Materials Meets Engineering - Frankfurt

Frederik Thoma
June 18th 2019
Agenda

• Requirements and challenges to the automotive industry
• Automotive evolution and scenario
• Radical change within European mobility market
• Plastic parts in an electrical vehicle, example: Jaguar I-Pace
• Smart materials fits new requirements
Requirements to future automotive industry

- All cars have to fulfill stricter CO2 and NOx requirements
- International commitment to reduce emissions (e.g. Kyoto-protocol, Paris agreement)
- Implementation of real driving emissions (RDE) test which completes WLTP*
- Reduction of fuel consumption

* Worldwide harmonized light vehicle test (lab test)

Source: international council on clean transportation www.theicct.org
Challenges for the automotive industry

Powertrain:
• Turbo charged smaller engines
• New developed DeNOx systems (e.g. SCR*)
• Enhanced charge air cooler systems (e.g. water cooled)
• Cylinder deactivation, Start/stop systems, energy recovery (micro hybrid system) etc.

Lightweight:
• Metal replacement
• Plastic replacement with other suitable plastics (e.g. PP instead of PA)
• Composites and hybrid structures (possible with PIT technique – will explain some sheets further)

Electrification:
• Step by step combustion engine reduction to 20% by 2030

* Selective catalytic reduction
European mobility market will face radical change in 2030

• 20-50% of all new car sales in Europe may be fully electrified by 2030
• New requirements will lead to new mobility trends:
  - Autonomous and shared mobility will increase greatly by 2030
  - The personal mileage will increase by two digit percentage
  - Car sharing will be more focused than an own car
European mobility market will face radical change in 2030

- 20-50% of all new car sales in Europe may be fully electrified by 2030

→ E-Vehicles have a lot of components which are not necessary in a combustion car

→ Plastics demand will increase significantly

Source: A2mac1
Examples of higher plastics demand → battery pack

- **9 kg of Plastics in the Battery pack**

All products are available within the APS portfolio!

<table>
<thead>
<tr>
<th>APS material opportunity</th>
<th>Application</th>
<th>Weight</th>
<th>Material</th>
<th>Material ref.</th>
<th>Manufacturer</th>
<th>#A2mac1 ref#</th>
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<tbody>
<tr>
<td>No Alternative</td>
<td>Cell Module, large</td>
<td>0.087</td>
<td>PPO</td>
<td>modified PPO-GF10</td>
<td>OEM Logo</td>
<td>1709-30</td>
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<td>Schualblend M/M8</td>
<td>Relay Box</td>
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<td>PC+ABS</td>
<td>Isabellenhuette</td>
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<td>Moplen / Hostacom</td>
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<td>expanded PP</td>
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<td>PA</td>
<td>PA66 GF30</td>
<td>TYCO Electronics (TE)</td>
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<td>2nd BMS Master ECU</td>
<td>0.134</td>
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<td>PPE+PS HI GF10 FR</td>
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<td>tbd</td>
<td>Insulator / Shield, Upper</td>
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<td>Hostacom/Hifax</td>
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<td>PPC</td>
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<td>Schulatec PPS GF40</td>
<td>Electronic Components Base Plate</td>
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<td>Marquardt</td>
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</table>

Base Plate in PPS GF40 → e.g. Schulatec PPS GF40 black

Source: A2mac1 / Alain Gourjault, LYB
Further examples for plastics within other main e-vehicle parts

- Relay box → 2kg plastics (PA66, PA66GF30, PA66GF30FR, PBTGF30, PC+ABS)
- AC/DC inverter 1 and 2 → 4kg plastics (PBTGF30, PA66, PA66GF30, PPSGF30, PPSGF40)
- Charger → 4 kg plastics (PPAGF15, PA66GF25-35, PA6GF50, PBTGF30, ABS)

9kg + 10 kg additional volume for specific e-vehicle parts

Source: A2mac1 / Alain Gourjault, LYB
Plastic parts in an electric vehicle, example: Jaguar I-Pace

