Aachen, 25th May 2018

AMAP FORUM 2018:

Aluminium trumps in Lightweight Construction

- **Lightweight construction through flexible rolling of high-strength aluminium**
- **Structural components with functional integration through aluminium hollow castings**
- **New design and calculation methods for high-strength aluminium alloys**

As an engineering material, aluminium is inseparably connected to lightweight automotive design. At the AMAP FORUM on 19th of April 2018 in Aachen, scientific and industry experts demonstrated clearly that the development is not standing still and that the lightweight potential of non-ferrous metals is far from being tapped with examples from innovative successes in research and collaboration in practice. 14 entrepreneurs from industry and five institutions of the RWTH Aachen University joined together to form the AMAP Open Innovation Research cluster. The topics of the interdisciplinary collaboration range from product and material development, modelling and metallurgic process technology to new production technologies.

Light metals like aluminium and magnesium are best placed to fulfil the increasing demands of present and future vehicle generations: compliance with maximum emission limits for cars with conventional internal combustion engines and consumer demand for a wider range of electric vehicles at affordable prices.

Higher strength – lower weight

Aluminium has continually grown in importance as a construction material in recent decades. Today's passenger cars in Europe drive around with an average of 150kg of aluminium, where with 100kg, the lion's share of non-ferrous metal is in castings for powertrain and wheels. Lightweight automobile construction with a complete aluminium Body-in-White (BiW) was the preserve of exclusive manufacturers like Jaguar for a long time. The breakthrough into the mass market was made by Ford in the USA in 2015 with the new version of its classic F-150, as Dr. Jürgen Wesemann of the Ford Research Centre in Aachen explained. This pick-up truck, with its light construction high-strength aluminium body, marked the turning point from the steel construction used for decades in this vehicle, which is almost legendary in America. Almost unknown in Europe, F-series pick-up trucks have been the best-selling vehicle in the USA for 36 years.

Ford F150 – the breaktrough for Aluminum BiW in mass production

Aluminium alloys with 4 different chemical compositions are used in the F-150 BiW's. This enables efficient recycling by separation of production scrap by grade. As Wesemann explained, these 4 alloys become 10 "grades" with different mechanical properties. By using high and highest strength aluminium alloys in the form of panels and extruded profiles, the BiW can be 45% lighter than previous steel constructed models. The gasoline-engine pick-up truck has the best-in-class fuel consumption figures in relation to payload and towing.

Mastering the correct joint technology in the right places plays an important role in the aluminium-intensive construction of the F-150. Processes such as laser-welding, resistance spot welding, self-pierce riveting, FDS-screws, adhesive bonding and clinching spots are used in the F-150.

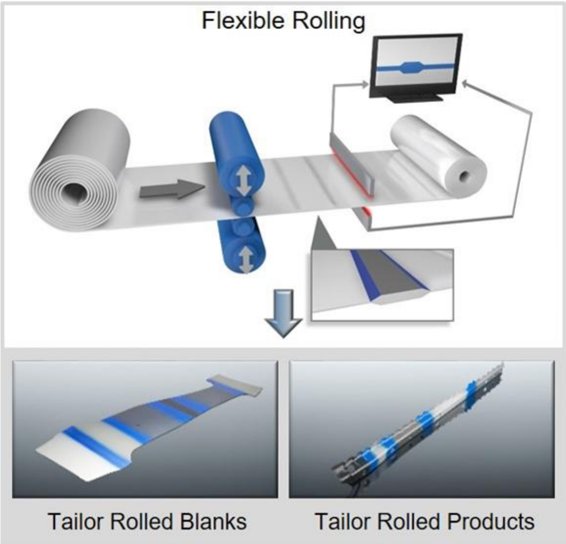
Ford-Expert Wesemann sees future development focus areas in, for example, the development of new high-strength aluminium alloys to continue weight-reduction, tailor-made material and component properties and in the further development of advanced casting technologies with the aim of further weight savings and cost reduction. In Wesemann's view, there is also development potential in joining processes. Ford thus joined with the RWTH institute ISF in an AMAP project on the promising joining procedure Refill Friction Stir Spot Welding. Other important components of economic aluminium lightweight solutions are CAE and virtual optimisation.

