Mechanical and microstructural study of titanium alloy (ZTi-Powder® and ZTi-Med®) via additive manufacturing

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Ti64 alloys have been widely used for aeronautics and biomedical implants because of their superior corrosion resistance and mechanical properties. For instant, Ti64 is already used in aircraft engines however it represents only 15% of its uses in classical engines due to insufficient strength, low hardness, and poor wear performance at high temperatures. Titanium matrix composites (TMC) however seems to present the best combination of ceramic hardness and wear resistance and the softness of titanium matrix. ZTi-Powder® (Figure 1) is a TMC material developed by Z3DLAB in order to overcome the drawbacks of Ti64 alloy, mechanical properties showed interesting results[1,2] hardness increased by almost 80% without drastic reduction in ductility and high mechanical resistance at high temperatures was observed.

Ti64 is also widely used in the medical field such as dental implants and medical devices. However, many studies reported that unsatisfactory loads transfer from the implant devices and the relatively high elastic modulus of implant materials may lead to bone resorption. To overcome these issues, Z3DLAB developed a new dental implant design (DNA implant) and results showed that 84% of the implant's internal volume was colonized by bone cells. These results led to a publication in Helion journal [3]. Also, Z3DLAB developed a new titanium alloy ZTi-Med® (Figure 2) and achieved the lowest elastic modulus using Selective laser additive manufacturing technology (SLM). being very close to that recorded for the human bone (25GPa).

References

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[2] A. Hattal, T. Chauveau, M. Djemai, J. J. Fouchet, B. Bacroix, G. Dirras, Data in Brief 2020, 29, 105249.
[3] A.-F. Obaton, J. Fain, M. Djemaï, D. Meinel, F. Léonard, E. Mahé, B. Lécuelle, J.-J. Fouchet, G. Bruno, Heliyon 2017, 3, e00374.

Figures

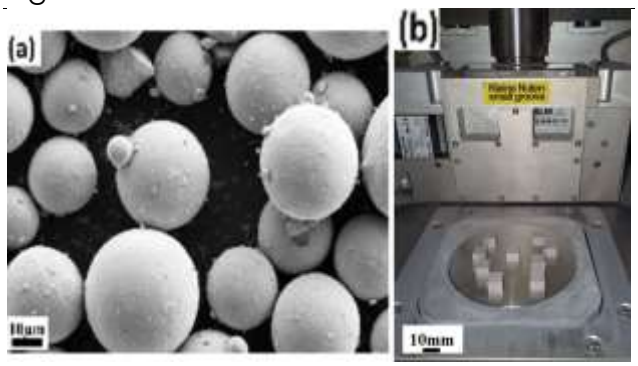

Figure 1: (a) ZTi-Powder starting materials (b) SLM manufactured parts of ZTi-Powder®

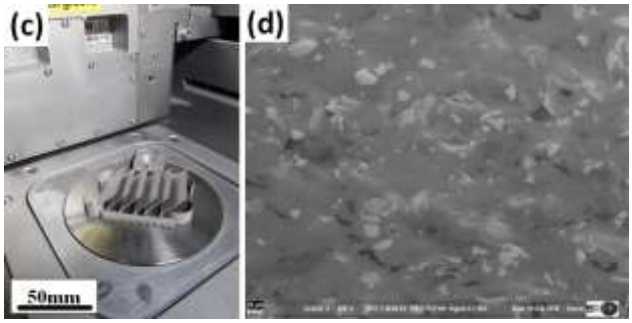

Figure 2: (c): SLM manufactured parts of ZTi-Med®,(d) microstructure via SEM of ZTi-Med®