<table>
<thead>
<tr>
<th>Plastic grade</th>
<th>Volume (kg)</th>
<th>APS portfolio</th>
<th>Brand name</th>
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<tbody>
<tr>
<td>PPC</td>
<td>106</td>
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<td>Hostacom</td>
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<tr>
<td>PP</td>
<td>8</td>
<td>✓</td>
<td>Moplen</td>
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<tr>
<td>PA</td>
<td>35</td>
<td>✓</td>
<td>Schulamid PA</td>
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<td>PBT</td>
<td>6</td>
<td>✓</td>
<td>Schuladur A</td>
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<td>ABS</td>
<td>9</td>
<td>✓</td>
<td>Ronfalin ABS</td>
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<td>ABS+PC</td>
<td>16</td>
<td>✓</td>
<td>Schulablend</td>
</tr>
<tr>
<td>ASA</td>
<td>3</td>
<td>✓</td>
<td>Ronfalin ASA</td>
</tr>
<tr>
<td>PC</td>
<td>8</td>
<td>✓</td>
<td>Perlex</td>
</tr>
<tr>
<td>PE</td>
<td>6</td>
<td>✓</td>
<td>Hostalen</td>
</tr>
<tr>
<td>PES</td>
<td>1</td>
<td>X</td>
<td>e.g. Ultrason</td>
</tr>
<tr>
<td>POM</td>
<td>2</td>
<td>✓</td>
<td>Schulaform</td>
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<tr>
<td>PUR</td>
<td>34</td>
<td>X</td>
<td>e.g. Desmopan</td>
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<tr>
<td>TPE/TPV</td>
<td>5</td>
<td>✓</td>
<td>Invisiona</td>
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<tr>
<td>PET</td>
<td>9</td>
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<tr>
<td>PMMA</td>
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<td>✓</td>
<td>Polyman PMMA</td>
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<tr>
<td>PPE</td>
<td>1</td>
<td>X</td>
<td>e.g. Noryl</td>
</tr>
<tr>
<td>PPS</td>
<td>6</td>
<td>✓</td>
<td>Schulatec PPS</td>
</tr>
<tr>
<td>total</td>
<td>257</td>
<td></td>
<td>14 of 17 grades</td>
</tr>
</tbody>
</table>

Source: A2mac1
PPC volume in the I-Pace is higher than the average EU ICE cars

Source: A2mac1 / Alain Gourjault, LYB
New requirements and new trends within European mobility market

• New requirements will lead to new mobility trends:
  - Autonomous and shared mobility will increase greatly by 2030 (connected cars lead to high amount of electrical component → EMV shielding, flame retardant products)

→ PIT Technology can be a smart solution for the EMV shielding topic
PIT – LyondellBasell technology for cost effective approach

PIT laminate preparation (LyondellBasell Competence Partner):

- **Lacquer** optional
- **Foil** (e.g. aluminium)
- **Adhesive** *(Qestron foil)*
  - From *Qestron PP Compound* made by LyondellBasell

**PIT Laminate**

- Semi finished good
- To be delivered to molder

Back injection step (Tier1):

- **Thermoplastic**

  **Standard process:**
  - Injection molding
  - Extrusion,
  - Thermoforming
  - Compression, etc.

  **Final part**
PIT – Smart approach for hybrid parts in one injection step

Source: Lyondellbasell / trials
PIT – Smart approach for hybrid parts in one injection step

**Hostacom PPU 2090L (unreinforced)**

- **Flex Modulus (MPa ISO 178)**
  - HC PPU 2090L (unreinforced)
  - 0.2 mm Decor
  - 0.2 mm Aluminium
  - 0.2 mm Steel

**Hostacom M2 U01 (PP TD20)**

- **Flex Modulus (MPa ISO 178)**
  - HC M2 U01 (PP TD20)
  - 0.2 mm Al
  - 0.2 mm Al
  - 0.4 mm Al
  - 0.4 mm Al
Electromagnetic shielding for batteries and powertrain

Co-operation with Prof. Dr. Norbert Seliger University of Applied Science Rosenheim Laboratory for EMV

Electromagnetic shielding, light weight, design freedom
New requirements and new trends within European mobility market

• New requirements will lead to new mobility trends:
  - The personal mileage will increase by two digit percentage (also people will use cars which do not have a driver license → robo taxis)

