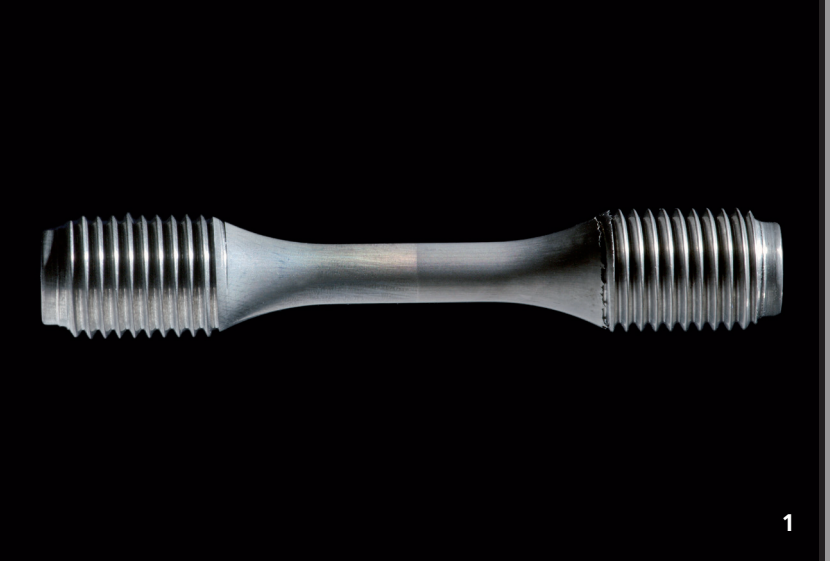

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PROCESS DEVELOPMENT FOR REPAIR OF MONO-CRYSTALLINE TURBINE BLADES WITH SLM

Task

Quite often, high-pressure turbine blades (HP blades) are produced nowadays as single crystals with a special investment casting process in the aviation industry. Damage in the area of the blade tip by burning, abrasive wear or cracking is disastrous if it extends into the inner cavity of the blade and the cooling structure. Such damage cannot be repaired with currently available methods. Since it can manufacture complex geometries in a final near-net shape, the additive manufacturing process Selective Laser Melting (SLM) should be considered as a repair process.

Method

The nickel-based superalloys used for HP blades were developed especially for directional (DS) or single-crystal (SX) solidification and are highly susceptible to cracking when they are processed with SLM. For this purpose, in cooperation with the MTU Aero Engines, Fraunhofer ILT examined SLM-based processing of the DS alloy René 142® on an SX substrate of René N5® at very high preheat temperatures on a modified laboratory facility. SEM and EBSD were used to examine the manufactured samples for the formation of defects and grain structure.

1 Creep sample (left: René N5 SX, right: René 142 SLM).

2 Cross section of René 142® on René N5® with visible grain structure.

Result

With preheat temperatures considerably greater than 1000 °C in the working plane, crack-free samples can be manufactured with low porosity (< 0.2 percent). The structure exhibits homogenously arranged grains solidified in the direction of construction. The orientation of the <001> crystal layer is parallel to the building direction and only has a small scattering of approx. ± 7° maximum. The creep strength of heat-treated samples – consisting of René 142® and René N5® in equal parts – is greater than that of the widely used nickel-based superalloy MAR-M-247LC® (DS) at 980 °C and identical tensile testing.

Applications

The repair of components with DS or SX microstructure is particularly important for turbomachinery construction in the aviation industry and energy management.

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