Hybrid additive manufacturing using LPBF for repair applications

The additive manufacturing process laser powder bed fusion (LPBF) is already being used on an industrial scale to produce highly complex components in small batches. In particular, industrial users are interested in realizing lightweight construction potential, e.g. through topology optimization, as well as in integrating a wide variety of functions in components (e.g. sensor technology). In hybrid additive manufacturing processes, layers are remelted on top of layers starting from a conventionally manufactured base body so that the overall component consists partly of conventionally manufactured and additively manufactured component areas. In principle, this hybrid process can reduce production costs and process times, as the costly and time-consuming LPBF process is only used for critical component areas or functional surfaces. In addition, hybrid additive manufacturing allows components (e.g. turbine blades or tools) to be repaired, which can significantly improve both the ecological and economic balance of component production.

Challenges of hybrid additive manufacturing

In hybrid additive manufacturing, the base body of the component serves as a substrate for the LPBF manufacturing process. To ensure that the overall component is functional, research needs to realize a material-locking, offset-free connection between the two component areas. To guarantee this, it is crucial to precisely reference the coordinate systems of the component, machine and laser scanner system.

Results and future research activities

Initially, Fraunhofer ILT evaluated a camera-based referencing system for its positioning accuracy and demonstrated it using the repair of turbine blades. Manual referencing of the component areas ensured both a material-locking connection and precise geometric alignment between the components.

In future work, the institute will assess machine-independent, adaptive referencing systems. In these systems, referencing is based on 3D scans of the components to be repaired. The system automatically adapts the LPBF production geometry to the actual geometry of the components that may be deformed during operation.

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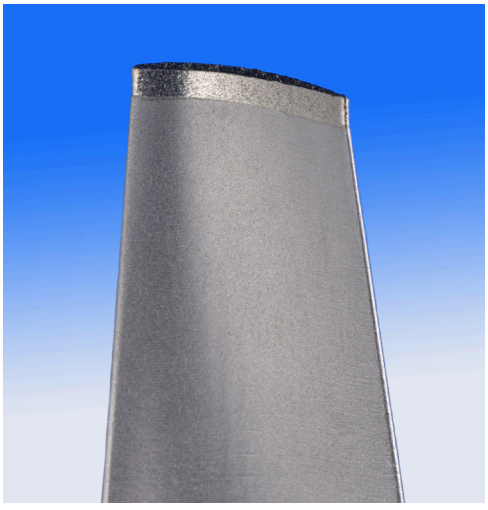

1 Transition between LPBF area (top) and cast base component. 2 Microstructure of the bonding zone between the base material and the LPBF area.