Microstructure and porosity of Ti-6Al-4V samples produced by Electron Beam Melting

***Fabienne Delaunois*[*1], Pol Blanchard[2], Olivier Rigot[3], Thomas Kairet[3]

[*1] Metallurgy Department, University of Mons (UMONS), Mons, 7000, Belgium.
Email: Fabienne.delaunois@umons.ac.be

[2] Druart s.a., Péronnes-lez-binche 7134, Belgium.
Email: Pol.Blanchard@druart-hvac.be

[3] SIRRIS, Gosselies, 6041, Belgium.
Email: Olivier.Rigo@sirris.be
Email: Thomas.Kairet@sirris.be

The selective laser melting (SLM) and electron beam melting (EBM) are additive manufacturing (AM) processes consisting in the fabrication of a three-dimensional near-net-shaped parts by selective melting of a metal powder bed directly from computer models.
Titanium alloy Ti-6Al-4V 5 ELI (Extra Low Interstitial) is the most widely used alloy for these technologies. Spherical pores were the main defects in SLM and EBM samples due the high local energy density, and EBM is preferred when a low porosity is required. Moreover, as-build SLM products show very high tensile strength but poor ductility with high residual stress levels and EBM products are less susceptible to creep. This study focusses on the EBM technic. The parameters of EBM process such as building temperature, samples geometry and the use of a pre-build stage for the building of actual samples influence the microstructure and the porosity of the products after building. The microstructure evolution of as-built samples in both horizontal and vertical sections was visualized by optical microscope. The porosity in each section was measured. The microhardness was checked. Results showed that the build temperature had no significant effect on the microstructure. The porosity had a spherical shape due to the residual oxygen content of the powder and was generally low (about 0.22 vol.%). But the local porosity could reach 5 vol.% for samples with small section, with a maximum pore diameter of 100 µm. The use of a stage influenced the microstructure and the microhardness. Surface creep was observed in the case of samples with insufficient massiveness.

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