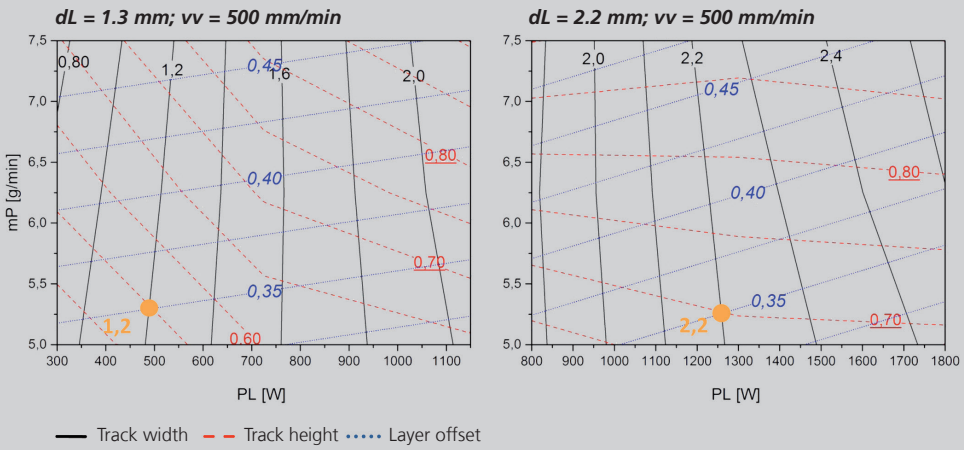

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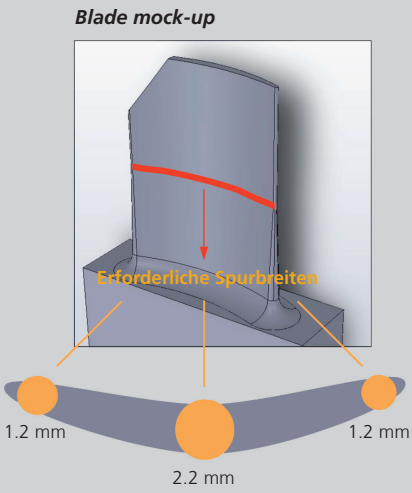

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DEVELOPMENT OF PROCESS DIAGRAMS FOR LASER CLADDING

Task

To develop a process for repairing of turbomachines, e.g. blade tips, with Laser Metal Deposition (LMD), the geometry and the material combination (substrate and filler material) are decisive factors. To reduce the required development effort, a »technology processor« has been developed within the Fraunhofer Innovation Cluster AdaM. On the basis of experimental and model-theoretic results obtained from a database and a modeling tool, this processor will provide initial values for process parameters and proposals for developmental strategies to use LMD for blade tip geometries. To represent the experimental knowledge for the user, process diagrams are developed for LMD.

Method

By means of a design-of-experiment approach, a process parameter field was created for three laser beam diameters dL, three feed speeds vv and, in each case, three laser powers PL and powder mass flows mP for the filler material Inconel 718. Then, tracks and thin walls were cladded with these parameters, analyzed metallographically and the track width, track height and the layer offset were documented. The geometries achieved are presented as a function of the process parameters (see Fig. 3).

Result

Thanks to the process diagrams, a representation has been developed with which the process parameters laser power PL, beam diameter dL, powder mass flow mP and feed speed vv can be depicted in a plane and welding results can be read with respect to the geometry. Figure 4 shows a blade with a profile width of 1.2 to 2.2 mm, which should be cladded in the region of the blade tip. The laser power required and the layer offset (see Figure 3: track width as vertical black lines; layer offset as diagonal blue dotted line) can be read out of the process diagrams as the initial process parameters for the track widths 1.2 and 2.2 mm at a constant powder mass flow (e.g. mp = 5.25 g/min). Furthermore, the identified test results serve as a basis for further model-theoretical investigations.

Applications

The process diagrams developed here can be applied to many repair cases. Fields of application are, in particular, turbomachinery construction and general mechanical engineering.

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3 Process diagrams for the beam diameter dL 1.3 and 2.2 mm for Inconel 718.

4 Blade which should be cladded in the tip area. The process parameters result from the process diagrams.