



LASER-BASED ADDITIVE MANUFACTURE WITH IRON-ALUMINIDE ALLOYS

Task

The interest in iron-aluminide alloys as a construction material for lightweight construction has been growing in the last few years due to the numerous advantages of this material. Fe-Al alloys have low density, high oxidation resistance, strength against hot corrosion as well as a low share of strategic elements: the main reasons why these alloys can replace high-temperature steel. While these alloys exhibit low ductility and low creep resistance, they do not, however, stand in the way of their wider usage. From a technical point of view, additive laser processes, thanks to quick cooling rates, make it possible to get components with a fine-grained micro-structure, in order to reach the desired properties. A first goal in the joint project RADIKAL, funded by the Federal Ministry of Education and Research, is to test how easily a binary Fe-Al alloy can be processed. For this, simple bulk volumes were built and tested for density and cracks.

Method

Initial tests were conducted with the binary Fe 28at.% Al alloy. These were processed with Laser Metal Deposition (LMD) and Selective Laser Melting (SLM). The goal was to produce crack-free bulk volumes with low porosity.

Result

The selected alloy can be processed into crack-free bulk volumes with low porosity. When SLM was used, a density of > 99.9 percent was reached, and with LMD > 99.5 percent. Cracks were prevented by preheating (100 - 200 °C). Initial mechanical tests have shown that, in comparison to cast samples, SLM testing specimens exhibit higher strength. Adapting the process parameters did not, however, lead to grain refinement. Nonetheless, the results attained form the foundation for the processing of, e.g., ternary alloys, which form grain refining precipitations through a further alloying element and, thus, hold great interest for applications of the future.

Applications

Applications of the future of Fe-Al alloys lie in mechanical, chemical, thermal and corrosive heavy-duty components. Examples can be found in turbine engines, in assemblies for energy conversion or in the aerospace industry.

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3 LMD solid body out of Fe-28At.%Al.

4 Solid body of an Fe-Al alloy manufactured with SLM.