Das Rennen hat begonnen, aber eine Kehrtwende in radführenden Bauteilen, Batterie und BIW Strukturen – Fahrzeugleichtbau-Markttendenzen bei Hilfsrahmen, das Rennen 2030 ist möglich!

Dipl.-Ing. Jost Gärtner,
AluMag® Automotive GmbH & AluMag® Automotive LLC, Menden

**AUTOMOTIVE LIGHT WEIGHTING MARKET TRENDS IN: BATTERY TRAY - BIW - CHASSIS/SUSPENSION**

**EV PENETRATION IS & WILL IMPACTING THE DEMAND FOR LIGHT WEIGHTING - MULTIBLE CHOICES**

**ABSTRACT:**

The rising demand for electric vehicles (EVs) is expected to suppress the demand for ICE aluminum powertrain applications. On the other hand EVs and automatic driving applications will also provide many new prospects for aluminum, as well as other lightweight materials and processes.

The lecture by AluMag® will provide insight into three promising aluminum applications, components in focus are:

1. BATTERY TRAYS [BEV & PHEV]
2. BIW comparison
3. CHASSIS/SUSPENSION

The paper is be based on five recent analyses, AluMag® has executed from end of 2018 to January 2020. The figures have partly taken out and have been replace by relations and Percentage.

Europe will represent the main region with China and a side view of North America.

The AluMag® paper does contain dozens of pictures from third parties, which have always been always names right hand side above of those.
The penetration of BEVs (Battery electric vehicles) is expected to increase from 1.57% in 2019 to 10.15% of total European production in 2025, while PHEVs (Plug-in electric vehicles) will increase from 1.09% to 5.92% over the same timeframe. The forecast generated based on AluMag European Automotive forecast considering outlooks from various industry sources. Recent announced sales and production figures for Europe discloses an increasing demand for BEVs, while PHEV sales is dropping. As around 50 new PHEV as well as new 33 BEV models will come to market during 2020 alone, AluMag® expect the penetration of BEVs and PHEVs to continue to grow over the analyzed timeframe and growth will be fueled by local production of VW ID3 & TESLA.
AUTOMOTIVE LIGHT WEIGHTING MARKET TRENDS
IN: BATTERY TRAY - BIW - CHASSIS/SUSPENSION

BATTERY TRAYS - PRINCIPAL COMPONENTS BASED ON AUDI CONCEPT

Source: AUDI

PRODUCTION PROCESS FLOW AS EXAMPLE

AUDI E-TRON:

APPENDIX: NEV BATTERY TRAYS - BENCHMARKING EXTRUDED

BATTERY TRAYS - BENCHMARKING EXTRUDED BASED ON AUDI E-TRON

AUDI E-Tron Battery Tray Based on AL Extrusions

Source: Confidential AluMag® Source

Source: Confidential AluMag® Source

Source: Confidential AluMag® Source

Source: Confidential AluMag® Source

Source: Confidential AluMag® Source

Source: Confidential AluMag® Source
PRODUCTION PROCESS FLOW AS EXAMPLE AUDI E-TRON:
The production process flow illustrate "not" the typical steps in the value chain of a battery tray based on aluminum extrusion. But it shows and indicates the huge difference between simple / budget engineered and high-end versions.

According to an expert familiar with the matter informed, the cost of the processes, the various quality checks, transportations between and to the final destinations, are app xxx EUR/Tray. Just "Laserering Contract Points free from E-Coat" cost xx EUR/Tray. The weight is around 110 Kg/Tray.

AUTOMOTIVE LIGHT WEIGHTING MARKET TRENDS IN: BATTERY TRAY - BIW - CHASSIS/SUSPENSION

BATTERY TRAYS - BENCHMARKING EXTRUDED BASED ON AUDI E-TRON

Source: AluMag®

PRODUCTION PROCESS FLOW AS EXAMPLE AUDI E-TRON:
The production process flow illustrate "not" the typical steps in the value chain of a battery tray based on aluminum extrusion. But it shows and indicates the huge difference between simple / budget engineered and high-end versions.

