

INNOVATIVE LIGHTWEIGHT CONSTRUCTION

... an important contribution to zero-emission mobility of the
future

Dr. Carina Schlögl (C.Chimani)

LKR Leichtmetallkompetenzzentrum Ranshofen



WHY?

Why lightweight construction is still important?



WHY DO WE ENGAGE IN LIGHTWEIGHT CONSTRUCTION?

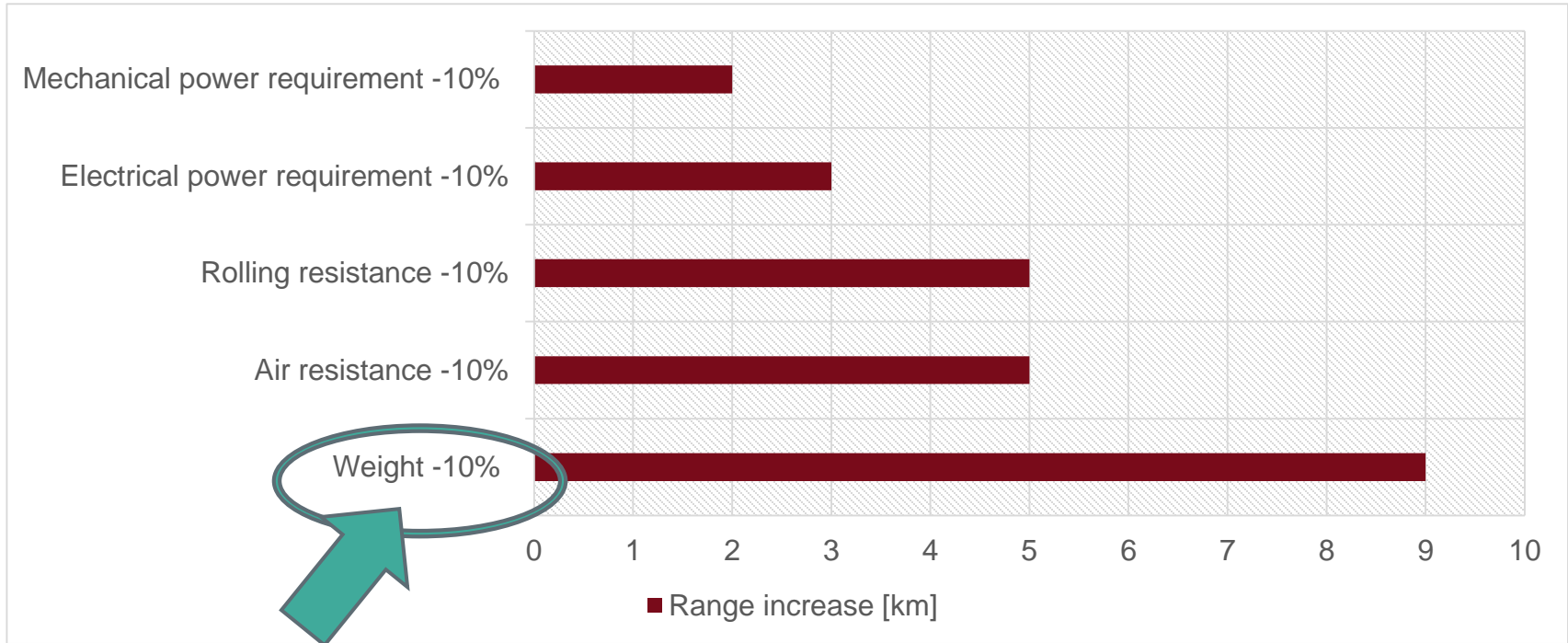
The future of vehicle concepts will be primarily characterized by

- (1) renewable energy sources and
- (2) improved energy efficiency.

