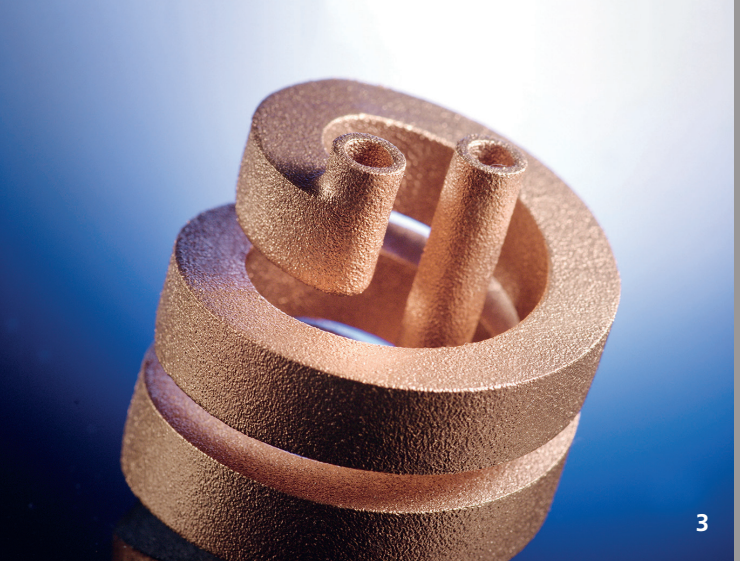

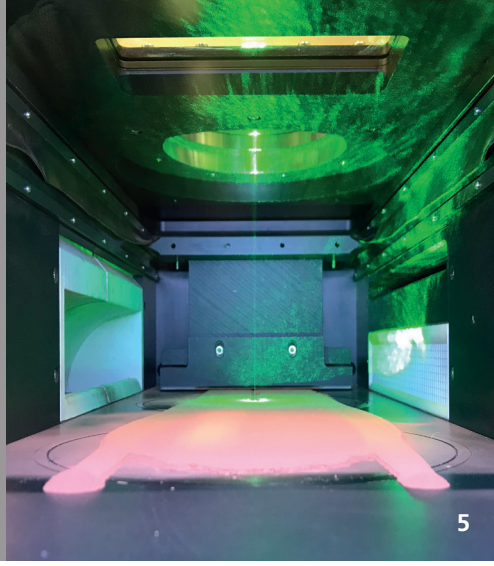

ADDITIVE MANUFACTURE OF HIGHLY CONDUCTIVE COPPER BY LPBF

Task

Fraunhofer ILT is currently working on a project funded by the AiF (The German Federation of Industrial Research Association »Otto von Guericke e.V.) and the DVS (German Welding Society) to implement system technology with a beam source emitting in the green wavelength range for the additive manufacturing process laser powder bed fusion (LPBF). The use of the green laser beam source makes it possible to process pure and electrically highly conductive copper. In comparison to copper alloys and other materials, pure copper is characterized by a low absorptivity for the conventionally used infrared wavelength and, due to its high thermal conductivity and low melt viscosity, poses a challenge for stable process control in LPBF's melting process. Conventionally processed copper alloys have a maximum of 80 percent of the conductivity of pure copper after additive manufacturing. However, for electrotechnical applications, full conductivity of the pure copper material is necessary to develop more efficient and functional components and to take advantage of additive manufacturing.

Method

Fraunhofer ILT characterized the available laser beam sources emitting in the green wavelength range in terms of their suitability for the LPBF process; then they were evaluated and used to develop the initial process parameters.

A systematic variation of the process parameters as well as adjustments of the powder material and shielding gas atmosphere shows how they influence the relative material density as well as the achieved material properties.

Results

By varying the process parameters, the institute was able to process pure copper using LPBF, achieving a relative material density > 99.8 percent. Controlled oxygen reduction in the atmosphere makes it possible to build up material samples that achieve the full specific conductivity of pure copper at 58 MS/m. Currently, the institute is focusing on developing process management suitable for the production of components.

Applications

Copper and its alloys are predominantly used in mechanical, plant and electrical engineering, where high electrical or thermal conductivity is required. When the advantages of additive manufacturing are fully exploited, new possibilities emerge for more efficient or functionally optimized components.

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3 Induction coil made of pure copper.
4 Micrograph of a pure copper sample.
5 Process picture: LPBF of copper using green laser radiation.