- Constellium
- Extrusion
- Straightening
- Cutting to 6 m length
- Heat Treatment
- Cutting to final length
- Calibration by Hydroforming & Punching
- TKA
- Eloxal Weil der Stadt
- AUDI Györ
- ALRO

- Typical steps
- Steps depending on OEM specifications and concepts

According to an expert familiar with the matter informed, the cost of the processes, the various quality checks, transportations between and to the final destinations, are app xxx EUR/Tray. Just "Laserering Contract Points free from E-Coat" cost xx EUR/Tray. The weight is around 110 Kg/Tray.

AUTOMOTIVE LIGHT WEIGHTING MARKET TRENDS IN: BATTERY TRAY - BIW - CHASSIS/SUSPENSION

BATTERY TRAYS - BENCHMARKING EXTRUDED BASED ON VW MEB ARCHITECTURE > ID.3

Source: Confidential AluMag® Source

Source: Confidential AluMag® Source

Source: Confidential AluMag® Source

Source: Confidential AluMag® Source

Source: Confidential AluMag® Source

Source: Confidential AluMag® Source

Source: Confidential AluMag® Source

Source: Confidential AluMag® Source

Source: Confidential AluMag® Source
AUTOMOTIVE LIGHT WEIGHTING MARKET TRENDS IN: BATTERY TRAY - BIW - CHASSIS/SUSPENSION

BATTERY TRAYS - EXAMPLES OF MATERIALS BY CAR SEGMENTS

BATTERY TRAY MATERIALS BY SEGMENTS

Units

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td></td>
</tr>
<tr>
<td>Steel</td>
<td></td>
</tr>
</tbody>
</table>

Source: AluMag®

BEV BATTERY UNITS WITH STEEL / ALUMINUM CONTENT

PHEV BATTERY UNITS WITH STEEL / ALUMINUM CONTENT

AluMag® has analyzed 272K BEVs and 185K PHEVs being produced or started production in Europe in 2019. Of the 272K BEVs, more than 60% had an aluminum tray, rest were made out of steel. Of these Aluminum trays more than 98% were a process hybrid, made out of AL sheet with extruded parts and in several cases also cast parts, like the VW ID3.

On the other side 75% of the analyzed PHEV battery trays were made out of aluminum and 25% out of steel. The aluminum versions with 97% utilized cast aluminum content.
The European demand for aluminum within battery trays, will be seven times higher in year 2025 compared to 2019 [CAGR: 37.61]. During the same timeframe steel demand is expected to increase too; with a factor of 10 until year 2025. The forecast is based on the battery material mix of the year 2019 and most recent NEV outlooks. Steel trays are mostly used in the lower segments where the market offering was very limited in 2019. During the next couple of years a number of new A & B segmented NEV models are planned to be launched, which could have a positive impact on the steel demand vs aluminum.

In 2017 42% of all NEVs produced in China were fitted with an AL trays. 35% had an extruded AL tray while 7% had a cast AL tray. The remaining 58% were fitted with steel trays. By 2030 the penetration of AL trays could be influenced by factors such as adjustment of the Chinese incentive program, introduction of solid state batteries and improved battery technology. Newly developed processes and grades of AHSS has the potential to significantly outperform AL for future battery trays as result of steel performance flexibility, lower cost, light weighting capability, safety / collision performance, reduced greenhouse gas emissions and superior recyclability. Two German supplier have been contracted by OEMs for such advanced forming and alloy grade steel battery trays.
The demand for cast aluminum within battery trays is expected to grow by a factor of 17 in the period 2017 – 2030 in China. [10% foreign OEM Production penetration]. Cast aluminum is rarely used as material for BEV & PHEV battery trays in China, which is partly related to the lack of a qualified supply chain / equipment. Cast aluminum for BEV trays will likely only play a minor role while steel sheet and extruded aluminum are predicted to be the preferred material. But foreign Premium OEMs such as VW, Daimler, Cadillac & BMW favor cast aluminum as housing for PHEV batteries. Subaru & Geely has implemented HDPC Magnesium in battery trays.