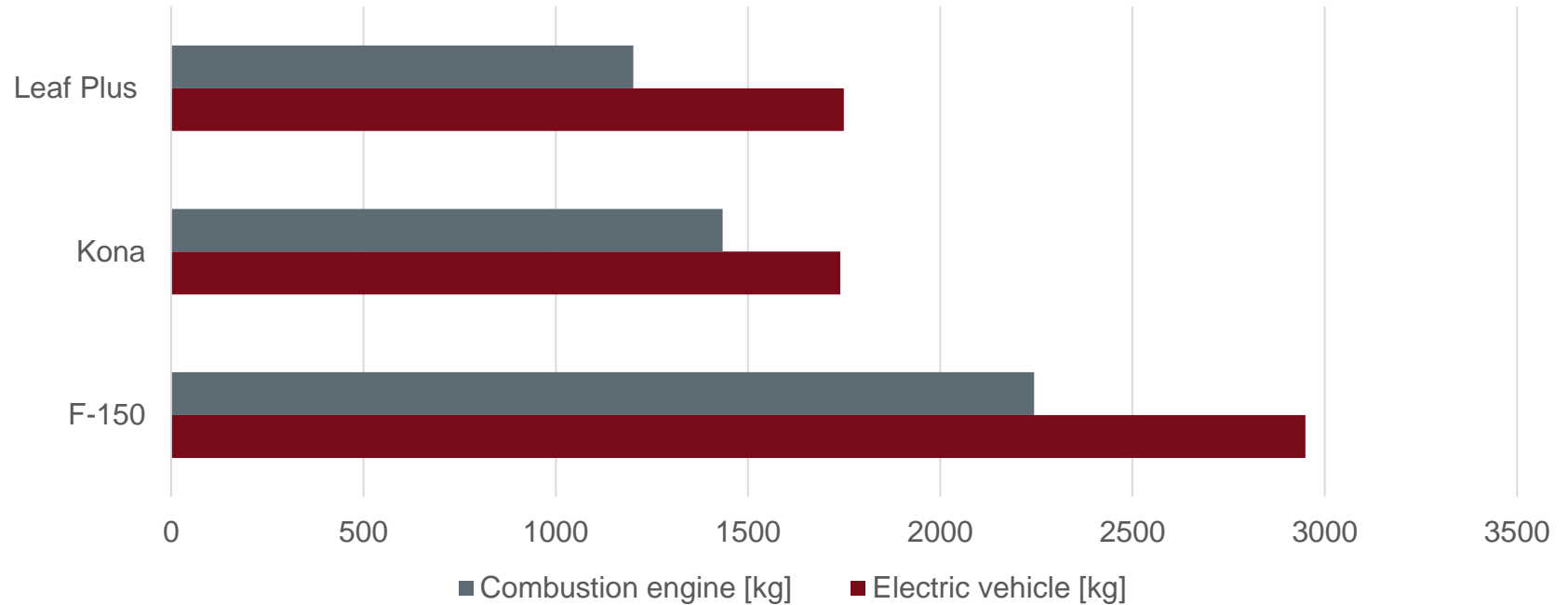
This addresses the drive technologies and driving resistances.


Weight reduction and lightweight design strategies are therefore indispensable and increasingly important contributions to safe, sustainable and affordable mobility.

