Investigating the 3-dimensional microstructure of a 3D printed Ti 42 Nb alloy for bone implant applications

Stefan Zaefferer[1)] and Sravya. Tekumalla[2)]

[1)] Max-Planck-Institute for Iron Research, Düsseldorf, Germany [2)] Victoria University, Victoria, Canada

The beta Ti alloy Ti 42 Nb is highly promising for permanent bone implant applications because of its extremely low elastic modulus, which approaches that of human bones, and its chemical inertness in body fluids. Additive manufacturing by Laser powder-bed fusion (L-PBF) appears as a very valuable technique to produce implants of tailored shapes, and mechanical properties and optimum integration into the bone. Ti 42 Nb is actually well L-PBF printable but it leads to microstructures that are very different from those known from other commonly printed materials like 316L stainless steel. For example, the TiNb material does not show the typical dislocation cell structures observed in 316L and other materials.

We produced 2 Ti 42 Nb samples with different L-PBF printing strategies which showed very different crystallographic textures and mechanical properties. In order to understand the texture formation of these samples we applied our newly developed EBSD (electron backscatter diffraction)-based large volume microstructure characterization system (ELAVO 3D) to study the 3-dimensional microstructures. We found that the shapes and crystal orientations of the grains are very different in both samples. We present a first interpretation on the relationship of printing properties and texture evolution. Furthermore, by means of EBSD-based measurement of elastic stresses, we could show that the low elastic modulus of the material is responsible for the lack of dislocations in the printed material. This may be beneficial for the fatigue behaviour of the material.