学　位　論　文　内　容　の　要　旨

博士の専攻分野の名称　　博士（工学）　　氏名　SITI HIDAYATUL AQMAR BINTI ZAKARIA

学　位　論　文　題　名

Bio-functional Coating on Selective Laser Melting Manufactured Porous Ti6Al4V Scaffolds Produced by Using Plasma Electrolytic Oxidation
(選択的レーザー溶融製造多孔質 Ti6Al4V スキャフォルドのプラズマ電解酸化による生体機能コーティング)

The recent advances in manufacturing such as selective laser melting (SLM) have allowed the fabrication of complex geometries and lightweight three-dimensional (3D) components. Lattice structure serves as an alternative design to existing implants by reducing the stiffness thereupon eliminate the stress-shielding effect whilst improving osseointegration process. In purpose to reinforce the osseointegration with the adjacent tissue after the surgery, the porous scaffold is coated with bio-functional coating by using plasma electrolytic oxidation (PEO) technique. Ti6Al4V has been material of choice for medical application and it is viable for SLM technology and PEO technique. The aim of this study is four-fold. Firstly, to develop SLM manufactured porous Ti6Al4V coated with bio-functional PEO-treated layer. Secondly, to evaluate the characteristics of bio-functional PEO coatings on SLM manufactured porous Ti6Al4V scaffolds. Thirdly, to investigate the mechanical properties of scaffolds and the effect of PEO process on mechanical strength of SLM manufactured scaffolds. Fourthly, and last, to identify the bioactivity of the PEO-treated scaffolds with Simulated Body Fluid (SBF) immersion test.

Coating formed were probed using field emission scanning electron microscopy (FESEM), electron dispersive spectroscopy (EDS), X-ray diffraction analysis (XRD) and X-ray photoelectron spectroscopy (XPS). ImageJ open software was used to carry out image analysis, which allowed the investigation of coating properties such as size of micropores formed on the coating. The compressive test according to ISO 13314:2011 was conducted on the scaffolds and showed a comparable result to human cancellous bone mechanical properties. The scaffolds also have the ability of apatite formation after 28 days of immersion time.

This study has indicated the potential of PEO treatment of Ti6Al4V porous scaffolds for orthopedic implants in the aspect of bio-functionality and bioactivity of the coating. Additionally, PEO treatment slightly enhance mechanical properties of SLM manufactured Ti6Al4V porous scaffolds with increasing treatment time. These results provide a benchmark against which further work optimizing PEO process parameters on SLM manufactured porous Ti6Al4V to enhance bio-functionality of scaffolds could be undertaken.