Wesemann could summarise that successful lightweight design is not only down to aluminium as the construction material. To ensure that successful products and solutions come out of innovation, close collaboration between material researchers, aluminium producers, component suppliers and the automotive industry is required. In his presentation the Ford Manager made clear that only a consistent approach over the whole value-added chain of aluminium would lead to the goal – an approach such as that being followed by the AMAP research cluster.

Custom-rolled aluminium sheets

A vivid example of innovative aluminium technologies was given by Dr. Udo Brüx, Director of the Centre for Lightweight Design of the automotive supplier Mubea. As Brüx explained, Mubea is working together with Ford and the aluminium producer Constellium in an AMAP project on transferring the technology of flexible rolling to aluminium, which was originally developed by Mubea for steel sheets.

The technology for so-called Tailor Rolled Blanks (TRB) is a cold-rolling process, in which variable sheet thicknesses can be set according to locally required strength and rigidity by an adjustable roller gap. This innovative technology for custom-made material solutions allows thickness variations for steel of up to 50% within one construction component.



Principles and Products of Tailor Rolling
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The aim of the research undertaken is industrial manufacture of custom-made sheets to realise weight-optimised high-strength aluminium structural components. This considers the entire process chain: from FLEXrolling to the subsequent heat treatment and cold-forming to the artificial aging of the component, right up to the joining technology. Development is accompanied by extensive methods for characterisation of materials and prognosis of the forming behaviour up to the crash characteristics of the component.

As Brüx explained, the results of flexible rolling with the aluminium alloys used so far (6xxx) are promising. With appropriate heat treatment, the material attains a high strength with sufficient ductility.

The next step is to create high to highest-strength components with a 7xxx AlZnMg(Cu) alloy. Since this high-performance material has only limited ductility for cold-forming, heat-forming is mandatory. The weight-specific strength of these Tailor Rolled Blanks in combination with artificial aging after the quenching process could approach that of press-hardened steel.

Function Integration with Hollow Aluminium Casting

AMAP member Nemak is a worldwide supplier of aluminium lightweight solutions for passenger cars. Structural castings are an increasingly important growth area. For more than two years, Nemak has been manufacturing structural cast components for German and European OEMs at various production sites. Prof. Dr. Franz Josef Feikus, R&D Manager of Nemak Europe GmbH, presented the dynamic and research-intensive development in this area with the example of a hollow structural component in high pressure die casting.

Today steel mainly dominates in the cost-sensitive mass market, but ultra-high strength steel materials are also used in the premium sector in safety-relevant components. A collaborative research project has been initiated at AMAP to substitute steel components by aluminium castings. It is envisaged that along with weight saving, an increased load capacity is possible with the vacuum assisted high pressure die casting process dedicated to a serial production. This makes the technology interesting as a light construction alternative to the current widespread sheet shell construction methods with press-hardened steels. The current research project focuses to realize an inner ribbing for the Al-castings. This design provides a low weight with minimal wall thickness and increases the rigidity and strength of the component.

Nemak and its consortium partners have chosen an A-pillar as demonstrator for the project. The crash-relevant A-pillar has to preserve the survival space for the occupants.

The wall thickness of the aluminium pressure-casting part is no thicker than 3 mm. The cavity space of the complex ribbed inner structure is formed by salt cores. Despite their filigree structure, the cores must withstand the molten aluminium introduced under high pressure at high mould-filling velocity in the pressure casting process and then be subsequently easy to remove.

The design is based on methods for topology optimisation and extensive simulations including simulation of crash behaviour.

It is expected that with the developed design and calculation methods and the high pressure die casting process, it will be shown that hollow structure parts for vehicle bodies can be manufactured on an industrial scale. Together with the lightweight construction aspects of CO_2 reduction, the design is marked out by its higher rigidity and the possibility for function integration. Components, which in steel construction are conventionally made up of several sheet parts welded together, can be cast as a single component in the pressure cast process.

In a next step, the project partners intend to carry out further investigations into the casting process and joining aluminium and steel and develop a business model.

