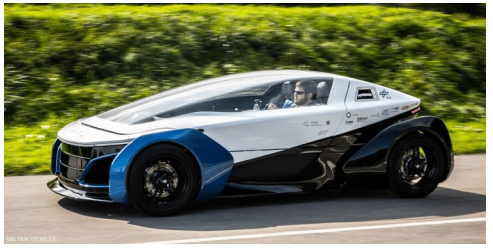
outokumpu
high performance stainless steel

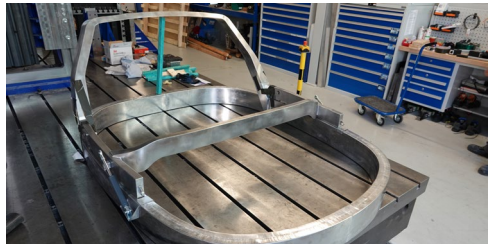
Foam-filled Stainless Ring Structure for DLR Next Generation Car

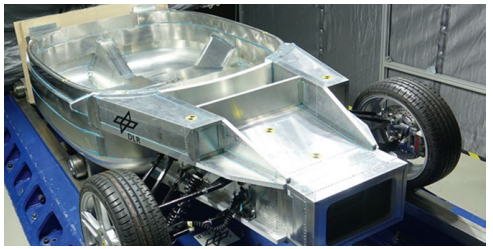
Member company Outokumpu

Manufacturer Deutsches Zentrum für Luft- und Raumfahrt e.V. - Institut für Fahrzeugkonzepte (DLR, German Aerospace Center)

Categories original application concept for stainless steels; promotes a bespoke or non-standard grade; strong environmental potential; preservation of scarce resources; life-cycle costs lowest compared to competing materials







Pictures courtesy of the German Aerospace Center (DLR).

The Challenge

Twenty institutes of the German Aerospace Center (DLR) rised to the challenge of developing new vehicle concepts with their "Next generation Car" large scale project which develops solutions for the upcoming challenges of sustainability, zero emission and cost-efficiency without decreasing lightweight and safety expectations. For the area of regional transport, DLR developed the "Safe Light Regional Vehicle" (SLRV) having its Roll-out in October 2020. The vehicle offers zero emissions as it is powered with a highly efficient hybrid fuel-cell-battery drive-train resulting in a driving distance > 400 km. The car body structure is designed as an ultimate lightweight structure resulting in a weight of just 90 kg without doors but having the highest possible passive safety.

The reason behind the outstanding combination of lightweight and safety is an innovative sandwich construction. An essential component of this car body is a circumferential ring structure filled with foam. For the ring structure, Outokumpu´s new ultra-high strength stainless steel Forta H500 was used, offering an initial yield strength > 530 MPa with an elongation of > 50 % at the same time. Because of its specific TWIP hardening mechanism, the material reacts perfectly during impact situations with a significant strain hardening and highest possible energy absorption. As a fully austenitic material it is alloyed without Nickel and therefore price stable for automotive series applications. The total vehicle price is expected to be approx. 15,000 € which results for a usage life of 10 years with 300,000 driving km in a related price of 10 cent per km.

Why?

Megatrends like urbanization (including quiet traffic), new mobility services (car sharing, commuter support) and environmental compatibility combined with the question of a safe and affordable mobility already starts affecting personal´s life and the whole processing industry in the automotive supply chain. New solutions need to be developed which can solve the challenging contrasts of lightweight, safety, cost-efficiency and sustainability. New materials like ultra-high strength stainless steels could offer a significant support to solve those challenges.

Needed Action

- DLR designed a completely new vehicle structure using an innovative sandwich construction with a circumferential ring structure where ultra-high strength stainless steel is filled with foam
- The vehicle structure is combined with a highly efficient and quiet hybrid fuel cell – battery engine including a fuel cell system (8 kW), a hybrid battery (25 kW), a hydrogen high pressure tank and two synchronous motors
- Outokumpu delivered its new ultra-high strength stainless steel Forta H500 to fulfil the needed challenging requirements in point of lightweight, safety, sustainability and processing
- DLR manufactured the complete vehicle with its roll out on October 2020
- Extensive laboratory tests including crash tests related to US-NCAP standards
- Extensive test drives to determine and improve driving behaviour and driving distance

Action Review

Specific and measurable:
Clear and detailed targets for all development areas like driving distance (> 400 km), weight of the structure (< 100 kg), total vehicle weight (< 450 kg), emissions (zero), lifetime costs (10 years of usage with 300,000 km driving distance and purchase price for the vehicle of 15,000 €), crash-test results (zero mm intrusion into passenger compartment)

Achievable; Realistic and time-bound:
Large-scale project was scheduled to have its successful roll-out on 2020-10-01 with its first test drive, all development targets solved successful in time

Horizontal Expansion Capability

The developed sandwich stainless steel ring structure can be also used in future for other passenger vehicle types. In fact, it can be also derived to other applications in mobility and transport like any kind of commercial vehicles to protect passengers (buses) or goods. The design approach can be also used to protect stationary goods.

In general, the integrated new technologies in the project offers new application opportunities for stainless steels as the material could be also applicated for the bipolar plates of the fuel cell system, the pressure tank or as part of the electric engine.

Outcome

- Driving distance of 400 km
- Low and scalable manufacturing costs also for low and medium-sized quantities (15,000 € purchasing price per vehicle resulting in 10 cent per kilometre mobility costs)
- Lowest possible weight of the structure: 90 kg (because of the stainless-foam sandwich ring structure design)
- Fulfilment of crash test: zero mm intrusion into passenger compartment
- Zero emission vehicle