Joining of Steel-Aluminium Hybrid Structures with Electron Beam on Atmosphere

F.-W. Bach[a], A. Beniyash[b], K. Lau[c] and R. Versemann[d]

University of Hanover, Institute of Materials Science,
Schönebecker Allee 2, 30823 Garbsen, Germany

[a]bach@iw.uni-hannover.de, [b]beniyash@iw.uni-hannover.de, [c]lau@iw.uni-hannover.de,
[d]versemann@iw.uni-hannover.de

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Abstract. Against the background of the required weight reduction in transportation through lightweight construction, the application of hybrid structures, where dissimilar materials are joined together, has a high technical and economical potential. In the field of sheet machining, combinations of steel and aluminium are especially interesting. In comparison to conventional steels, the application of aluminium alloys as supporting materials makes a distinct weight reduction possible. On the other hand, steels have advantages in the fields forming and welding. The application of modern high-strength steels with reduced sheet thicknesses allows weight reduction, too.

But joining of material combinations of steel and aluminium is problematic. On the one hand brittle intermetallic compounds are formed between steel and aluminium. On the other hand the aluminium melt has a bad wetting behaviour. Different physical properties of both materials have to be considered, too.

To achieve sufficient mechanical properties of such joinings it is necessary to limit growth of intermetallic compounds between steel and aluminium. This can be actualized by an exact energy supply. With the electron beam on atmosphere a precise and easily controllable energy supply is possible.

The publication demonstrates successful investigations, which were performed with the 175 kV-NVEBW (Non Vacuum Electron Beam Welding) installation at Institut of Materials Science, University of Hanover. With NVEB joining hybrid structures between zinc coated steels and 5.xxx and 6.xxx aluminium alloys were produced. In a welding-brazing process (the steel remained in the solid phase whereas the aluminium was molten) combinations with acceptable mechanical properties could be joined. By use of optimized joining parameters as well as a surface activating flux, both, a good wetting and a thin intermetallic compound < 10 µm were attained. Another possible strategy is a pure brazing process, for which an example is also given in the paper. The paper shows metallurgical and mechanical investigations, among other things results of element distribution analysis and tensile tests.