



HIGH-ENTROPY MATERIALS FOR THE ADDITIVE MANUFACTURING OF MOLDING TOOLS

Task

High-entropy alloys are a new alloy class that combines high heat resistance with good ductility. They are, therefore, particularly suitable for components that have to withstand, both mechanically and thermally, substantial loads. For example, press hardening tools are subject to these stresses and also require the integration of complex channel structures to effectively cool the tool. Within a collaborative research project, Fraunhofer ILT has developed a high-entropy alloy that can be processed using Selective Laser Melting (SLM), also known as laser-beam melting or Laser Powder Bed Fusion (LPBF).

Method

On the basis of the Al_xCoCrFeNi alloy system, promising alloy compositions were first identified. The process used was laser material deposition (LMD), which, in contrast to SLM, enables a rapid screening of many alloy compositions with small amounts of powder mixtures. First, the aluminum content was adjusted to produce a bimodal microstructure representing the best possible compromise between high strength and sufficient ductility. Through further additives as well as adaptation of the process control, the thermal stability of the microstructure was improved by grain refining and increasing the strength.

1 Solid body made out of Al_{0.7}CrCoFeNi with LMD.

2 Nanoscale microstructure of a specimen made with LMD (source: ACCESS e.V.).

Results

LMD was used with an Al_{0.7}CoCrFeNi alloy and, through adaptation of the process control, extremely fine-grained microstructures were produced which reach a substantial hardness through alloying additives: up to 800 HV_{0.1}. However, the microstructures produced still have a high crack sensitivity, which makes it necessary to use preheating in the process.

Applications

The process can be applied in additive manufacturing where, in particular, the highest demands are placed on design and material properties. In addition to tool making, applications can be found in turbomachinery and the aerospace sector.

This project is being carried out for the state of North Rhine-Westphalia through the use of funds from the »ERDF Regional Operational Programme 2014-2020« under grant number EFRE-0800627.

Contact

Markus Benjamin Wilms M.Sc.
Telephone +49 241 8906-567
markus.benjamin.wilms@ilt.fraunhofer.de

Dr. Andreas Weisheit
Telephone +49 241 8906-403
andreas.weisheit@ilt.fraunhofer.de