

# Functionally graded materials: continuous casting and forming of electrical copper conductors

## Motivation

With regard to the demand for increased lifetime and high power density, the potential of monolithic metallic structures has been largely exhausted. Therefore, trend-setting academic and industrial activities have emerged that focus on the use of hybrid material structures for electrical applications. The present project aims at investigating the process route for the fabrication of electrical copper conductors. In particular, the project focuses on the development of functionally graded copper components that exhibit locally adapted structural behavior optimized for specific electrical application requirements.

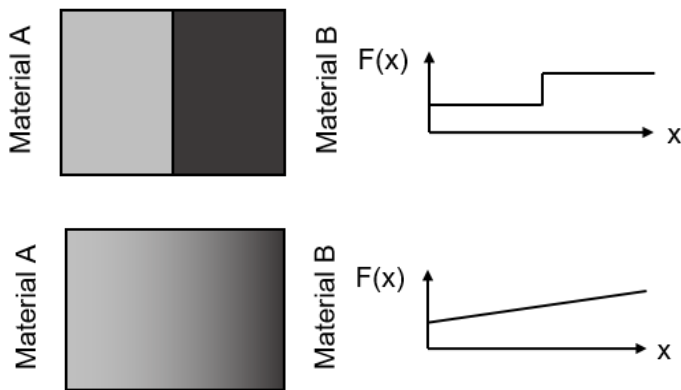


Figure 1: Hybrid materials: layered compound and functionally graded material

## Solution

The initial graded component character is created in the casting process by adding a zinc alloy component to a pure copper base material. A defined material gradient across the semi-finished product cross-section is to be set by dissolution and diffusion mechanisms. The graded starting material is further processed by extrusion and wire drawing. The challenge in solid forming of functionally graded materials lies in controlling the material flow in the process. The novelty in this project lies in the targeted control of the material flow by the process temperature. By adjusting the process

temperature during extrusion, the strength of the different materials can be varied in such a way that the material is accelerated or slowed down locally. Another major focus of the project is the characterization of the mechanical, structural and electrical properties of FGMs throughout the process chain.

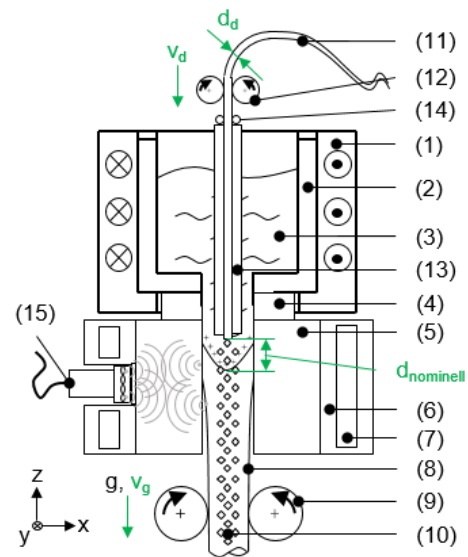


Figure 2: Principle sketch of the set-up for determining the temperature profile in inorganic molding material during casting

## Outlook

As part of the research project, a methodology is being developed for the cross-process production of functionally graded materials (FGM). A novel feature of the approach is that the mechanical and electrical property profiles in the process route "continuous casting, extrusion and wire drawing" can be adjusted by controlling the process temperatures. The investigations are carried out using electrical copper conductors as an example and can be applied to a large number of metallic material combinations.