RANGE INCREASE DUE TO REDUCTION OF POWER REQUIREMENTS



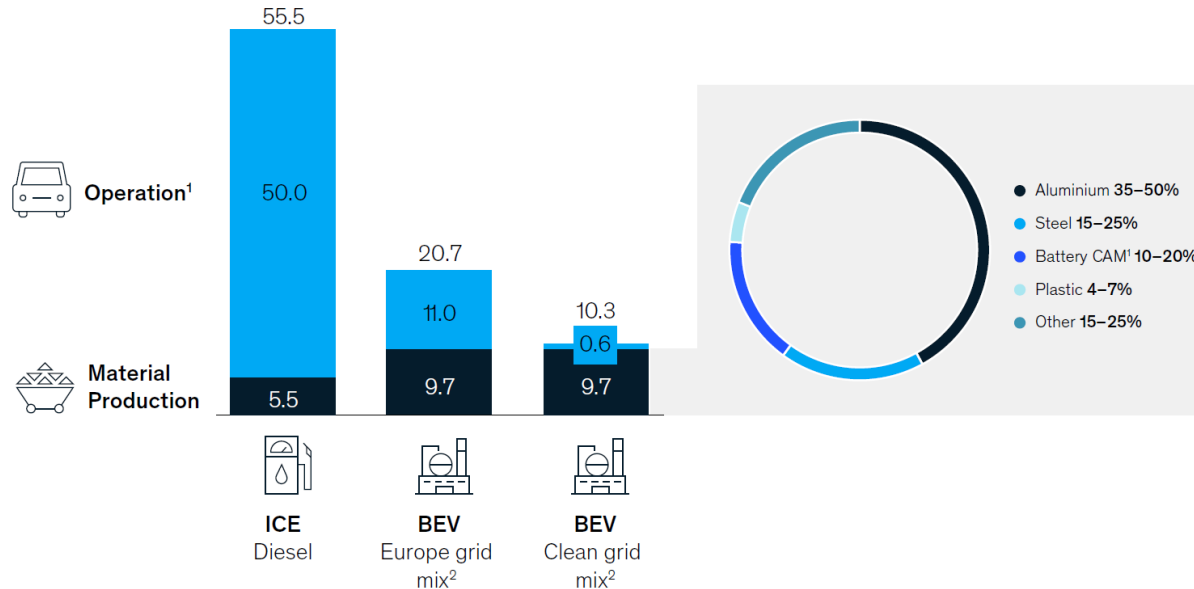
ELECTRIC VEHICLES WEIGHT MORE ...



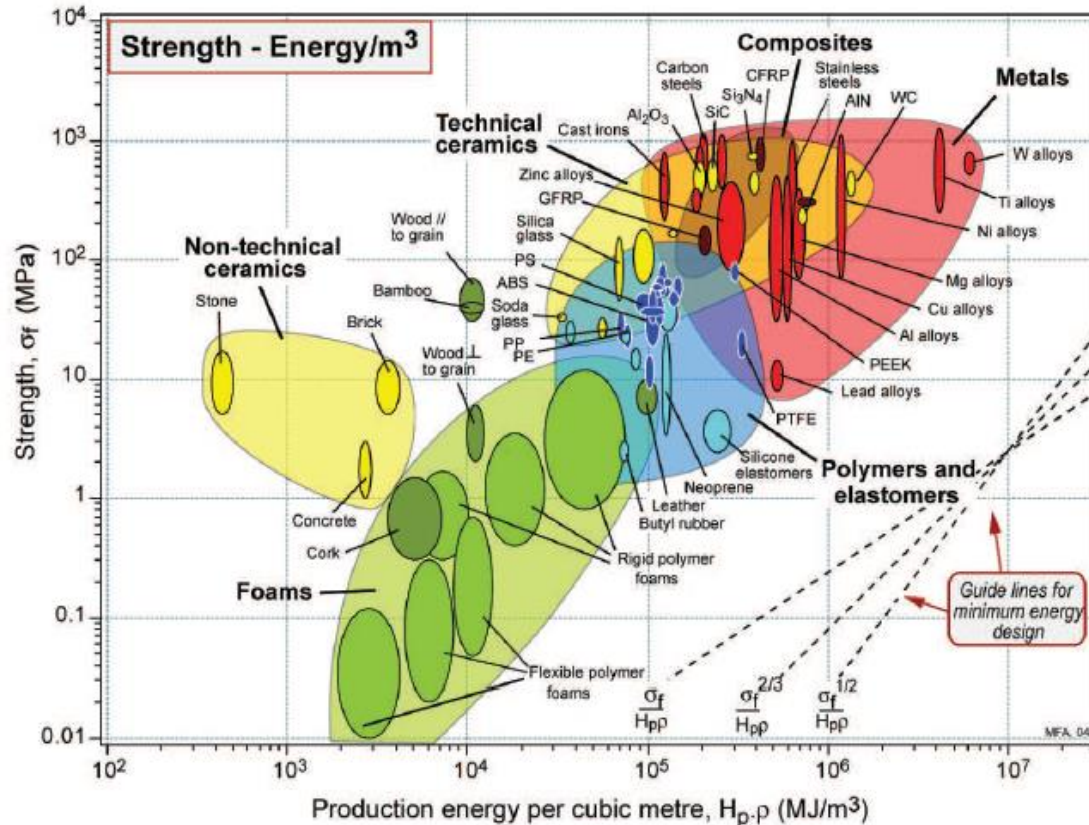
Source: Blake Shaffer, Make electric vehicles lighter to maximize climate and safety benefits, Nature | Vol 598 | 14 October 2021;