ILLUSTRATED OBSERVATIONS - SOLID STATE BATTERY A GAMECHANGER 2030+

Lithium | Solid State
---|---
400 KM / 249 Miles | 800 KM / 497 Miles
High Risk | Low Risk
High | Low
ST sheet & AL sheet, extrusion & cast | ST sheet & AL sheet Composite
Required | Not Required

AUTOMOTIVE LIGHT WEIGHTING MARKET TRENDS
IN: BATTERY TRAY - BIW - CHASSIS/SUSPENSION

MULTI PROPULSION BIW PLATFORMS & MODULES A GLOBAL COMMON PATH

Multi-energy or multi-propulsion about architectures, modules and platforms are used
within the automotive industry.

As electrified powertrains [PHEV, BEV and possibly FCV [Fuel Cell Vehicle]] to will
become the significant propulsion, the OEMs are engineering modularized body
structures, green houses, underpinnings, chassis and suspensions to match the
mix of body styles and drivetrains to accommodate those ranges under mass market
price constraints.

Depending on model sizes, lines, and performance as well as the target markets,
light weighting will remain a key at least for BEV until improvements to battery technology are expected to have a greater driving
range. At the other hand, the cost-efficiency could see a change in preference for body structure materials, with additional weight
savings afforded by more exotic materials no longer warranting their premium to the same degree.

BEV have been recently engineered with aluminum for weight saving purposes BIW, crash components, battery housings and Hang-on
could be monopolized by steel for mass market platforms. The argument follows a steady trend by automakers to closely
integrate e-mobility into their future strategies, with electrified vehicles no longer residing as just a premium option.

Within next pages loaded the light weighting approach and architecture strategy, driven by the electrification of cars and modularized
body structures, will be described by some selected OEM and architectures.
AUTOMOTIVE LIGHT WEIGHTING MARKET TRENDS
IN: BATTERY TRAY - BIW - CHASSIS/SUSPENSION

BIW INFLUENCED & AFFECTED ARCHITECTURE BY VARIOUS PROPULSIONS

MULTI PROPULSION BIW PLATFORMS & MODULES ARE A GLOBAL COMMON PATH

PSA new generation of platforms, is the key to the industrial, technological implementation, will accommodate the e-drive systems with its flexibility needs for electrified cars in the same production lines where ICE models are manufactured too. 100% electric vehicles will be built on the e-CMP platform - the platform that will arrive at the El Palomar plant. The PHEV will be manufactured on the EMP2 [Efficient Modular Platform 2].

A tunnel in the underbody structure caters for both the ICE and its driveline, but also for the battery packs of an EV or PHEV. However, due to the weight of these batteries, the gravity point of the BIW is lowered, and the underbody structure must be redesigned to optimize crash safety. The targeted weight targets and crash performance compromise of the e-CMP has been realized by the partial use of AL, CFRP and UHSS.

VOLKSWAGEN has established the dedicated e-mobility MEB [Modular Electrification Baukasten [Toolkit]] - a scalable platform specifically for mass market EVs. Various other automakers have made similar moves, with Hyundai and the former RENAULT-NISSAN-MITSUBISHI Alliance also making prominent steps to develop battery electric solutions. Then there are automakers that have built their entire business around the electrified and fully electric powertrain, such as BYD and TESLA respectively.
MULTI PROPULSION BIW PLATFORMS & MODULES A GLOBAL COMMON PATH

With the higher weight of the batteries, does lead to different engineered underbody structures, wheels, chassis, suspension, .... This again depends on the continued improvement of battery technology respectively the weight which could take some of the pressure away from light weighting.

With the higher weight of the batteries ArcelorMittal foresee more advanced AHSS [advanced high strength steel] solutions, in particular hot stamping of the underbody structure according to Mr Jean-Martin Van der Hoeven, CMO Global Automotive & Mobility Solutions at ArcelorMittal. They projects that by 2025 roughly 50% of the European new car market will consist of electrified vehicles, which HEV, PHEV and BEV.

ArcelorMittal believes that BIW solutions will utilize higher volumes of steel in future as OEMs weigh up the benefits of either buying more advanced batteries, or instead paying for more complex light weighting strategies.

