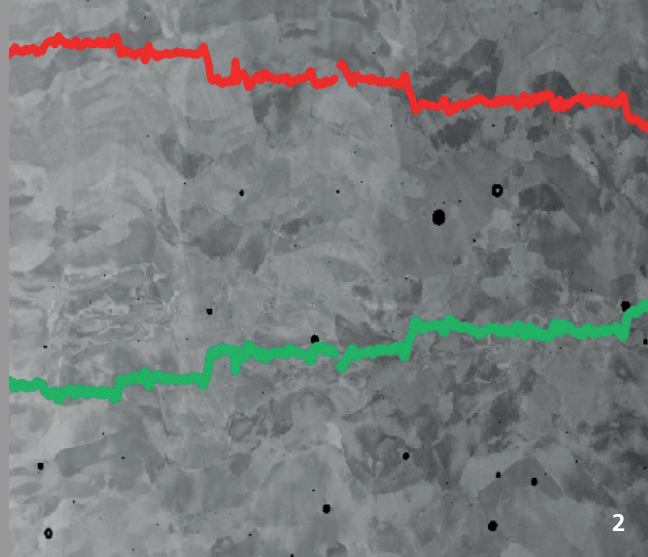


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FUNCTION ADAPTED COMPONENTS THROUGH MATERIAL GRADING

Task

Thanks to material grading, a component can be optimally adapted to the loading profile. A potential application for this is in turbine blade manufacturing. As a rule, the stresses within a turbine blade vary locally. The foot must primarily have a high strength, while the blade must be protected against corrosion and abrasion. Furthermore, gradations for the hybrid construction are of interest. As an additive manufacturing process Laser Metal Deposition (LMD) can be used to produce graded materials thanks to its powder-nozzle technology. The investigations described here have been carried out using the example of iron aluminide alloys, which are gaining interest as a construction material for lightweight construction in hot or corrosive environments. The layered increase in the aluminum content (improved oxidation resistance) and a grading to stainless steel (hybrid design) are being investigated.

Method

The grading is achieved in-situ by simultaneous supply of two powder components. One component is the binary alloy Fe-28at.-%Al. The second component is pure Al or 1.4404. By varying the applied powder mass flows, the composition of each layer is set to a defined value.

1 Solids out of Fe-Al.

2 Process element concentration Fe (red) and Al (green, from 0 to 40 at.-%) over the cross section of a graded sample.

Result

In the first approach, a step-like increase in the alloy composition is adjusted by a continuous increase in the powder feed rate of Al. The Al content is thereby increased from 28 to more than 40at.-% via a construction height of 5 mm. In the second approach, 1.4404 is initially built on a stainless steel substrate. In each further layer, the portion of 1.4404 is reduced while the percentage of Fe-28at.-%Al is increased. The tenth and last layer is comprised of the binary Fe-Al alloy. In both cases, defect-free solids have been constructed.

Applications

This graded or hybrid construction process will find applications primarily in complex and heavy-duty environments such as in turbine engines or pumps.

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