High performance composite and polymer solutions for green, new mobility

Michael Rockel, Head of Greater China Sales & Marketing
LANXESS High Performance Materials Business Unit

Chengdu, September 13

LANXESS – a global specialty chemicals group

Specialty chemicals company

- Spin-off from Bayer in 2004
- Specialty chemicals portfolio: chemical intermediates, specialty chemicals and plastics

Global success story

- 74 sites worldwide
- Approximately 19,200 employees in 25 countries
- Global sales of EUR ~9.7 billion in 2017

Strategy of profitability and resilience

- Strengthening of leading position in medium-sized markets
- Consolidation in Europe, expansion in USA and Asia

China is one crucial cornerstone of LANXESS global business

LANXESS China

- **17** subsidiaries (including 3 joint ventures)
- **5** offices
- **9** R&D Centers
- **9** production sites
- Around **1,900** employees
- LANXESS' continuous investment in China demonstrates its firm confidence in the Chinese market and the long-term commitment

High Performance Materials at a glance – Leading supplier of engineering plastics

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Energizing Chemistry

Key figures

- Sites: 3 in APAC, 2 in China
- Employees: ~ 1,600,
- Customers: ~ 600

Brands

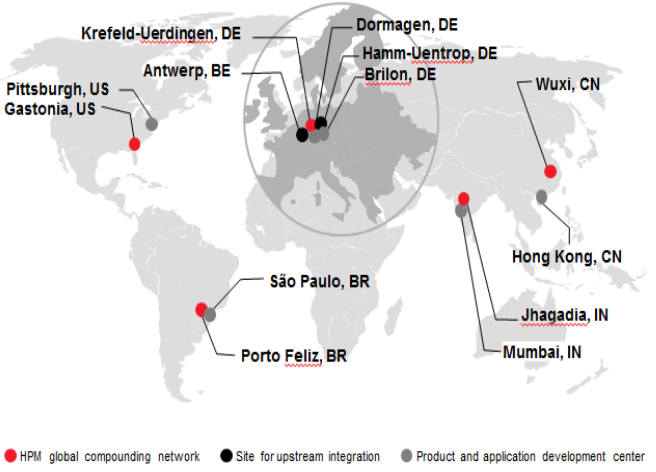
Durethan®	Pocan®	Tepex®
PA 6, PA6,6	PBT	Composite

Applications

Markets & growth drivers

- Market position: Among global top 5
- Key industries: Automotive, electric/electronics

Global Presence



- Global compounding network
- Backward integrated supply
- Product and application development

