SPP 1640|A3

Investigation and enhancement on bonding by cold bulk metal forming processes

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Abstract

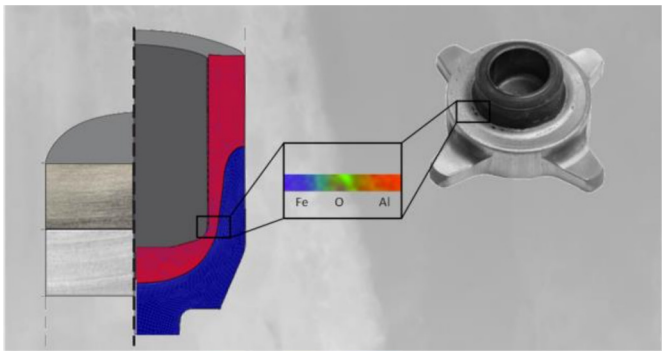
Due to the usually high mechanical requirements, today's lightweight construction materials repeatedly reach their strength limits. A combination of materials with different physical properties (e.g. aluminum-steel) offers a promising option to adjust components to the load. Impact extrusion is a suitable starting process for creating material-locking connections between solid components. This process generates a high surface enlargement and contact normal stress, which are necessary to achieve a high bond strength.

Project description

Within the scope of the project, the cold pressure welding process was investigated by means of experimental and numerical analyzes. A high-strength welded connection between steel and aluminum, which classically cannot be joined by fusion welding, was realized as shown by the demonstrators in Figure 1. In addition, the joining mechanism was analyzed so that the findings gained can be transferred to other components and processes.

Results

At the beginning of the project, an adjustment of the initial strengths proved to be advantageous for increasing the bond strength. Furthermore, it was found that the surface pretreatment has a significant influence on the composite formation and strength. Various mechanical and chemical processes for surface pretreatment were analyzed with regard to their influence on the formation of the composite. Methods that produce a high purity of the surface (e.g. brushing, etching and plasma treatment) were particularly suitable and are therefore promising measures to strengthen the composite. The goal of improved reproducibility of the process was also achieved by a deeper understanding of the bonding mechanism. The composite mechanism was analyzed by TEM and electron energy loss spectroscopy, thus increasing the understanding of the process on a near atomic level. It has been shown that no intermetallic phase is formed. The surface preparation method of brushing was optimized and the load capacity of the components was investigated under realistic conditions on a torsion test rig. Likewise, no increased corrosion of the composite zone was detected, so that an industrial transfer of the knowledge gained so far is the next step in the follow-up project.



[1] Cold extrusion welding of steel and aluminum

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