HONDA with the new global modular architecture, will share more components across models and help HONDA to cut the manhours required to develop new mass-selling models by 30 per cent by 2025 as it strives to streamline its operations. The new global modular architecture will accommodate not just different body shapes and sizes, but also batteries and motors of different capacities as well as a FCV derivate. This new HONDA Architecture is the company’s answer to similar modular platforms such as Volkswagen’s MEB, TOYOTA’s e.TNGA, PSA’s CMP and others. Aim is also to reduce the numbers of variants of each model by two-thirds to simplify development and production to improve efficiency, while at the same time cutting down on the number of regional models by basing them on global vehicles.

AUTOMOTIVE LIGHT WEIGHTING MARKET TRENDS IN: BATTERY TRAY - BIW - CHASSIS/SUSPENSION
AUTOMOTIVE LIGHT WEIGHTING MARKET TRENDS IN: BATTERY TRAY - BIW - CHASSIS/SUSPENSION

BIW INFLUENCED & AFFECTED ARCHITECTURE BY VARIOUS PROPULSIONS – LEXUS LS

Platform: SOP: 
TNGA-L 2017 EOP: 2023

Production Location / Average Yearly 
JAPAN: 10,000 to 15,000 units

HPDC AL & MG Applications:
- AL front & rear suspension domes were planned but skipped
- AL front HPDC subframe planned but skipped recently and switched back to steel. Entire chassis & suspension in steel and ferro

Other Applications:
- Steel rear subframe
- Battery tray in steel sheet

TOYOTA TNGA ARCHITECTURE WITH DIFFERENT MODULES TO ACCOMMODATE DIVERS BODY STYLES / PROPULSIONS

Source: TOYOTA & AluMag
Source: https://www.quora.com
AUTOMOTIVE LIGHT WEIGHTING MARKET TRENDS IN: BATTERY TRAY - BIW - CHASSIS/SUSPENSION

BIW AND CMS - MATERIAL ALLOCATION: ACURA RDX OLD VS NEW

HONDA ACURA RDX COMPARISON

Source: HONDA

50% increase of steel, from HSS to AHSS over last generation. Now with front/rear AL CMS the AL content increased from 2.5 to 4%

AUTOMOTIVE LIGHT WEIGHTING MARKET TRENDS IN: BATTERY TRAY - BIW - CHASSIS/SUSPENSION

BIW AND CMS - MATERIAL ALLOCATION: AUDI A6 OLD VS NEW

AUDI A6 COMPARISON

Source: AUDI

BIW material mix almost a carryover from AUDI A6 C7 to C8 generation.
The BIW of the E-Tron has a much lower penetration of AL compared to Q7. Only if the battery is included the AL share is close to identical.

The penetration of AL has raised from 0 to 5%. The front shock towers are AL HPDC.
AUTOMOTIVE LIGHT WEIGHTING MARKET TRENDS IN: BATTERY TRAY - BIW - CHASSIS/SUSPENSION

BIW AND CMS - MATERIAL ALLOCATION: PORSCHE PANAMERA VS TAYCAN

PORSCHE PANAMERA VS TAYCAN COMPARISON

Source: PORSCHE

The BIW of the Taycan contains 6% more aluminum than the Panamera.

BIW AND CMS - MATERIAL ALLOCATION: RANGE ROVER EVOQUE OLD VS NEW

RANGE ROVER EVOQUE COMPARISON

Source: ingenia.org.uk

Source: Range Rover, Automotive Circle

89% increase of high strength steel over last generation. Now with front CMS and suspension domes in AL.
EUROPEAN ALUMINUM CONSUMPTION WITHIN BIW [EXCL. BATTERY TRAY - CMS - HANG-ON]

FORECAST & 2018 OEM SHARE OF AL BIW CONSUMPTION

From 2010 to 2020 the demand for aluminum in BIW structures grow by a factor of nine. Until 2020 the increasing consumption of AL within automotive frame applications is primarily fueled by the premium OEMs eager to lightweight their vehicles. After 2020 a higher penetration of electric vehicles as well as an expected leap into the higher middleclass will keep the consumption of AL frame applications on the rise. JLR is the biggest consumer of BIW AL as it uses full AL bodies for many of its models. VW, Daimler and BMW are runner ups using mostly hybrid BIW for their premium vehicles.

