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CRASHWORTHINESS OF HYBRID METAL / FIBER-REINFORCED PLASTIC STRUCTURES

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ABSTRACT

The application of hybrid components in high volume automotive car bodies currently faces two main challenges, which will be addressed in this keynote lecture:

(i) Capable finite-element (FE) simulation methods for computer aided-engineering (CAE).
(ii) Development of efficient manufacturing processes for hybrid components.

For the assessment of the crashworthiness of the hybrid structures the specific energy absorption is considered. The presented study covers the complete process chain from manufacturing to recycling.

Keywords: Hybrid structure, crashworthiness, finite-element analysis, intrinsic manufacturing.

INTRODUCTION

Due to ecological constraints, as reduced CO_2-emissions and the limitation of resources, automotive lightweight design becomes increasingly important. However, despite of reducing the vehicle masses in order to lower fuel consumption, the car occupant protection must at least be maintained or even has to be improved. To reach this ambitious aim new and innovative material concepts for structural components are needed. Following the approach of material-based lightweight design, the use of high- and ultra-high-strength metal alloys or the substitution of metals by fiber-reinforced plastics (FRP) is currently forced.

With regard to costs, preferably metallic structures are used, however, with regard to lightweight potential, FRP materials often outperform the metallic solutions. In this sense, the combination of FRP with sheet metal to hybrids can provide cost-efficient solutions compared to pure FRP components and a high lightweight potential as well. A further advantage of the hybrid structure is that the integration in existing body-in-white structures can easily be achieved by conventional processes. For all structures, crashworthiness is one of the major dimensioning parameters.

RESULTS AND CONCLUSIONS

In the case of hybrid structures consisting of metal and FRP parts, specifically adapted complex mechanical as well as physical-chemical properties can be achieved within one structural component, leading to a significant weight saving potential. Fig. 1 shows the specific energy absorption (SEA) of circular tubes under axial impact. The hybrid component indicates an increased SEA of about 37% compared to the aluminum specimen.

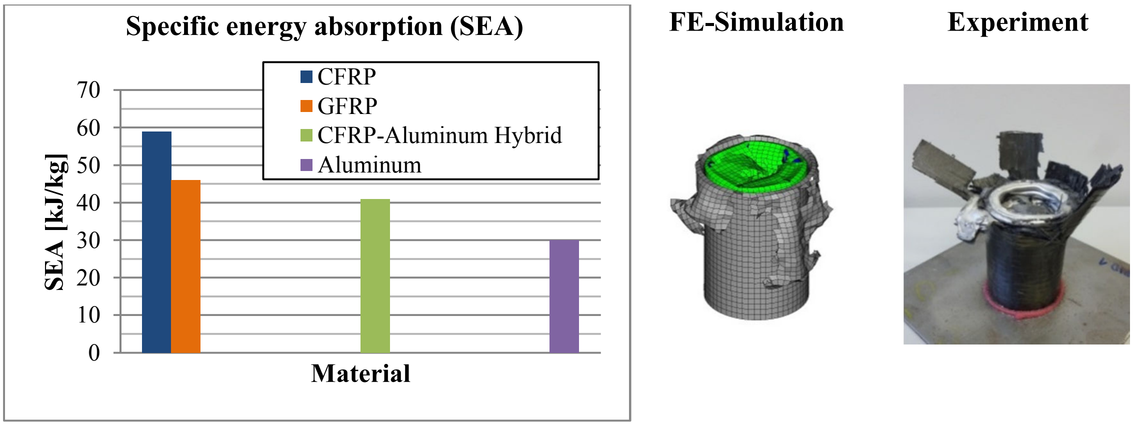

Fig. 1 - Specific Energy Absorption for thin-walled circular tubes under axial impact

For the efficient design of components capable simulation methods are needed. Recent work indicates progress in the development of a predictive FEM strategy, relying on few adjustable parameters [1]. Figure 1 shows the good agreement between experiment and simulation.

Although the lightweight potential is obvious, there are very limited high-volume industrial applications due to the cost-intensive manufacturing of such components. One promising approach to lower the costs is the development of intrinsic production technologies. An example is shown in Figure 2, where forming and bonding of the hybrid component are integrated in a one-step process [2].

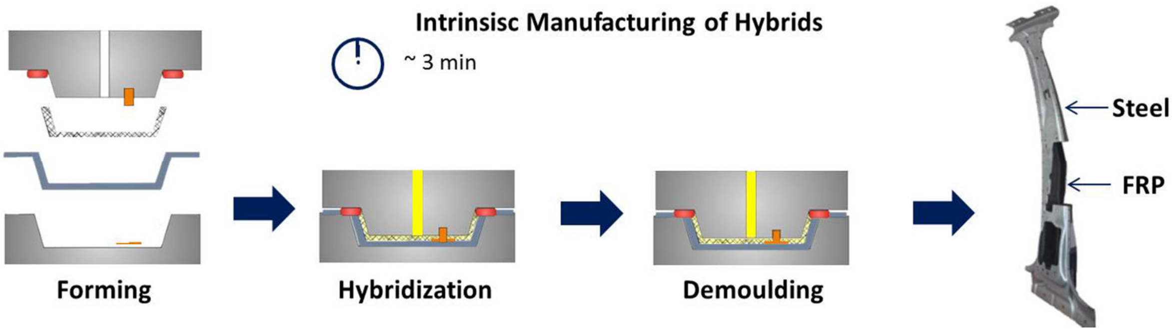

Fig. 2 - Intrinsic production process of hybrids

In conclusion, metal-FRP hybrid structures can be seen as a key technology for future lightweight design, both in regard of cost-effective solutions and a high lightweight potential.

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