Chair of Metal Forming and Casting
TUM School of Engineering and Design
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Flat rolling of extruded Al/Cu composite strips with geometrically designed interfaces

Final Report

Motivation

By combining two dissimilar materials, the properties of the resulting composite can be optimized with respect to both cost and material characteristics, such as weight and electrical conductivity. The conventional production route for aluminum-copper clad semi-finished products by means of cold roll bonding requires multiple processing steps to achieve the required bond strength. Reducing the process chain to a composite continuous casting process followed by finish rolling enables the near-net-shape and cost-effective production of aluminum-copper semi-finished products. The formation of intermetallic phases within the bonding zone during continuous casting begins upon the initial contact between the liquid aluminum and the copper strand. The elevated process temperatures further promote their formation. A high degree of surface expansion is required during rolling to fracture the brittle intermetallic phases and bring the base materials into direct contact, thereby enabling the formation of a metallurgical bond.

Methodology

The objective of this work was to develop an energy-efficient process for the production of aluminum-copper composite semi-finished products as an alternative to conventional roll bonding. For this purpose, a horizontal composite continuous casting process was established, in which a copper strand is first cast and subsequently combined with molten aluminum within the same mold to produce a composite strand. The continuous casting facility was extensively modified, and the process parameters were systematically investigated, with particular emphasis on the thermal interactions between the copper substrate and the aluminum melt.

Results and Outlook

To estimate intermetallic phase formation, laboratory-scale specimens were inductively heated under a controlled atmosphere, and the resulting phases were analyzed with respect to the applied thermal boundary conditions. In a second step, the composite strands were flat-rolled into semi-finished products. The development of the metallurgical bond was investigated as a function of process parameters such as temperature and thickness reduction. The bonding zone was characterized metallographically, and shear strengths exceeding 60 MPa were achieved. In addition, a profiled interface for mechanical interlocking of the layers was investigated.

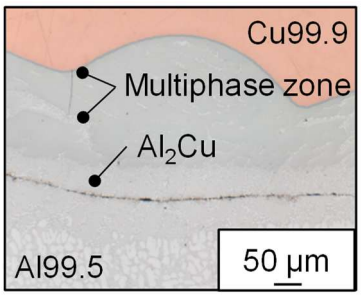

Figure 1.Al-Cu Composite at Laboratory Scale, Hoyer et al., 2022, 36. Aachener Stahlkolloquium Umformtechnik,

Publications

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Project Partners

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