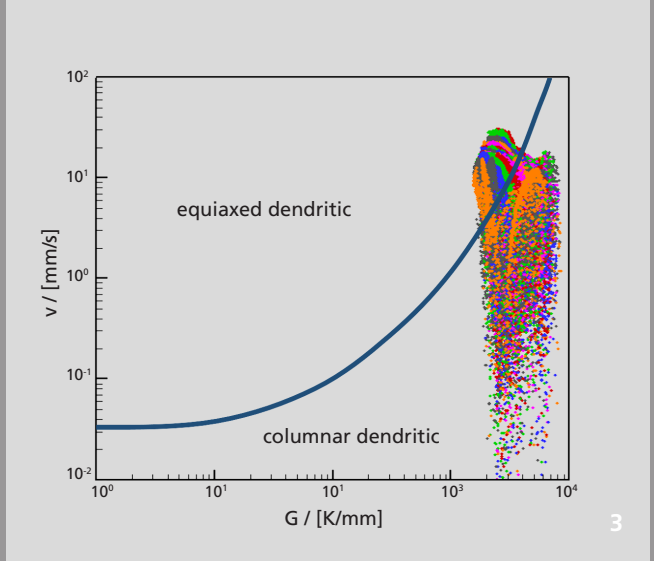

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LASER MATERIAL DEPOSITION WITH OSCILLATING LASER BEAM

Task

There is a high demand for repair deposition welding for components made of heat-resistant Ni- or Fe-based alloys. Selected high-temperature alloys can be processed with laser material deposition (LMD) at room temperature with a technically crack-free microstructure, but only at very low deposition rates. When the application rates are increased, solidification conditions result in a grain structure over multiple layers with cracks along the grain boundaries. The aim is to develop a process strategy with increased deposition rates, which can prevent this grain structure along the build direction and, thus, the resulting cracks from forming.

Method

In order to achieve a fine-grained structure, the solidification conditions must be adjusted so that equiaxed dendritic growth is preferred. For this purpose, a simulation tool was used to determine the resulting local solidification rates and cooling rates in advance as a function of the process parameters for a laser beam oscillating perpendicular to the direction of travel. The results were entered in a solidification diagram (Figure 3) and the areas identified for a preferably equiaxed dendritic growth. The experiment was implemented with scanner optics, which deflects the laser beam perpendicular to the direction of travel.

Results

The use of scanner optics for LMD leads to an oscillating solidification front with solidification conditions that prevent larger grains from forming in the build direction due to preferably equiaxed dendritic solidification (Figure 4). With the process developed here, significantly higher deposition rates can be reached with the same quality of deposition compared to the state of the art.

Applications

This method is suitable for all applications in which high-temperature materials susceptible to cracking must be processed with LMD, such as those in turbomachinery.

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3 Calculated solidification and cooling rates on the solidification front at different points in time, as well as the resulting micro structure.

4 Cross-section of a 3D structure with an oscillating laser beam and out of a nickel-based alloy susceptible to cracking.