High volume production of lightweight automotive structures

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1 Motivation

In times of globalization and simultaneous worldwide resource depletion energy-efficient mobility is increasingly becoming the focus of social and economic interest. The transformation of conventional drive concepts with gasoline and diesel engines via plug-in hybrid solutions is going to fully electrically driven Urban Vehicles, as the BMWi series, Tesla Motors and many more demonstrate.

In particular the relatively young species of electric vehicles is dependent on obtaining a market acceptance by realizing a certain minimum distance. Hence, a reduction in weight of the vehicle in general and the structural components in particular is mandatory in the sense of increased energy efficiency. But even for vehicles with conventional internal combustion engines the lightweight has a more important role: With the EU Directives becoming effective in 2020, European car manufacturers need to reduce the average CO2 fleet emissions below 95 g/km [FRIE13].

One promising solution to accomplish these ecological and political requirements represents the structural and particularly the material lightweight. Hence the fiber-reinforced plastics (FRP) could lately be established in the market with its excellent mechanical properties combined with low density. By the use of modern high-performance materials such as unidirectional carbon fiber reinforced plastics (UD-CFRP) the same functionality of the components, i.e. same stiffness and strength, is realized with weight savings compared to steel up to 75 % and to aluminum by 60% [FRIE13]. Such potential can however only be exploited if it is possible to reduce manufacturing costs of CFRP components dramatically. For example, the mass-related costs for CFRP elements in automotive applications is up to 70 €/kg, whereas they amount to about 3 or 6 €/kg for steel and HS steel and about 7 €/kg for aluminum [JAHN12].