High Performance Materials – innovation building blocks

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Automotive

Lightweight Technologies

Under the Hood

Alternative Powertrain

Exterior

Interior

Automotive E/E

Electric/Electronic

Industrial E/E

LED & Lighting

Consumer Electronics

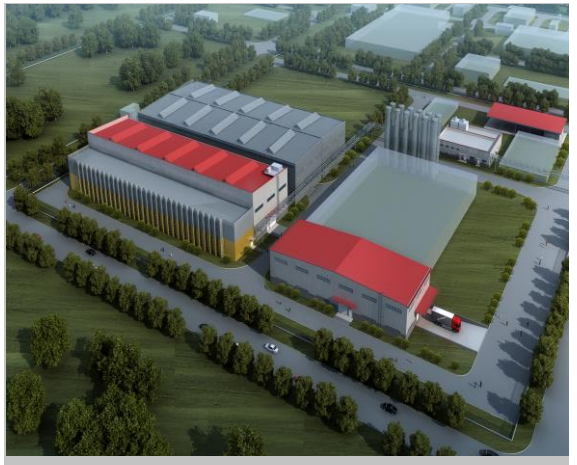
Household Appliances

Pictures: LANXESS, BMW, Daimler, Intercontec, Vorwerk

HPM is a core business of LANXESS

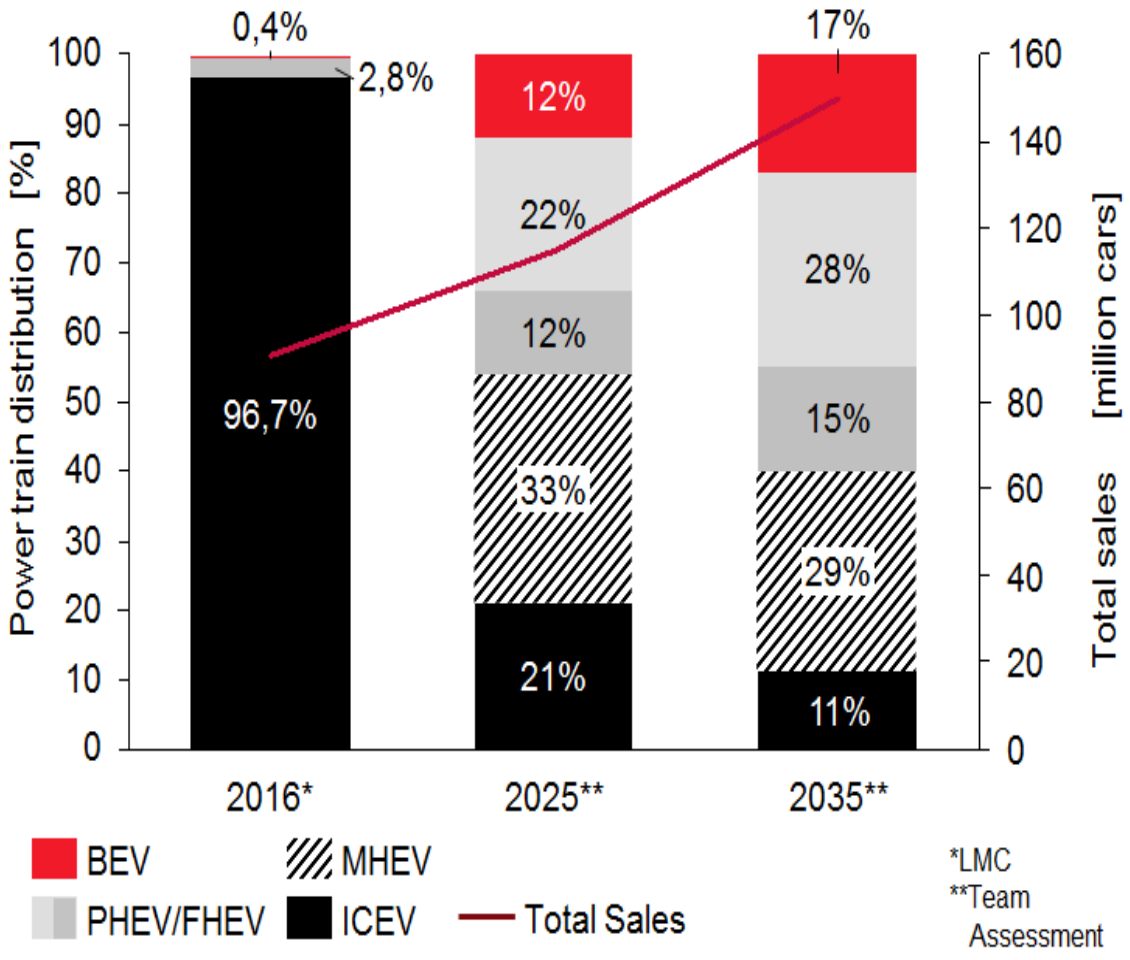
HPM China

- **4** offices (Shanghai, Guangzhou, Beijing and APAC HQ in Hong Kong) & 4 home office locations (Tianjin, Baoding, Shenzhen, Suzhou)
- **1+1** production sites 60KT + 25KT (Q2 2019)
- **1** R&D Center in Wuxi
- **1** CAE Development and Part Testing
- Around **180** employees
- LANXESS' continuous investment in China demonstrates its firm confidence in the Chinese market and the long-term commitment



New project in Changzhou
Phase 1: One line, 25KT
Investment: USD 25 mio
Master plan: 130KT
Startup: Q2 2019

LANXESS e-mobility scenario
Global view



Key takeaways

- Worldwide increased development of electrified powertrains to fit CO_2 targets after 2023
- MHEV as immediate action with lowest costs for slight CO_2 reduction
- Long-term focus on BEV and PHEV
- Still 83% of powertrains with ICE in 2035, but 90% electrified
- China being the leading driver of electric mobility

Challenges for e-Mobility

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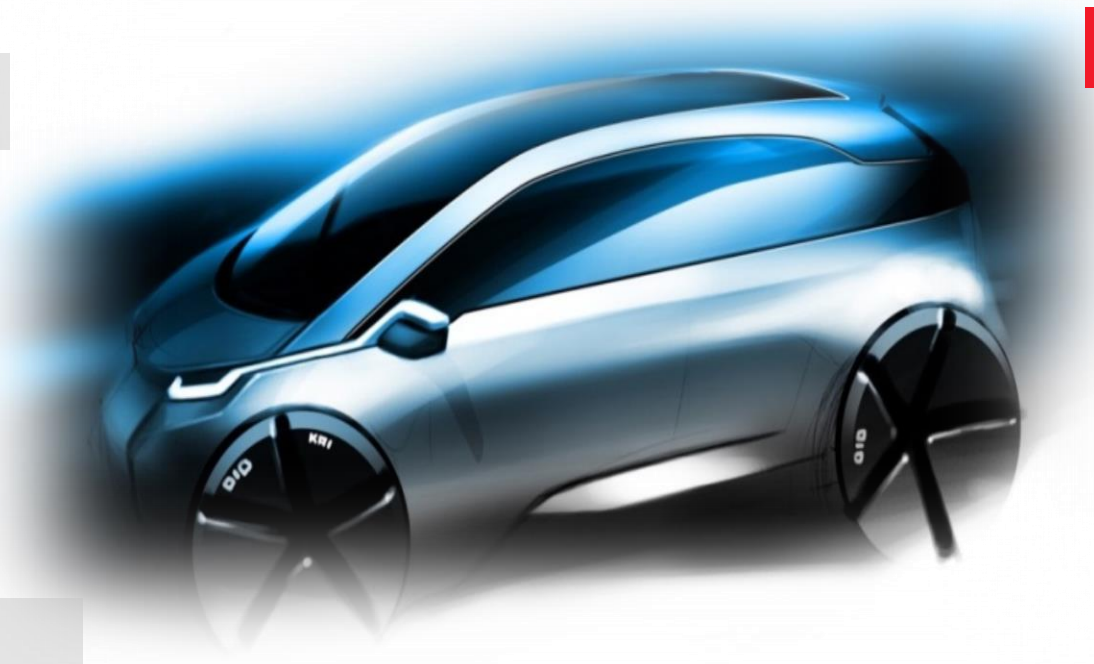
- Freedom of design
- Weight reduction
- Cost reduction
- Safety
- Recyclability
- Integration of functions

