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Flat rolling of extruded Al/Cu composite strips with geometrically designed interfaces

By combining two different materials, the product properties of the composite material can be optimized in terms of costs and material properties such as weight or electrical conductivity. The previous process route for producing aluminum-copper composite semi-finished products using cold roll cladding requires several process steps to achieve the necessary composite strength. Reducing the process route to a continuous composite casting process with subsequent finish rolling enables the production of aluminum and copper semi-finished products close to the final dimensions and at low cost. The formation of intermetallic phases in the composite zone in the continuous casting process already begins with the first contact of the liquid aluminum with the copper strand. The increased temperatures during the process also promote formation. A high surface enlargement is necessary for a successful rolling process so that the brittle phases can break open and the base materials can come into contact with a material bond. Until now, this has resulted in delamination between the bonding partners, as high shear stresses occur in the bonding zone due to the difference in strength of the base materials.

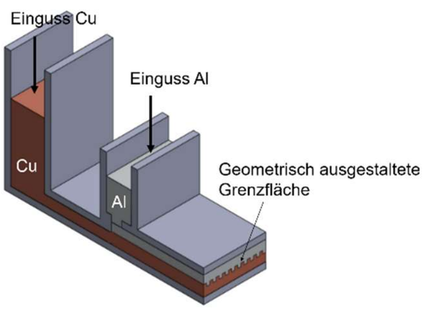

Figure 1: Process sequence for horizontal composite continuous casting

Approach

Our current research project, funded by the German Research Foundation (DFG) - 457434681, focuses on the composite continuous casting process route with subsequent finish rolling. Together with the Institute for Forming Technology (ibf) at RWTH Aachen University, the Chair of Forming Technology and Foundry Engineering (utg) is researching the realization of the shorter process route compared to cold roll cladding. Due to the pronounced intermetallic phase formation in the bonding zone and the resulting delamination in the rolling process, this process has not yet been used industrially. A geometrically pronounced interface is to be introduced into the composite zone using a structured sliding mold to realize the economically attractive process route of continuous composite casting and subsequent flat rolling despite pronounced intermetallic phase formation. This geometric constraint can prevent relative movements between the bonding partners and thus reduce undesirable shear stresses. Therefore, the increase in surface area during rolling can be realized without the bond partners shearing off.

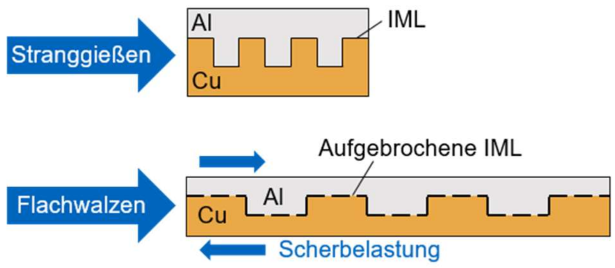

Figure 2: Rolling the geometrically designed interface

Procedure and outlook

Different mold geometries are investigated experimentally and simulatively to investigate the solidification conditions at the interface. The geometric design of the interface influences both the process stability and the effectiveness in avoiding shear stresses and, thus, the bond strength of the end product. Due to the pronounced solidification shrinkage during casting, shrinkage effects on the mold profiles must be considered. The geometry in the bonding zone also influences the ability to compensate for shear stresses occurring during the rolling process.
Finally, the results are to be used to expand the portfolio of geometries produced by continuous casting to include profiled surfaces and to enable the production of aluminum-copper composite semi-finished products.

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