Physical Properties Characterisation of 3D printed Titanium Alloy Parts Manufactured by Selective Laser Melting (SLM) for Potential Orthopedic Applications

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INTRODUCTION:

Selective Laser Melting (SLM) is a type of Additive Manufacturing (AM) technology for rapid prototyping of manufacturing 3D printed components parts in complex structure. This technology allows the direct fabrication of functional parts with complex shapes particularly in orthopaedic application from digital models. In orthopaedic field, titanium (Ti) based implants have been widely used in orthopaedic surgery due to their excellent properties and biocompatibility. The present work is aimed to investigate the physical properties of 3D printed titanium alloy through SLMed technology.

MATERIALS & METHODS:

A commercially available Ti6Al4V spherical shape powder with density relatively 4.42 g/cm3 with Coefficient of thermal expansion in the range of 8 × 10-6 K-1 to 9 × 10-6 K-1 is provided by Renishaw, United Kingdom. The density of specimens was then calculated by measuring Volumetric Energy Density (VED) of the specimens using equation 1. The analytical balance is based according to ASTM D 1475-98. As for tensile testing, the parameters evaluated include layer of thickness, hatch distance, hatch increment angle, power, point distance, exposure time and scanning speed.

RESULTS:

The correlation of density and porosity for three 3D printed titanium alloy (Ti6Al4V) part specimens as shown at Figure 2. Roughly density for all the sample indicates in range of 4.416 to 4.419 g/cm3 which mean the sample has achieved 99.91 to 99.97 % near to the theoretical of Ti6Al4V metal powder (4.420 g/cm3)

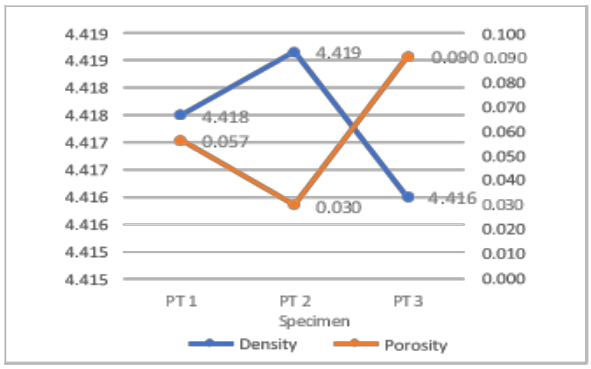

Figure 1: Correlation between density and porosity of 3D printed titanium alloy parts.

DISCUSSIONS:

Titanium alloy performs a crucial function in orthopaedic surgery. Although 3D printed technology is established, studies on its physical properties are still needed for the establishment of orthopaedic implants. From this study, the use of high laser power has improved the density of the printed parts due to the sample has receive sufficient heat to melt the nanoparticle of the powder during the process and fused interparticle of titanium alloy powder properly.

CONCLUSION:

The present study reveals the physical properties of the 3D printed Titanium Alloy SLMed technology has a good potential to function as orthopedic implant in future.

REFERENCES:

1. Wang et al., Journal of Clinical Medicine 2023; Vol 12; 444.
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