Microstructure and residual stresses of high-strength steel to aluminium alloy friction stir welds

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The increasing use of light weight constructions requires the development of reliable and cost efficient joining methods. Based on the plastic deformation in the solid state and without associated melting, friction stir welding (FSW) has become an important process for joining dissimilar alloys. In automotive and other transportation industry particular interest arises in hybrid systems containing both steel and aluminium alloys.

In the present work, FSW was applied to produce a dissimilar butt-joint between HC260LA high-strength steel and AA6181-T4 aluminium alloy. The complex material flow and the different thermo-mechanical material properties result in a very complex microstructure. The results show a well defined interface aluminium-steel, where fine intermetallic bands are formed. The dynamic recrystallization process, which occurs during welding, results in the formation of nanosized grains in the steel side, while in the aluminium side the grains are only slightly smaller than in the base material.

Unlike similar FSW joints, the residual stress analyses reveal in the present case an asymmetric stress profile when going from the aluminium to the steel side. The stress values are in general low and the mechanical properties of the butt-joints, consequently, appear to be not influenced by the residual stress state.