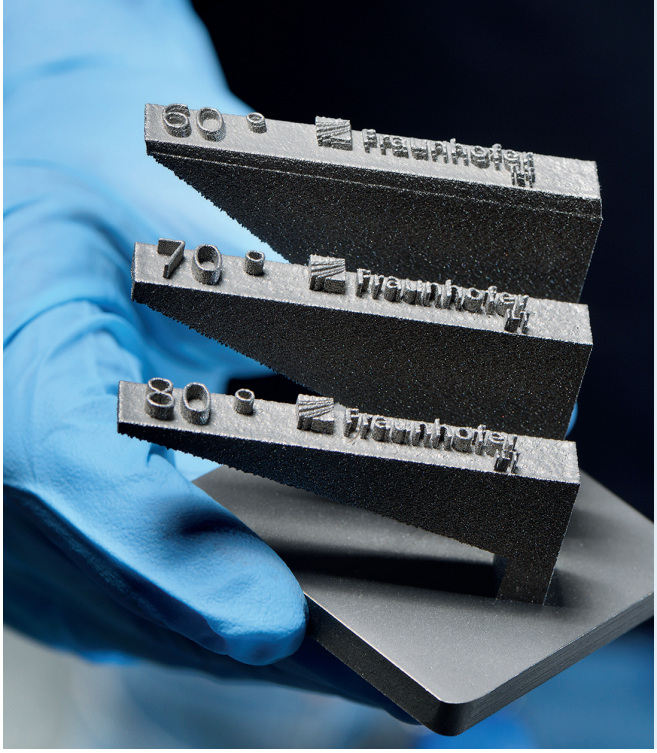

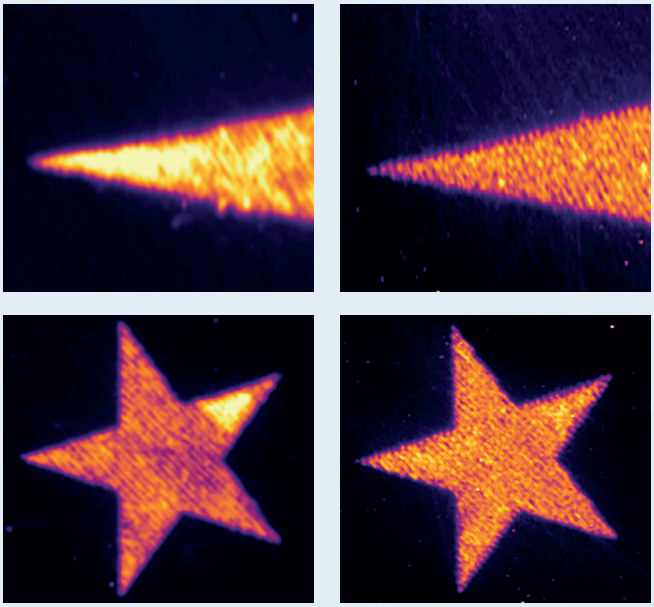

1 Specimens manufactured with adaptive process control with up to 10° overhang structures.
2 Thermographic images of test specimens without closed-loop control (left) and with closed-loop control (right).

Adaptive process control in laser powder bed fusion

Complexity in three dimensions "for free"?

In principle, metallic additive manufacturing makes it possible to produce complex components with nearly any geometrical shape. However, component geometry and orientation as well as local fluctuations of the process boundary conditions influence the spatial and temporal temperature distribution and, thus, the processing result. For example, overhanging or filigree component areas can thermally deform or crack. As current solutions, additional support structures are manufactured and the component geometry is restricted. To overcome this, Fraunhofer ILT is currently researching how manufacturing parameters can be locally adapted to homogenize component properties.

Process modeling and closed loop control

The institute is pursuing two complementary approaches in parallel. In the first, it is extracting typical geometric features from components and modeling and experimentally investigating the effect of these features on the temperature distribution. In addition, it is deriving rules for locally adapting the process parameters from the results and implementing them by means of a specially developed plant control system. In the second, it is monitoring the thermal emissions of the melting process and using the data in a closed loop to adapt the laser power.

More geometrical freedom with the same quality

By adapting the process parameters based on these rules, the institute can already produce components support-free and with an overhang angle of up to 10°. Even tapered component areas can be manufactured with much greater geometrical accuracy. By means of a closed control loop, the radiation intensity of the melt pool can be successfully homogenized. So far, this has made it possible to improve component quality, especially in the case of complex geometries within a single layer. In the future, the institute will combine the two approaches in an adaptive process control.

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