hip replacement. However, mechanical properties of Ti-6Al-4V implant can be deteriorated due to corrosion pits. In the past decades, the rapid developments in additive manufacturing have broadened their applications in biomedical area due to the high geometrical freedom in fabricating customized implants. However, the high-localized thermal input and fast cooling rate during laser processing usually result in non-equilibrium phase with high residual stress. Therefore, it is necessary to apply proper post-treatments on the as-print parts to ensure better properties. In this work, various post-treatments (e.g. post-heat treatments, hot isostatic pressing) were applied aim to improve the corrosion behavior of direct metal laser sintered Ti-6Al-4V parts. The effect of post-treatment temperature on the mechanical properties and corrosion behavior were examined experimentally. Microstructure, phase fraction and residual stress are evaluated. A discussion on factors influencing corrosion rate was presented, and the corrosion mechanism on the Ti-6Al-4V part in simulated body fluid was proposed. Based on the electrochemical measurement results, enhanced corrosion resistance was observed in the samples after high temperature annealing treatment in the α+β region, and solution treatment in β region followed by aging.