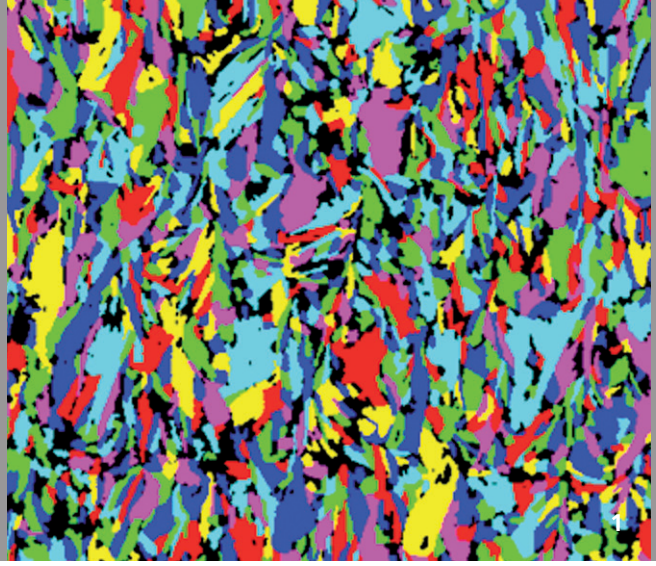

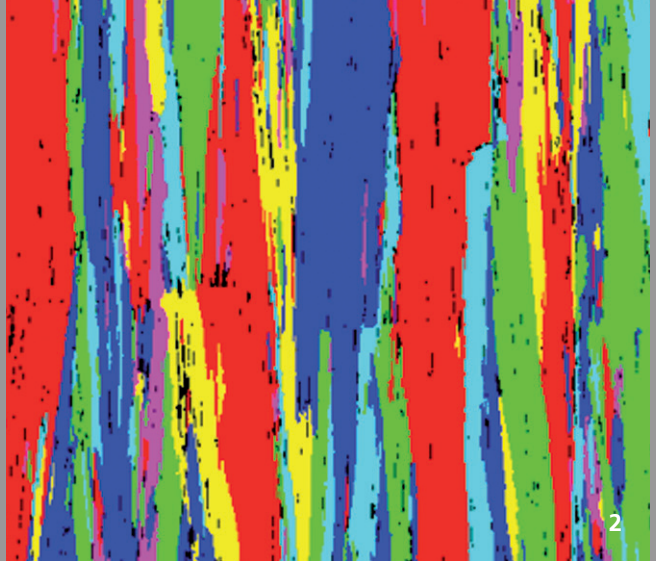

MICROSTRUCTURAL PROPERTIES OF IN718 PROCESSED WITH HIGH POWER SLM

Task

Recently, end users are becoming more and more interested in using the additive manufacturing process Selective Laser Melting (SLM) for mass production with increased lot sizes. For this reason, in recent years higher laser powers (PL ≤ 1 kW) have been increasingly used in commercial SLM plants to improve the productivity of SLM. To use this laser power, the process parameters (e.g. laser-beam diameter, scanning speed and layer thickness) have to be adjusted according to the processed material. This adjustment, however, changes the cooling and solidification conditions in the melt pool bath and, thereby, the resulting microstructure and material properties of the finished part.

Method

For this reason, as part of the EU project »AMAZE«, basic studies were conducted on the extent to which high-power SLM process control influences the resulting microstructural and material properties of the material IN718. In these investigations, Fraunhofer ILT analyzed the resulting microstructure (e.g. grain size or orientation) and determined the mechanical properties (e.g. tensile strength, elongation at break). Additionally, it examined the influence of adapted thermal post-treatments on the material properties.

1 EBSD analysis conventional SLM (P_L = 300 W | d_s ≈ 70 µm).

2 EBSD analysis HP-SLM (P_L ≤ 1,5 kW | d_s ≈ 720 µm).

Result

In the first step a process control was developed for different laser beam diameters with laser powers of P_L ≤ 1.5 kW for densities ≥ 99.5 percent. Subsequent characterization of the microstructure (SEM, EBSD) shows that, when a laser beam diameter of d_s ≈ 70 µm is used, a fine structure (dendrite arm spacing DAS ≈ 1.6 µm) is formed in which the grain growth is re-initiated layer to layer (Figure 1). In comparison, grains form at a laser power of P_L = 1.5 kW and adapted process parameters and are oriented epitaxially in the building direction (DAS ≈ 2.3 µm, Figure 2). The significantly different solidification rates (conventional SLM: solidification rate ≈ 580 mm/s | HP-SLM: solidification rate ≈ 60 mm/s) cause the microstructure to develop differently. In the next step, Fraunhofer ILT will identify the extent to which these structural properties influence the mechanical properties.

Applications

Components additively manufactured out of IN 718 can be used mostly in the fields of aerospace and power engineering.

Contacts

Dipl.-Wirt.Ing. Sebastian Bremen
Telephone +49 241 8906-537
sebastian.bremen@ilt.fraunhofer.de

Dr. Wilhelm Meiners
Telephone +49 241 8906-301
wilhelm.meiners@ilt.fraunhofer.de

Fraunhofer Institute for Laser Technology ILT, www.ilt.fraunhofer.de
DQS certified by DIN EN ISO 9001, Reg.-No.: DE-69572-01