T CO₂E EMISSIONS OVER LIFECYCLE MILEAGE

“Material emissions will dominate vehicle lifecycle emissions when clean energy is used for charging and are the next frontier for automotive emissions reduction.”



T CO₂E EMISSIONS OVER LIFECYCLE MILEAGE



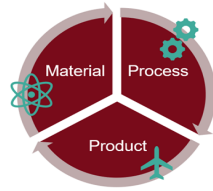
HOW?

How can we implement sustainable and efficient lightweight construction?





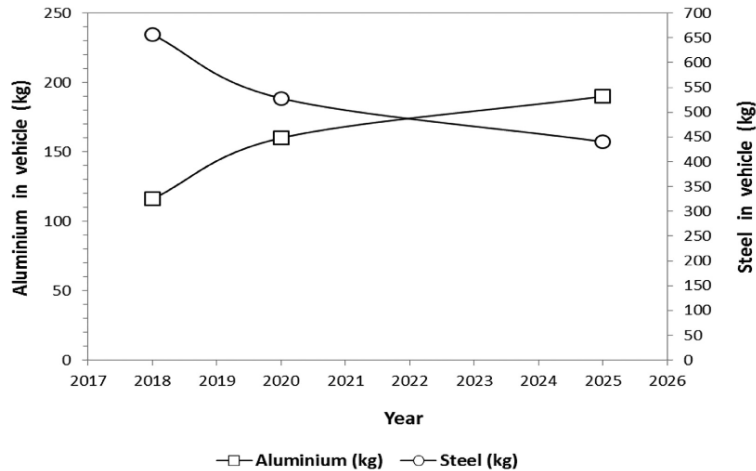
MATERIALS ...



“[...] Each material brings its own cost and technical challenges as well as emissions impacts from production and supply chains. Researchers need to assess these trade-offs to find safe, clean and affordable solutions. [...]”

