



ADDITIVELY MANUFACTURED HEAT SINKS FOR QUANTUM TECHNOLOGY APPLICATIONS

Task

In quantum technology applications, the individual operating temperatures of optical components are precisely controlled to ensure efficient operation. This thermal control is achieved via heat sinks, which, unlike the optical components, are usually made of metallic materials. During operation, however, thermally induced mechanical stresses occur between the heat sink and the optical component because the combined materials exhibit different thermal expansions. Furthermore, there is a challenge to set the temperatures in optical components locally and selectively with minimally extended thermal transition ranges between different temperature fields.

Method

Fraunhofer ILT used the design freedom of additive manufacturing to develop a multifunctional heat sink. On the basis of thermal simulations, it incorporated innovative design features such as lattice structures and developed novel structural elements that allow local adjustment of the mechanical behavior. The heat sink was additively manufactured from the titanium alloy TiAl6V4 using laser powder bed fusion (LPBF) and subsequently stress-relieved to avoid LPBF-induced deformation.

Results

An innovative design principle was utilized to compensate for thermally induced stresses in the interface area between optical component and the heat sink. Specifically, a tailored mechanical stiffness was used to set a defined deformation during operation. Minimization of thermal transition areas was ensured by lattice structures connecting the two differently tempered areas of the heat sink. Combining necessary mechanical stability with maximum thermal insulation enables the thermal transition area to be minimized.

Applications

In particular, this heat sink design can be applied in the field of quantum technology. Moreover, the design unlocks significant potential in the field of laser applications in space, where the reliability of the optical component is a top priority. In addition, improvements can generally be achieved in technical systems that consist of different component materials and in which precise temperature control is required.

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3 Additively manufactured heat sink.
4 Functional structures for thermal compensation.