MANUFACTURING PROCESSES FOR AUTOMOTIVE STRUCTURES IN MULTI-MATERIAL DESIGN CONSISTING OF SHEET METAL AND CFRP PREPREGS

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1 ABSTRACT

To meet the objectives of climate protection in the automotive industry new innovative and holistic approaches of lightweight design need to be found. In automotive lightweight construction three main trends are obvious: lightweight design is realized by using high-strength metal alloys, by substituting e. g. metals for composites, or by combining different materials. These multi-material systems involve the greatest lightweight potential if technological, mechanical and economical aspects are considered.

Current research work within the scope of a collaborative research project at the Chair for Automotive Lightweight Construction (LiA) and the Chair of Forming and Machining Technology (LUF) at the University of Paderborn concentrates on the development of manufacturing processes for the production of automotive structure components consisting of sheet metal blanks with local Carbon Fibre Reinforced Plastic (CFRP) patches. The aim of the investigations is to realize short process chains and cycle times, to reduce common time-consuming manual process steps and material costs. In this context, a local CFRP reinforcement in sheet metal structures offers a high lightweight potential because the reinforcing patch can be applied especially in highly loaded areas while the reinforcing properties can be adjusted to special load cases. Furthermore, due to the locally limited application of CFRP the material costs can be effectively reduced compared to mere CFRP parts. To implement the defined objectives as well as potentials of local reinforcements in
industrial applications several approaches are being developed. The research work focuses on two different technologies. On the one hand, the prepregs are locally moulded to sheet metal structures and cured afterwards. Caused by separate process steps for forming the sheet metal and a following moulding operation for the prepreg, this prepreg-press-technology is especially suitable for reinforcing press-hardened structural parts. One further approach investigated in the research project is an integrated forming procedure of sheet metal with a locally applied CFRP prepreg and an integrated or subsequent curing process. This approach promises short process chains, but a high complexity in process control and tool design given the differences in material properties of sheet metal and CFRP prepregs. The development of adequate tool concepts and process control is subject of this work. Both approaches will be investigated in detail and optimized by complementary experimental and numerical research work.

This paper will show basic technological investigations in the field of prepreg-press-technology and integrated forming of sheet metal and CFRP. After giving an overview of the process of manufacturing multi-material components by using sheet metal and CFRP prepregs research results regarding tool design, process and forming parameters as well as process control and cycle times will be discussed. With expected cycle times of less than five minutes the developed approaches for manufacturing locally reinforced components are one possibility to solve the challenges of high-volume manufacturing in the field of CFRP. Additional results for crash tests, e.g. of double-Z profiles, demonstrate the crashworthiness of this new class of materials. Finally, detailed concepts for high-volume processing of structural automotive components with multi-material systems will be discussed.