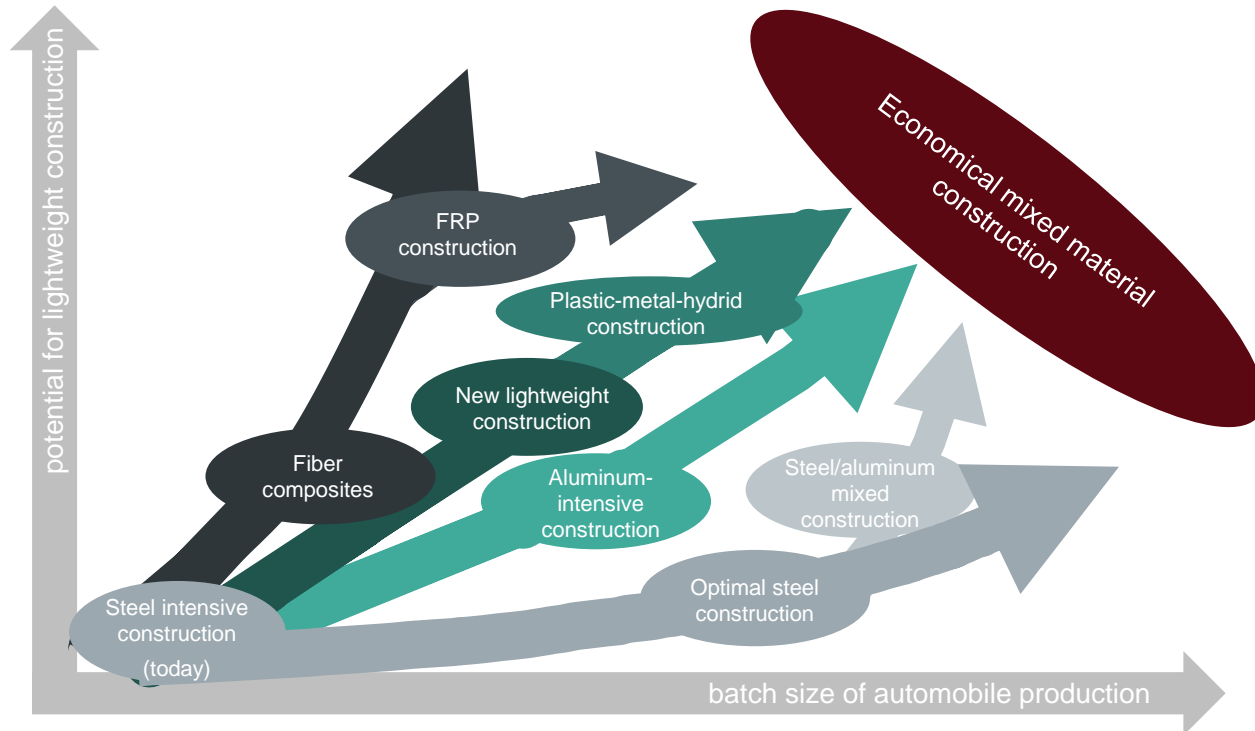
Der Audi TT

The Audi TT
Rohkarosserie in Mischbauweise – Materialien
Body-in-white featuring composite construction – materials



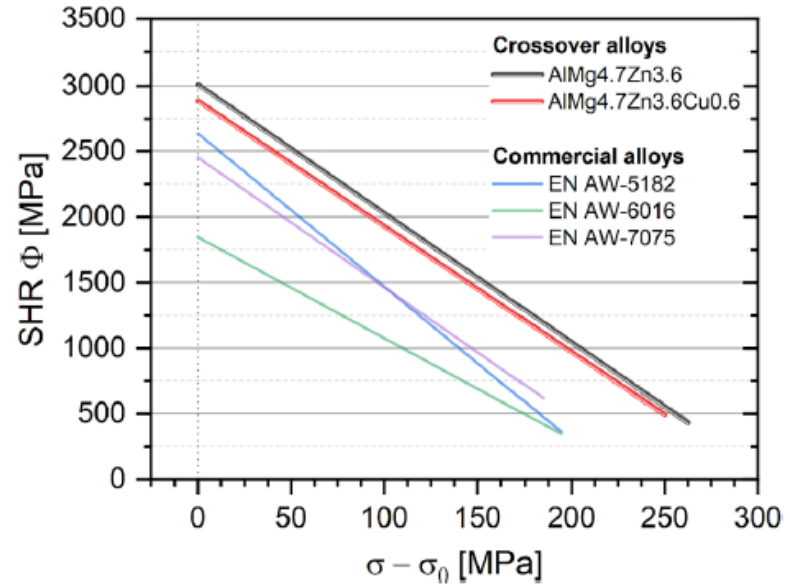
Peppas, A.: Sustainability analysis of aluminium hot forming and quenching technology for lightweight vehicles manufacturing, Journal of Thermofluids 10 (2021);

WHAT DOES THE FUTURE HOLD?