→ Robo taxi interiour will be more functional than estatic – use of *Softell* products.
Classical PP Compound compounded blend of PP and impact modifier

**Softell** is a PP EPR With fine dispersed rubber

**Softell®**
Name for base polymer
Name for PP compound *Softell TKG 300N* containing *Softell* resin as building block

Source: LyondellBasell /Michael Büdinger
## Softell TKG 2039N scratch & mar performance vs. PPTD20 Compound

<table>
<thead>
<tr>
<th></th>
<th>PPTD20 (Black)</th>
<th>Softell TKG 2039N (Black)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scratch Resistance PV 3952 (10N)</td>
<td>DL*</td>
<td>DL*</td>
</tr>
<tr>
<td>Typical automotive leather grain</td>
<td>2,7</td>
<td>0,3</td>
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<tr>
<td>Fine grain</td>
<td>4,5</td>
<td>0,1</td>
</tr>
<tr>
<td>Mar resistance as per PV 3974 (3N)</td>
<td>DL*</td>
<td>DL*</td>
</tr>
<tr>
<td>Typical automotive leather grain</td>
<td>1,4</td>
<td>0,93</td>
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<tr>
<td>Fine grain</td>
<td>1,87</td>
<td>0,7</td>
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<tr>
<td>Gloss level (60 °)</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Typical automotive leather grain</td>
<td>4</td>
<td>2,9</td>
</tr>
<tr>
<td>Fine grain</td>
<td>1,4</td>
<td>1,1</td>
</tr>
</tbody>
</table>

Values has been measured on VW 216 IP trim part

Source: Lyondellbasell /Michael Büdinger
Softell Textile: A new material for attractive textile appearance

Based on Softell matrix
LyondellBasell has developed a material with „textile look“

Advantages:
- Good surface quality, low gloss
- Good impact / stiffness balance
- Soft touch w/o textile
- Low gloss
- High scratch and UV-resistance
- Low odour and emissions
- Cost & weight saving
- Air Bag deployment behavior

Source: Lyondellbasell /Michael Büdinger
Fabric Wrapped Components replacement: Upper Pillar Trim
Textile Roofliner

- **Softell Textile**

- **Cleanability** – for future car sharing
  - Lower emissions and odor due to the elimination of adhesives

- **EV** – quiet PLEASE!!

- **Sound Dampening** – NVH – PC/ABS?
  - Total system cost reduction
  - BMW A/B Deployment - ductile
  - **No Adhesive = VOC “FREE”**

- Recycling is easier.
  - Airbag shot testing on black and textile upper pillars were positive

Source: Lyondellbasell / Michael Büdinger
European mobility market will face radical change in 2030

• New requirements will lead to new mobility trends:
  - Car sharing will be more focused than an own car (enhanced requirements according plastic parts → long fibre grades, low creep PP like advanced copo PP and PIT (plastic interface technology) for structural parts are suitable

→ Example: Surge tank within hybrid vehicles. Due to higher permanent use this application will be stressed more. Solution: Advanced PP with lower creep leads to reliable parts.
PP glass fiber - known materials for structural parts with a new feature
Deflection vs. time (at elevated temperature) = material creep

Tensile creep test (test longitudinal to fiber direction)

Source: Lyondellbasell /Klaus Klemm
PP glass fiber - known materials for structural parts with a new feature
Deflection vs. time (at elevated temperature) = material creep

Deflection vs. time (at elevated temperature) = material creep

Source: LyondellBasell /Klaus Klemm

Lower creep = longer life
European mobility market will face radical change in 2030

There are high investments necessary for the e-vehicle infrastructure
• Charging stations with fast loading system
• At home wall boxes
• Charging plugs
Smart solutions for new requirements

POLYFLAM® RMMK 125
SCHULADUR® A MV14 SHI FR1

PA/ABS, unreinforced, V-0 @ 0,8 mm, high impact
PBT, unreinforced, V-0 @ 0,8 mm, high impact

Wall box / company ABL sursum
Charging plug / company Phoenix Contact

Source:
Lyondellbasell / Phoenix Contact / ABL Sursum
Summary

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- Plastic parts in an electrical vehicle, example: Jaguar I-Pace
- Smart materials fits new requirements
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