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Performance materials enable sustainable mobility

Dr. Simon Kniesel
Group Leader R&D Ultramid®
Engineering Plastics Europe
Safe, cost-efficient and easy-to-use solutions for electric vehicles

The chemical content is **2.5 times higher (by value)** in a battery electric vehicle compared to a car with an internal combustion engine:

- **Powertrain**
  (e.g., cathode active material as key component of any battery cell)

- **Coolants**

- **Plastics**

- **Coatings**
  (e.g., to protect against corrosion)

Transformation of the powertrain affects the entire vehicle
High-performance material solutions enabling sustainable mobility

High-voltage lines are the veins of an electric vehicle and enable **safe power distribution**

Thermally conductive adhesives enable **thermal management in batteries**

Long-term color-stable orange engineering plastics enable **safe handling of high-voltage cables**

E-mobility requires new safety concepts to enable **passenger safety**

Plastic content will increase during the transformation to all-electric powertrains
Enabling safe power distribution
High-voltage lines are the veins of an electric vehicle

Challenges and requirements:

- Busbars can be found in many parts of the battery electric vehicle:
  - Differences in thermal expansion of metal conductor and plastic can lead to cracks
  - High electric isolation and flame retardancy needed
Enabling safe power distribution
New Elastollan® for busbars

Solution:

- New Elastollan® is highly compatible with metallic busbars:
  - Coefficient of Linear Thermal Expansion (CLTE) close to metallic busbars (copper, aluminum)
  - No phase transformation in the relevant temperature range
  - Superior thermomechanical stress resistance between –40°C and 120°C (>1,000 cycles)

- Easy to process and cost-efficient

First series in realization with a French Tier 1
Enabling thermal management in high power batteries

Challenges and requirements:

- Cells heat up during (fast) charging and driving
  - Optimum operating temperature 20°C–40°C
  - Battery cells must not be charged below 0°C or operated above 80°C
- Increasing energy densities require a high heat transfer
- Adhesives connect the cells to the cooling plate
  - High thermal conductivity is needed (1-3 W/mK)

Challenges that require new material solutions
Enabling thermal management in high power batteries
Thermally conductive 2K-polyurethane* adhesives for batteries

Solution:

- Combination of the versatility of polyurethane with best fit of thermally conductive additives

Innovative formulation fullfills high demands for:

- Flowability and required pressing force
- Thermal conductivity and thermal stability
- Adhesion

Thermally conductive 2K PU* adhesives: simulation supported formulation development

High flowability and processability at 75 vol% filler loading
Thermal conductivity of 3 W/mk

* 2 component polyurethane
Enabling safe handling of high-voltage cables

Challenges and requirements:

- The orange color RAL 2003 is the standard signal color for high-voltage connection e-mobility applications in electric vehicles
- Color stability requirement: 1,000h at 140°C
- Polyamides tend to severe discoloration during heat ageing

Long-term color-stable orange needed
Enabling safe handling of high-voltage cables

Solution:
Durable orange-colored applications through novel polyamide (PA) formulation and designed pigment formulation

<table>
<thead>
<tr>
<th>PA66 uncolored</th>
<th>PA66 non-optimized orange-colored</th>
<th>Ultramid® in RAL 2003</th>
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<tbody>
<tr>
<td>1,000 h</td>
<td>1,000 h</td>
<td>0 h 250 h 500 h 1,000 h</td>
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<td>90°C</td>
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<td>130°C</td>
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<td>150°C</td>
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Portfolio of long-term color-stable orange Ultramid®
Enabling passenger safety

Challenges and requirements:

- Trend toward shortened frontend
- Need for crash protection of the battery
- Higher overall vehicle weight

New vehicle architecture requires new safety concepts
Enabling passenger safety

Solutions:

- High-energy-absorbing plastic frontend realized in co-creation with a global OEM
- 3D formed crash absorbers from polyamide particle foam with high energy absorption (structural parts in car bodies)
- High stiffness and energy absorbing pultruded polyurethane and thermoplastic profiles

New material classes for next-level crash safety
Facing the sustainability challenge in e-mobility – next steps

Our contribution to sustainable mobility

2021

New Elastollan® for busbars commercialized

2022

Launch of comprehensive product portfolio for e-mobility:
- Durable orange
- New materials for crash absorbers
- Thermally conductive adhesives

2023

Novel materials for sound optimization of battery electric vehicles

2024 & beyond

Catalyze battery and vehicle development with new high performance material solutions

Decarbonization of mobility requires a broad portfolio of material solutions – BASF is the partner of choice for the automotive industry
- BASF

We create chemistry