ALLOY DESIGN ... CROSS-OVER

- „New“ aluminium alloys
 - 5xxx + 7xxx
 - 6xxx + 7xxx
 - Optimal property profiles
- Advanced recyclability

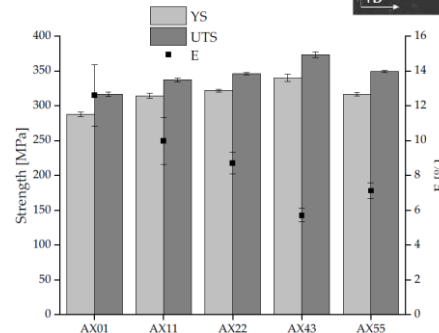
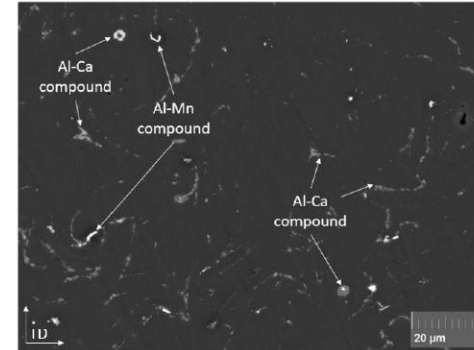


Source: Stemper, L. et al.: On the potential of aluminum crossover alloys, Progress in Materials Science 2021, 100873;

ALLOY DESIGN ... NEW/ALTERNATIVE PROCESS ROUTES

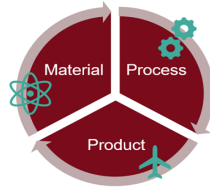
Aluminum and magnesium alloys that do not require certain process steps from conventional manufacturing routes ...

- Avoidance of homogenization treatments
- Acceleration of heat treatments
- Creation of further tolerances in the composition
- Avoidance of rare earths elements
- Reduction of protective gassing
- Optimum joinability
- ...



Source: Gneiger, S. et al.:
Investigations of high-strength Mg-
Al-Ca-Mn alloys 3 with a broad
range of Ca+Al contents, Metals,
2021;

PROZESSE ...



*“[...] On the product-level, the numbers are similar: concerning the automotive industry, the **production process** (in 2012) accounts for around 20 % of an automobile’s lifetime emissions of CO2-eq. and will increase to 36 % until 2030. For BEVs (Battery electric vehicles) in particular, in dependence of the electricity mix, the part of production related emissions could increase to 76 % until 2030 [...]”*

Source: Müller, R. et al.: CO2-based assessment for sustainable production planning in the metal processing industry, Procedia Manufacturing 21 (2018) 289–296;



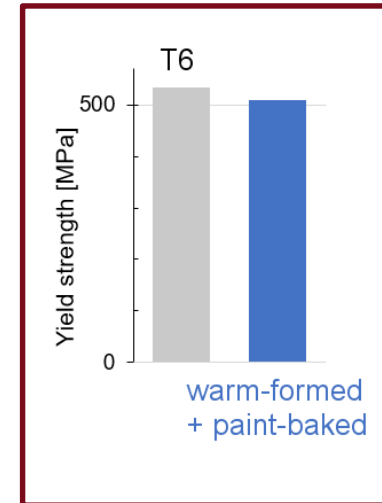
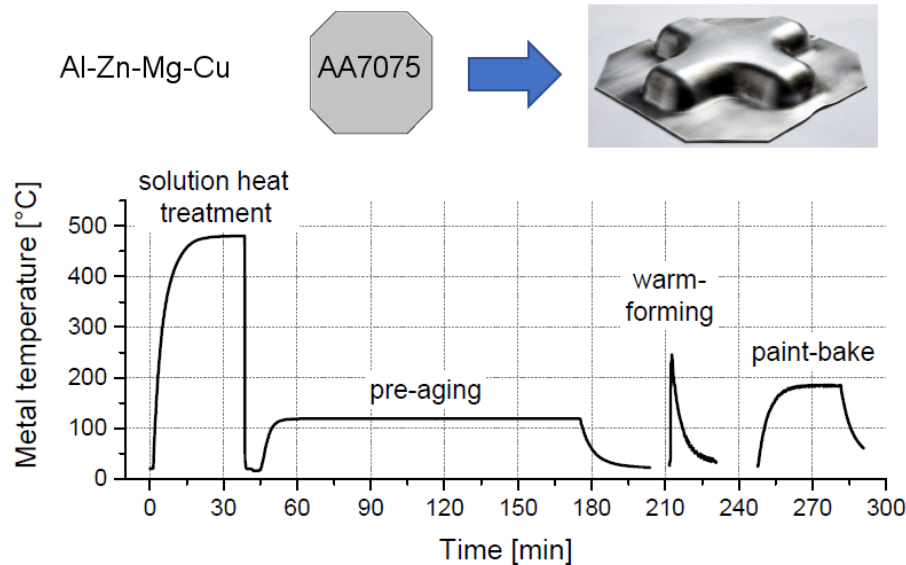
Source: Tesla;