CAST AL EXTRUSION

ILLUSTRATED OBSERVATIONS - PHEV & BEV GAME CHANGER & CHANCE

Around 2025 BEV will subsequently take over and account for the vast majority of EV sales.

Free OEM production capacity caused by increasing BEV penetration (fewer parts/systems per car) will result in a shift towards more in-house production.

Cast AL overcapacity likely due to current sales penetration. Excess capacity in CHN & increasing penetration of BEVs (fewer parts). With solid state batteries 2030 onwards (necessity to use AL in the structure decreased due to sufficient range)
By analyzing the most utilized platforms in Europe representing different segments and a combined market coverage of over 50% of all produced vehicles, AluMag® has analyzed the total demand for suspension arms [link arms, wishbones, control arms] in the region. Though the E-segment is relatively small in terms of produced vehicles, the front axle design is more advanced and utilize close to the same volume of arms as the C-Segment (26% vs 29%). The low number of arms utilized in rear A & B-segment cars (5% of total volume) is due to the high penetration of torsion beam axles where no arms are inserted. High segment cars are generally fitted with a more advanced axle design featuring more arms than low segment cars.

McPherson strut axle design has a penetration of 100% for A, B and C segment cars in the front. The D-segment is again split in two parts where premium vehicles such as the Audi A4, MB C-Class and BMW 3-series are fitted with multilink or double wishbone axles, and lower D-segment cars such as the Ford Mondeo and Opel Insignia are fitted with McPherson struts.

For E-segment cars front multilink axles are dominating with a penetration of 70% vs 30% for double wishbones. Overall McPherson axles are fitted to 80% of all passenger vehicles in EUROPE vs 10% penetration for multilink and 5% penetration for double wishbones axles. For rear axles torsion beams account for 56% of total market vs 44% multilink & 0.3% double wishbone axles.
AUTOMOTIVE LIGHT WEIGHTING MARKET TRENDS IN: BATTERY TRAY - BIW - CHASSIS/SUSPENSION

CHASSIS/SUSPENSION - WISHBONES/ARMS BY CAR SEGMENTS IN EUROPE

At the front suspension L-shaped arms are the most utilized design accounting for 57% of the total consumption, followed by I-arms [33%] and A-arms [11%]. Due to the high penetration of rear multilink axles I arms accounts for 63% of the total rear arms market followed by spring-arms [21%], Longitudinal-arms [13%], H-arms [2%]. A-arms with a penetration of only 1% are rarely used at the rear suspension.

TYPE OF ARMS DEMAND ALLOCATION IN EUROPE* BY SEGMENT

39% of all suspension arms utilized in Europe are made out of aluminum [Front & rear] vs 61% ferrous arms. Again the following rule apply: The higher the segment, the higher the penetration of aluminum arms. A to C-segment cars have a very low penetration of aluminum arms both in front and rear. Cars positioned in the lower D-segment such as Opel Insignia, Peugeot 508 and VW Passat are also rarely fitted with AL arms whereas cars of the higher D-segment/premium class [Audi A4, MB C-Class, Volvo S60] all are fitted with a lightweight AL suspension. So in a way the market is split in two parts. Ferrous intensive suspension from A to Lower D-segment vs aluminum intensive suspensions from higher D-segment and upwards.

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Of the three analyzed regions Europe has the highest penetration of aluminum subframes in regards to units and in percent of total car production. In Europe 13% of all produced vehicles are fitted with a front aluminum subframe, compared to 6% for the rear axle. USA has a higher penetration of aluminum subframes than China percentage-wise but more aluminum subframes [Units] are inserted in China. Foreign brands like BMW & VW accounts for the majority of inserted aluminum subframes in China. 66% of the total aluminum demand for subframes was consumed in Europe, 17% in China and the remaining 16% in USA.

