



PRODUCTION OF TURBINE COMPONENTS OUT OF MAR-M-509®

Task

Components in the hot gas zones of turbomachinery must exhibit great high-temperature strength and corrosion resistance. The cobalt-based superalloy MAR-M-509® meets these requirements and is primarily used for static components such as vanes in aircraft engines and stationary gas turbines. This alloy, which currently can only be produced by casting, should be processed with Selective Laser Melting (SLM) in the future. The project aims to monolithically produce, for example, blade seals with a honeycomb structure or components with internal cooling structures, each of which are difficult or impossible to manufacture with conventional methods.

Method

Within the BMBF-funded project »EFCOPOST«, the SLM process is being developed for the manufacture of complex structures having walls as thin as possible out of MAR-M-509® on a commercial SLM system. Based on this, both the microstructure will be analyzed (pores, cracks, grain structure) and mechanical properties determined in the heat-treated state (hardness, tensile strength at room temperature and up to 900 °C).

Result

While specific tolerances of the chemical composition of the powder are maintained, a crack-free structure has been achieved having a density > 99.8 percent with the developed process parameters. The minimum wall thickness achievable depends on the geometry and its orientation in relation to the building direction. In the best case, an average wall thickness of < 100 µm could be achieved with construction angles < 20°. Due to the layered manufacturing, the microstructure has elongated grains and a crystallographic preferred orientation in the building direction, which leads to anisotropic mechanical properties. Independent of this, the tensile strength is – both parallel and perpendicular to the building direction at room temperature and temperatures up to 900 °C – clearly greater than that of the cast material. In contrast, the modulus of elasticity is less than that of cast material in the entire temperature range.

Applications

The additive manufacturing of components from MAR-M-509® is primarily of interest for applications in turbomachinery construction. Furthermore, the alloy may be also used for high temperature applications in, for example, kiln technology and glass processing.

Contacts

Dipl.-Ing. Jeroen Risse
Telephone +49 241 8906-135
jeroen.risse@ilt.fraunhofer.de

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

3 Mockup of a blade seal with honeycomb structure.

4 Honeycomb in cross-section.