- Reduce process steps
- Optimization of process steps - especially in the high-energy range
- Avoidance of scrap production and waste
- Saving of operating materials
- Intelligent tools
- ...

highly efficient, robust, adaptive processes / process chains

COMBINATION OF STABILIZATION WITH WARM-FORMING

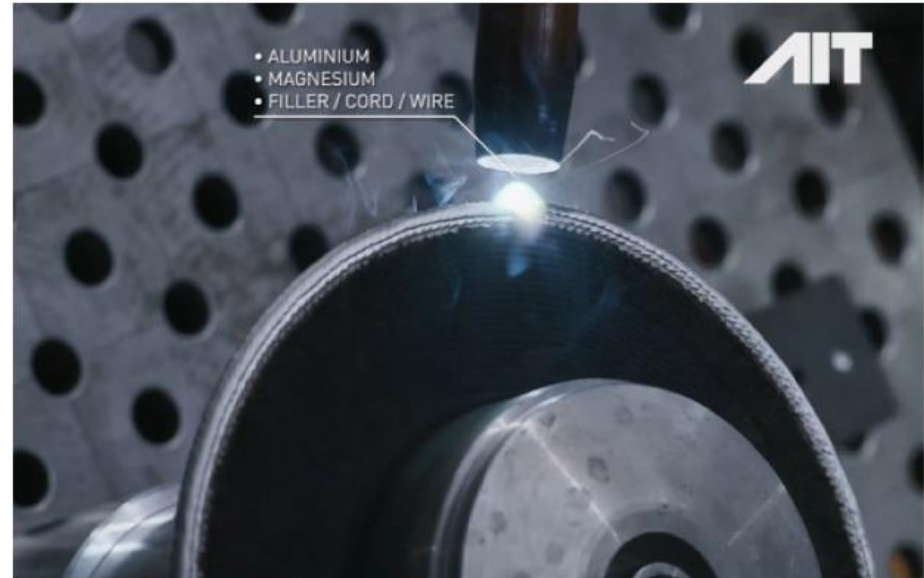
- **More economic process route** compared to W-temper forming or hot stamping
- **Superior paint-bake response** → near T6-strength!



Österreicher et al. (2020) Warm-forming of pre-aged Al-Zn-Mg-Cu alloy sheet. *Materials & Design*.

