

SELECTIVE LASER MELTING OF SUPERALLOYS

Selective Laser Melting (SLM) is an additive manufacturing method for producing complex metallic components in small quantities. Also offering low material consumption, this process is a great economic alternative to produce high value small-scale series, e.g. those found in gas turbines in the energy and aerospace industry. In addition to this economic advantage, SLM allows engineers to design parts without the usual restrictions imposed by conventional manufacturing methods. Turbine blades, for instance, can be produced with complex internal structures, increasing cooling efficiency or reducing overall weight.

Currently, SLM only plays a minor role in the production of gas turbines, the main limitation being the processable materials. Used widely in this field, nickel and cobalt based superalloys offer great mechanical strength, and corrosion and oxidation resistance at high temperatures. The key problem of these alloys, however, is their susceptibility to cracking during thermal processing as in SLM. Like in the field of welding, they can be graded as insusceptible to cracking (weldable) and susceptible to cracking (unweldable or difficult-to-weld).

Alloys Insusceptible to Cracking

The weldable nickel-based superalloys Inconel 718 and Hastelloy X, and the cobalt-based superalloy MAR M509 can be processed successfully by SLM. Produced parts have a sound and crack-free microstructure with a density of > 99.5 %.

1 Mockup of a monolithic turbine seal with honeycomb in cobalt-based superalloy MAR M509.

2 Segment of a nozzle guide vane manufactured in nickel-based superalloy Inconel® 738LC.



The mechanical properties are equivalent to those of conventional produced parts or even exceed them. The build rate of commercial SLM machines is in the range of 1 - 3 mm³/s. By increasing the laser power used to up to 1 kW and adapting further process parameters, the build rate can be increased on ILT laboratory systems to approx. 10 mm³/s.

Alloys Susceptible to Cracking

The microstructures of produced samples out of unweldable or difficult-to-weld nickel-based superalloys show extensive cracking. Investigated at Fraunhofer ILT, one approach to prevent cracking is to use high temperature pre-heating during the process. The principle feasibility of this approach was demonstrated on plain samples. Current studies are concentrating on process engineering and system development in order to manufacture more complex parts.

Our Service

- Adaption of SLM process for your materials and geometries
- Application testing of the process for your manufacturing

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