Main Structure Part on Rear End of the Car of a German OEM

Start-up for E-mobility

The young Aachen company e.GO Mobile AG, under its CEO Prof. Dr. Günther Schuh, Chair of Production Systems at RWTH und Managing Director of Cluster Production Technology, is showing how a standing start in E-mobility can become a start-up. Dr. Gregor Tücks, Vice President Production of e.GO Mobile explained at the AMAP FORUM how the product development of a cost-efficient electric city car e.GO Life is taking place in an Industry 4.0 environment on the RWTH Aachen Campus with an interdisciplinary approach.

The Internet of Production architecture enables fast and flexible development, as Tücks explained. Thus, for example, early simulations led to an above averagely rigid body shell, in which the rigidity of the battery housing is exploited for the passive safety of the whole vehicle. The consistent modular construction contributes to the low manufacturing costs, as the assembly of the Spaceframe made of aluminium extruded section profiles takes place in a multi-stage assembly process. The outer skin of the crash-resistant and light bodywork consists of light and low-cost plastic panelling.

e.GO in an Industry 4.0 environment on the RWTH Aachen Campus
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Emission free mobility is an important aspect of the e.GO Life, as Tücks explained, but not the only one. Data based services via user-friendly apps – keyword connectivity - and autonomous driving are also constituent parts for the Aachen developer.

Those who wish to own this city car will have to wait a while yet. e.GO Mobile is setting up the first production sites for assembling the e.GO Life and other vehicles such as the autonomously-driving electric minibus e.GO Mover and the four-door e.GO Booster on the Triwo Technopark on the previous Philips site in Aachen Rothe Erde.

AMAP – the Open Innovation Research Cluster – Efficiently and Perfectly Formed

The name says it all: AMAP – Advanced Metals and Processes. The Open Innovation Research Cluster AMAP is dedicated to material technology of non-ferrous metals and especially the manufacturing and processing of aluminium into innovative products for the automotive industry. The network connects a group of 14 industrial enterprises with five university institutes of RWTH Aachen University.

“We are an efficient network”, said Dr. Klaus Vieregge, Chairman of the AMAP Advisory Board and Head of the Hydro Aluminium Research and Development Center in Bonn. New members are always welcome, but a high number of members is not the focus of the AMAP cluster, we want to convince people by the efficiency of the work and the research results. With the ambition “Open Innovation”, AMAP follows a R&D and innovation strategy in which the university institutes of RWTH Aachen and industrial organisations are sharing their technologies and competences beyond their own boundaries and intellectual property rights. New ideas are generated and the complex knowledge of the RWTH institutes and company research partners is brought into project work with this interdisciplinary collaboration of industry and university institutions on current problems in the area of non-ferrous materials. This efficient sharing of risks between industry and science is an important basis of the win-win partnership.

Based at RWTH Aachen University, the research cluster follows the evolutionary thought of common research in one place, across industry and institutes. Dr. Christian Bollmann from ALERIS Rolled Products Germany reported that, “The different organisation philosophies of industry and academic institutions form a common understanding of a successful collaboration”. The collaboration does not just help the companies involved to save costs in pre-competition research but thanks to their interdisciplinary work together, the partners also learn how to look at a problem from different perspectives, Bollmann confirmed.

And it is not just incidental that the proximity to one of the most renowned technical universities in Germany opens the most important resource up to the involved companies – well-educated young academics. Dr. Klaus Vieregge confirmed: "The proximity to RWTH Aachen University opens up an opportunity to find talents in the very competitive area of engineering."

Dipl.-Ing. Gerd Krause, Mediakonzept, Düsseldorf

This press release and press pictures (Marcel Dohmen, pictures of life) can be found at: www.amap.de/News

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AMAP GmbH
The Open-Innovation-Research Cluster AMAP concentrates in the area of materials technology on manufacture and processing of non-ferrous metals, especially those with an aluminium basis. The founding members are ten industrial enterprises and four university institutes of RWTH Aachen University.
AMAP GmbH is a 100% subsidiary of the non-profit registered association Aluminium Engineering Center e.V. (aec), to which the directors of 10 institutes of RWTH Aachen University belong.
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