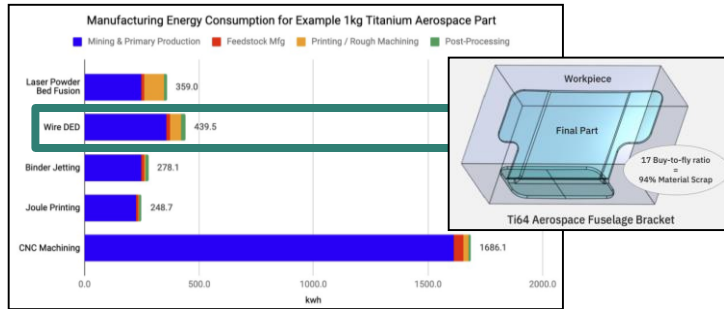
WIRE-BASED ADDITIVE MANUFACTURING

- **„Big parts“ AM-Technologie**
 - Novel technology of multi-pass welding
 - CAD+CAM+Robotics+Welding combined
 - High deposition rates
 - Large part sizes >0.4 x 0.4 x 0.4 m³
- **„Classic“ Business drivers**
 - Lead time reduction
 - Manufacturing cost reduction
 - Improvement in properties & geometries
- **„New“ Business drivers**
 - Reduced energy consumption
 - Reduced CO₂ footprint
 - Competitiveness through machine learning

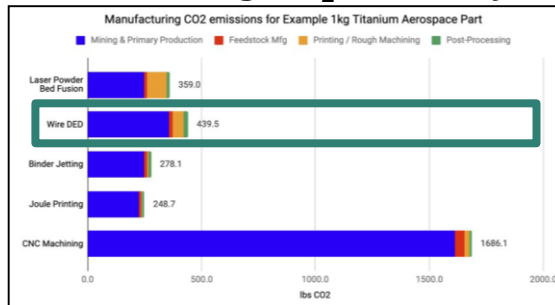


WIRE-BASED ADDITIVE MANUFACTURING

- **Manufacturing energy efficiency** (incl. mining)

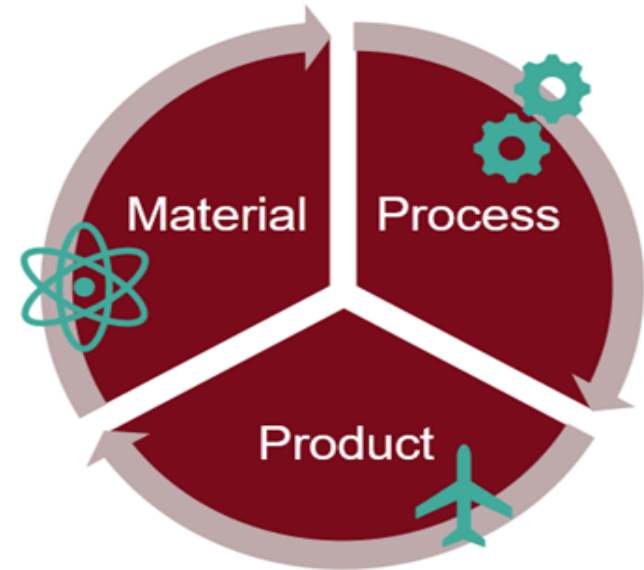
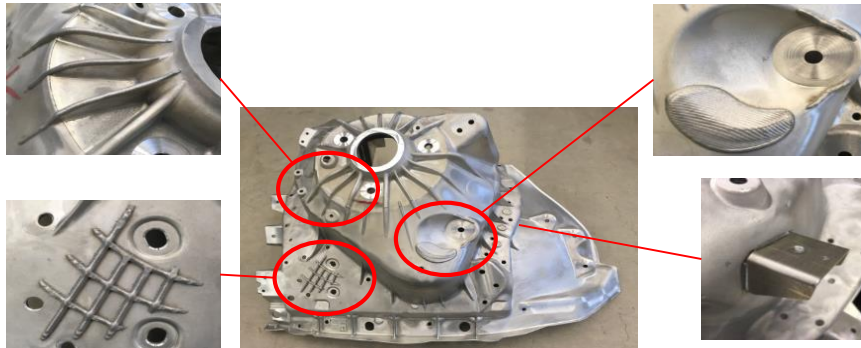


- **Manufacturing CO₂ efficiency** (incl. Mining)



THE OPTIMAL COMBINATION ...

Sustainable and efficient lightweight construction requires comprehensive concepts, both in terms of the materials used, process technology, product design and, of course, recycling.



THANK YOU!

Schlögl, 19.11.2021