In Europe the E-Large segment account for 47% of all aluminum subframes inserted compared to only 32% in USA and 25% in China. This can be explained by the high concentration of E-Large vehicle production in Europe by JLR, BMW, Daimler & VW Group which makes up a relatively big share of the total production. For all three analyzed regions only a few "A – Basic" and "B – Sub-Compact" vehicles are fitted with aluminum subframes and these two segments only account for a few percent overall.
VW Group is the biggest user of aluminum subframes in the triad region accounting for 34% of the market (USA, China, Europe) followed by BMW (16%) and Daimler (15%) in second and third place. Only eight groups account for a combined 98% of the total market for aluminum subframes in the analyzed regions. In China VW Group is also the biggest user of aluminum subframes with 28% of the total market followed by GM and BMW. Still foreign players account for 97.46% of the Chinese aluminum subframe market but the Chinese brands are slowly increasing their use. Brands like BYD, GEELY, FAW, NIO, ZHONGTAI and GAC have already launched their first models with aluminum subframes.

Of the independent foundry groups KSM, MARTINREA & ALUDYNE are among the leading supplier of cast aluminum subframes in the Triad region as well as in China alone. It is also worth noticing that VW Group & BMW cast a large piece of their cast aluminum demand for subframes in-house. Native Chinese suppliers like HONGTAI, WANAN, HONGTE & TUOPU only account for a small size of the total Chinese subframe market, expected to increase its shares.
AUTOMOTIVE LIGHT WEIGHTING MARKET TRENDS
IN: BATTERY TRAY - BIW - CHASSIS/SUSPENSION

CHASSIS/SUSPENSION - ALUMINUM SUBFRAME APPLICATIONS BY CAR SEGMENTS

In 2011 the "C-Compact" segment accounted for 41.99% of all aluminum subframes inserted on the European market dropping to 16.80% in 2017 and is expected to decrease further by 2020. The main driver behind the erosion of the C-Compact segment is VW decision to implement more steel for its MQB platform compared to the former PQ35 platform. In general the market for aluminum subframes is increasing but the growth is taking place in the upper segments and predominantly by the premium brands. OEMs like PSA, VW, & HONDA have implemented more steel for their C-Compact and lower "D - Midsize" segment cars replacing aluminum subframes with steel on models like the VW Golf, HONDA Civic, Peugeot 407/C5 & HONDA Accord.

EUROPEAN DEVELOPMENT OF ALUMINUM SUBFRAME MARKET: PROCESS HYBRID VS SINGLE PROCESS / METAL

From 2011 to 2015 the market penetration of process hybrid vs single processed metal aluminum subframes was stable with hybrid subframes holding about 50 – 53% of the European market vs single metal constructions with a share about 47 – 50%. Since 2015 hybrid constructions have been preferred by the OEMs seeing the penetration rising from 50.24% in 2015 to an expected 70.46% in 2020. Main driver behind this development in the aluminum subframe market is the launch of VW MLB-Evo, BMW CLAR & MB MRA platforms featuring hybrid aluminum subframes. In China 89% of all aluminum subframes were hybrid designs in 2017.
From 2017 to 2025 the market for aluminum subframes [Units] in China is expected to grow with 64% in total. [Average Scenario - CAGR: 6.6%]. The demand for cast, extruded and sheet aluminum within subframes will increase accordingly by a factor of 1.7 in the analyzed timeframe. As foreign [mainly European – 60%] OEMs accounts for 97.46% of the total Chinese aluminum subframes in use, the Chinese forecast is heavily dependent on the development of the European [And USA & Japan] aluminum subframe market.

The penetration of aluminum subframes in China in 2017 was 2.46% and is expected to grow with a CAGR of 6.6% reaching a share of 3.37% in 2025. 4.24% of all passenger vehicles produced in China are currently fitted with a front subframe with AL content while the same figure is only 0.68% for the rear subframe. The penetration of AL rear subframes is expected to grow with 8.97% compared to front AL subframes with a CAGR of 6.19%

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In the triad region the total aluminum demand consist of cast [78%], extruded [12%] and sheet [11%]. VW accounted for 24.78% of the total demand followed by BMW with 21.59% and Tata with 13.59%.

Though VW group is inserting the most aluminum subframes in China [in terms of units] of any groups, BMW & GM have a higher demand for aluminum in China due to the weight of the subframes installed.

Source: AluMag®
AluMag® is looking for automotive professional entrepreneurs in various booming and emerging countries or business partners / shareholder at AluMag®, please contact us for more details on how to partner-up!