

Teilprojekt A4: Pressure welding with electrochemical support

Elektrochemisch unterstütztes Fügen blechförmiger Werkstoffe (ECUF)

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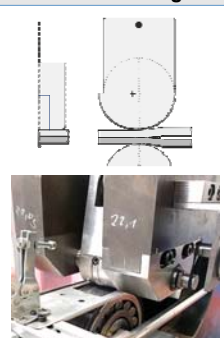
Status quo / Research goals

- Pressure welding applications: e.g. roll cladding
- Challenges
 - Limited range of metal combinations
 - Only fully-clad blanks, no single points
 - Only suitable for flat blanks
- Research for a new manufacturing process
 - Flexible design and placement of the pressure welded joints
 - Increase range of materials
 - Manufacture of hybrid metal blanks (e.g. steel - aluminium)
 - High strength materials

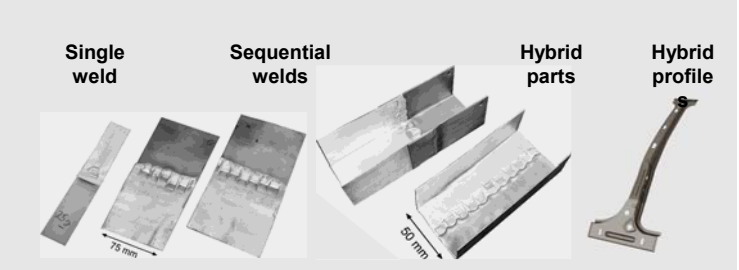
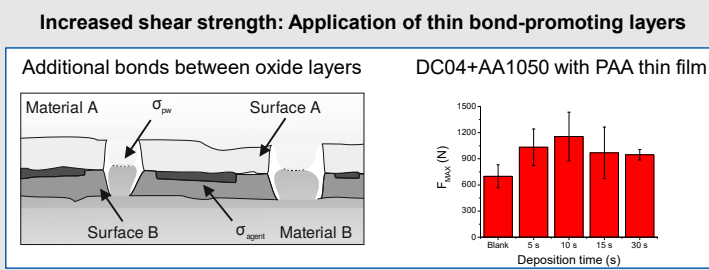
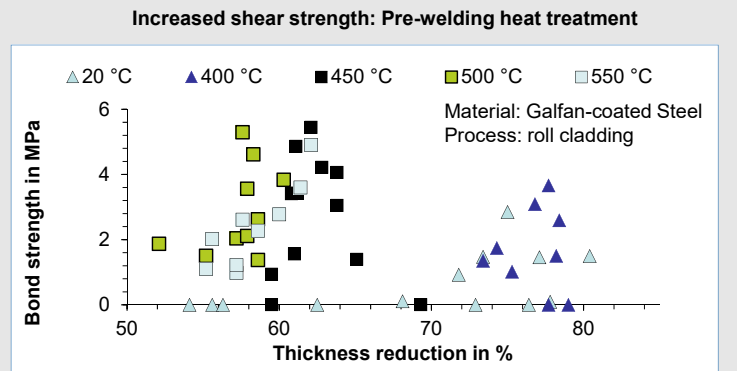
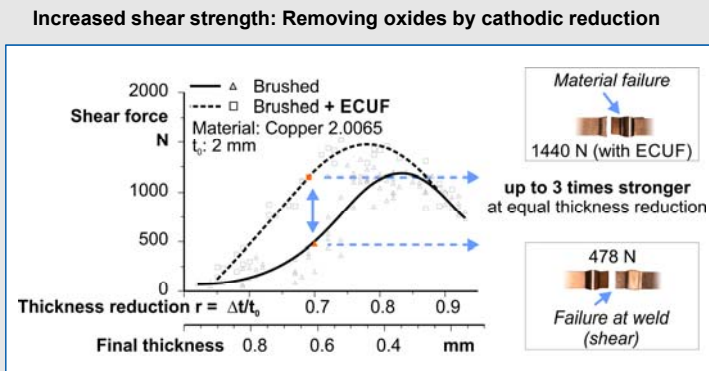
Research methods

- Experiments
 - „Joining by forming“ → incremental rolling
 - Mechanical tests (shear test, pull-off test)
- Micro-structural analysis
 - EBSD, ESMA, REM, AFM
- Surface analytics
 - Ellipsometry
 - Cyclovoltammetry
 - Corrosion
- FE-based analysis (forming & pressure welding)

Incremental rolling tool



Results



Summary

- Partially welded blanks can be manufactured by incremental rolling
- Tool and process design take great influence on weld strength
- Electrochemical surface technology can improve the weld-ability by material specific treatments:
 - Oxide reduction
 - (Hybrid) organic thin films
- Heat treatments can further increase the weld strength by
 - Post-welding HT: additional bonds (diffusion)
 - Pre-welding HT: creating brittle surface layers (e.g. intermet. phases)

Recent publications

“Influence of Heat-Pretreatments on the Microstructural and Mechanical Properties of Galfan-Coated Metal Bonds” I. Hordych, H. C. Schmidt, W. Homberg, H. J. Maier. AIP Conference Proceedings 1960 (2018), Vol. 1960, p. 40007.

“Cold Pressure Welding Aluminium-Steel Blanks: Manufacturing Process and Electrochemical Surface Preparation” H. C. Schmidt, A. G. Orive, W. Homberg, G. Grundmeier, I. Hordych, H. J. Maier. AIP Conference Proceedings 1960 (2018), Vol. 1960, p. 50007.

“Molecular Engineering of Aluminium-Copper Interfaces for Joining by Plastic Deformation” Hoppe, C., Ebbert, C., Voigt, M., Schmidt, H.C., Rodman, D., Homberg, W., Maier, H.J., Grundmeier, G. Advanced Engineering Materials 6 (2016), Vol. 18, pp. 1066-1074

“Effect of Pre-Rolling Heat Treatments on the Bond Strength of Cladded Galvanized Steels in a Cold Roll Bonding Process” I. Hordych, D. Rodman, F. Nürnberger, C. Hoppe, H. C. Schmidt, G. Grundmeier, W. Homberg, H. J. Maier. steel research int. 87 (2016) pp. 1619-1626