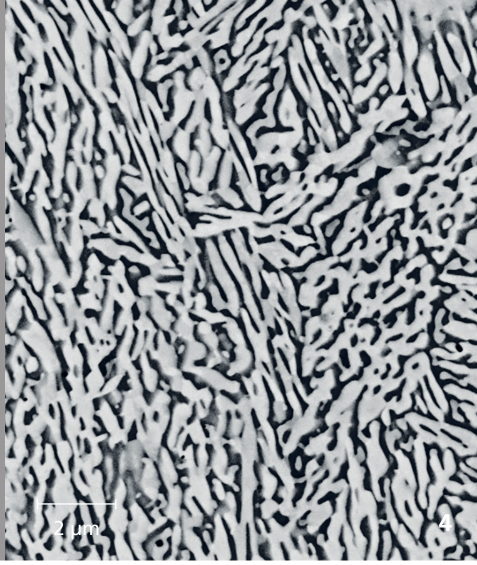

COBALT-FREE, HIGH-ENTROPY ALLOY FOR ADDITIVE MANUFACTURING

Task

High-entropy alloys (HEA) exhibit both high strength and ductility as well as good corrosion and wear resistance thanks to the large mixture entropy of multi-element compounds. These properties make HEA particularly suitable for producing components subject to complex stresses. As part of the NADEA joint project, Fraunhofer ILT has developed an HEA that can be processed with additive manufacturing (AM) and that surpasses the properties of conventional duplex steels. A key objective is to avoid the use of cobalt, a metal that is not only harmful to the environment and health, but that is also rare.

Method

Fraunhofer ILT is investigating how well $AlCrFe_2Ni_2$-based alloys can be processed with laser material deposition. With rapid screening by simulation (Access e. V.) and experiment (Fraunhofer ILT), both project partners selected a suitable material composition. One challenge they face, however, is reducing the material's susceptibility to cracking. Suitable build-up strategies were, therefore, developed focusing on local temperature management. The group aims to develop a stable process window for the geometrically variable, near-net-shape build-up of real component geometries such as pump impellers.

Results

The partners achieved crack-free processing of $AlCrFe_2Ni_2$ into a near-net-shape component with a density > 99.5 percent. Investigations at the project partner Access e. V. show that a superfine FCC-BCC duplex structure is obtained after solution annealing and ageing and has a yield strength $R_{p0.2}$ of 600 MPa. The tensile strength R_m is 1100 MPa with a total elongation of 27 percent. A comparable duplex steel achieves $R_m \approx 900$ MPa, $R_{p0.2} \approx 640$ MPa and $A \approx 20$ percent in the tensile test.

Applications

The alloy developed can be broadly used for the oil and gas industry and mining, and is equally predestined for applications in the off-shore sector and the chemical industry.

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Contact

Dr. Silja-Katharina Rittinghaus, Ext: -8138
siljakatharina.rittinghaus@ilt.fraunhofer.de

Dr. Andreas Weisheit, Ext: -403
andreas.weisheit@ilt.fraunhofer.de

3 Pump impeller.

4 $AlCrFe_2Ni_2$ microstructure (© Access e. V.).