Lehrstuhl für Umformtechnik und Gießereiwesen
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Multimaterial Molten Metal-Jetting

Motivation

Multi-material components offer considerable potential for extending the functionality of a component by combining different materials and their material-specific properties, as special properties can be made available precisely at the local load point. There are already a large number of conventional manufacturing processes that enable the production of multi-material components with discrete and continuous material transitions. If components with complex geometry and/or in small quantities are required, this can usually only be realized economically with additive manufacturing processes. Established additive processes mostly use powder and laser sources to manufacture the components. The currently difficult powder separation process following the actual construction process causes a high use of resources. The Molten Metal Jetting process, which uses an easy-to-handle wire-shaped semi-finished product, offers considerable potential for saving resources in the production of multi-material components. The droplet-by-droplet structure of components makes it possible in principle to change materials in all spatial directions with a resolution the size of a droplet. This means that filigree structures made of different materials can be produced cost-effectively within a single component.

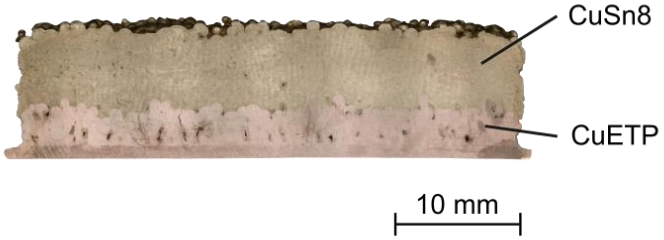

Figure 1: Multi-material component made of CuSn8 and CuETP using Molten Metal Jetting.

Approach

The aim of the research project is to demonstrate the fundamental manufacturability of multi-material components with controllable composite quality using molten metal jetting. Components consisting of technically pure copper Cu-ETP and the copper-tin-bronze CuSn8 are to be produced. It should be possible to carry out the material change with a resolution in the range of a droplet size. To begin with, a suitable print head is to be developed with which both materials can be processed during a printing process. To identify suitable process parameters, components are to be produced at different parameters and then characterized. There is a particular need for research in the production of components in which the higher-melting Cu-ETP is applied to CuSn8, as the substrate temperature should be close to the melting temperature of the construction material for processing. However, this is limited by the solidus temperature of the CuSn8 material of 860 °C, which means that the thermal energy for bonding the droplets to the substrate must be provided by the newly impinging droplets. The results obtained from real tests will be supported by the simulation of the printing process.

Outlook

By investigating the multi-material molten metal jetting, components with locally adapted properties can be produced cost-effectively. The knowledge gained can also serve as a basis for the production of composite components with a different material composition.

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