Materials for Future Automotive Body Structures

a report by

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Introduction

The research and development of ecological technologies for cars is becoming increasingly important for the automotive industry. It is seen as one of the greatest trends of this century to conserve natural resources and minimise air pollution. One of the ways of achieving this is by reducing the weight of vehicles and therefore lowering the rate of fuel consumption and emissions.

Today, however, the average weight evolution of passenger cars shows an upward tendency. Responsible for this is mainly the introduction of advanced safety and comfort systems. Additionally, the performance of the body has been improved, which has also increased the weight of the structure. The result of the customers' wish to have stronger engines over the years leads to an increased weight.

In the opinion of several scientists, carbon dioxide (CO_2) emitted from cars is responsible for the 'greenhouse effect' to a great extent and even small reductions of the fuel consumption of each car would result in an overall large reduction of CO_2 emissions. An assumed reduction of fuel consumption of approximately 0.3 to 0.4 litres per 100km could be achieved by a weight reduction of 100kg.[1,2]

The body of a car, including the interior, accounts for nearly 40% of the car's total weight and offers a high potential for lightweight construction. If the body mass is reduced, in theory, a secondary mass reduction can be realised. For example, the chassis, brakes and gears can be designed to be smaller and lighter, resulting in a reduction in the weight of the car .[3]

Measures of attaining lightweight constructions can be separated into three types as depicted in *Figure 1*.

- The first type of lightweight construction is to replace materials of high specific weight with lower density materials without reducing rigidity and durability. Common lightweight materials are, for example, metals such as aluminium, magnesium, high strengthened steels, foams or different types of unreinforced and reinforced plastics.

- Structural lightweight construction implies that load-carrying elements and exterior attachments are optimised in their design so as to reduce their weight without any loss in rigidity or functionality.

- Another way of realising lightweight constructions is to optimise the production process. First of all, the reduction of spot welds should reduce the body weight when replaced by new joining techniques such as laser welding or manufacturing processes such as hydroforming.

Use of Materials

Steel

Today's most commonly used materials for vehicles are still different types of steel. They offer a wide variety of material characteristics such as thermal, chemical or mechanical resistance, ease of manufacture and durability. The development process on steels continuously creates new materials for applications within the automotive industry with improved characteristics. These high strength grades are increasingly used in the high-volume production for parts such as sheets or profiles, which are assembled by special manufacturing techniques. Higher-strength steels currently account for 80% of the body of a European premium-class car such as the BMW 7er-series, introduced in 2001.[4] In parallel with the enlarged use of this material, the yield stress

1. *E Woisetschlaeger, "Keine Monokultur",* Automobil Entwicklung*, September 2001, p. 130.*
2. *H E Friedrich, "Leichtbau und Werkstoffinnovationen im Fahrzeugbau",* Automobiltechnische Zeitschrift*, 104 (March 2002) 3, p. 258.*
3. *T Parr, H Wallentowitz, R Wohlecker, D Wynands, K-H von Zengen, "Leichtbaupotenzial eines Aluminium-intensiven Fahrzeugs",* Automobiltechnische Zeitschrift*, 105 (March 2003).*
4. *A Poweleit, "The Body in White of the New BMW 7er Series", New Advances in Body Engineering, Body Euromotor Course, 28–29 November 2001, Aachen, Germany.*