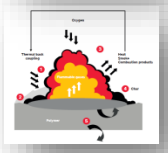


- electromagnetic shielding
- thermal conduction
- contact corrosion
- stiffness/strength
- tightness
- flame retardancy
- chemical resistance
- electrical properties
- …

Complex combinations of requirements

[Source: BOSCH, Kostal, Eberspächer]

Material and technology development for e-mobility



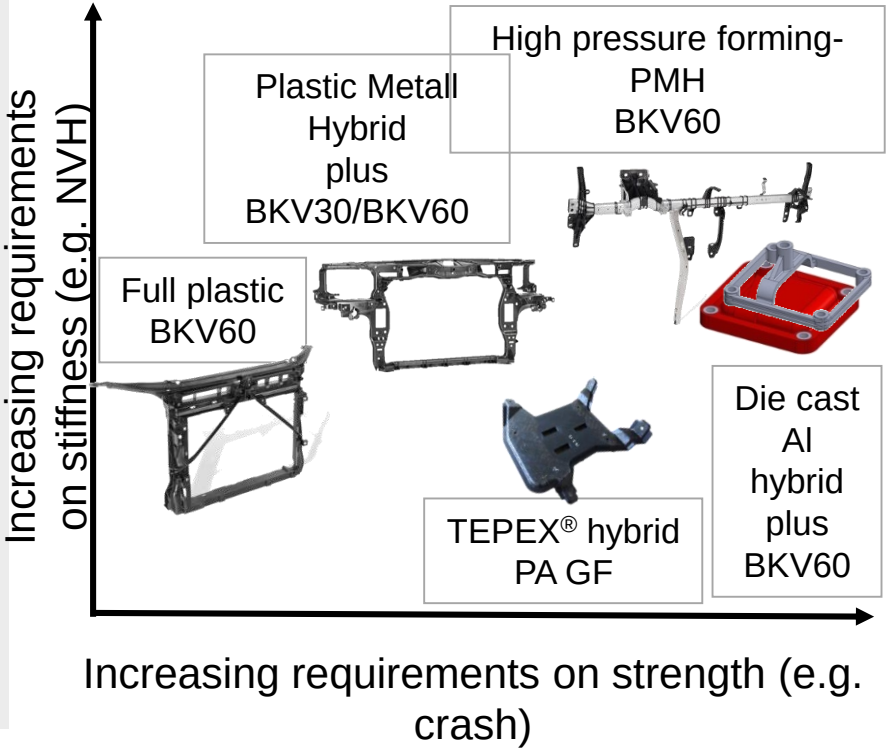
- **Lightweight applications**
- Flame retardancy
- Thermal conductivity
- Electromagnetic shielding

Lightweight technology toolbox LANXESS

Motivation

- Weight has significant influence on design of power train, brake system, body…
- Weight has significant influence on energy consumption
- Energy consumption influences the design and the costs for the battery system
- Consequent lightweight design has big potential for weight saving and cost reduction (less costs for battery invest – kWh)

LANXESS Lightweight technology toolbox



Plastics and composites – the key for electric mobility

Technology and material solutions for lightweight design

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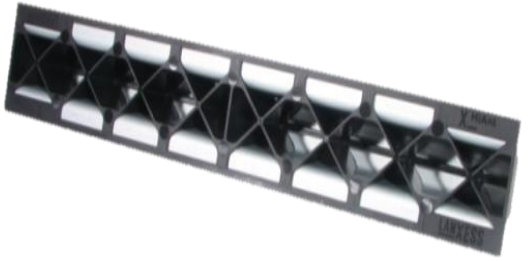
High modulus grades

- High stiffness, glass fiber content up to 60%
- Conventional injection molding process
- Low wall thickness possible because of excellent flowability
- First frontend entirely made of polyamide (w/o metal inserts)

Plastic metal hybrid



- Best of both worlds: plastic stiffening (ribs) allows for lower metal sheet wall thickness
- Freedom of design, small tolerances, consistently high reproducible quality
- Functional integration (clips, fasteners etc.)
- Advanced hybrid technology with adhesive bond for even better performance

Thermoplastic composites

- Continuous fiber with thermoplastic matrix – tailored to customer application
- Very high strength and energy absorption, high stiffness
- Functional integration by combination with injection molding process
- Short cycle times (~ 1 min), mass production
- No corrosion, simple recycling

Material solutions for lightweight design
Durethan® EasyFlow and XtremeFlow grades

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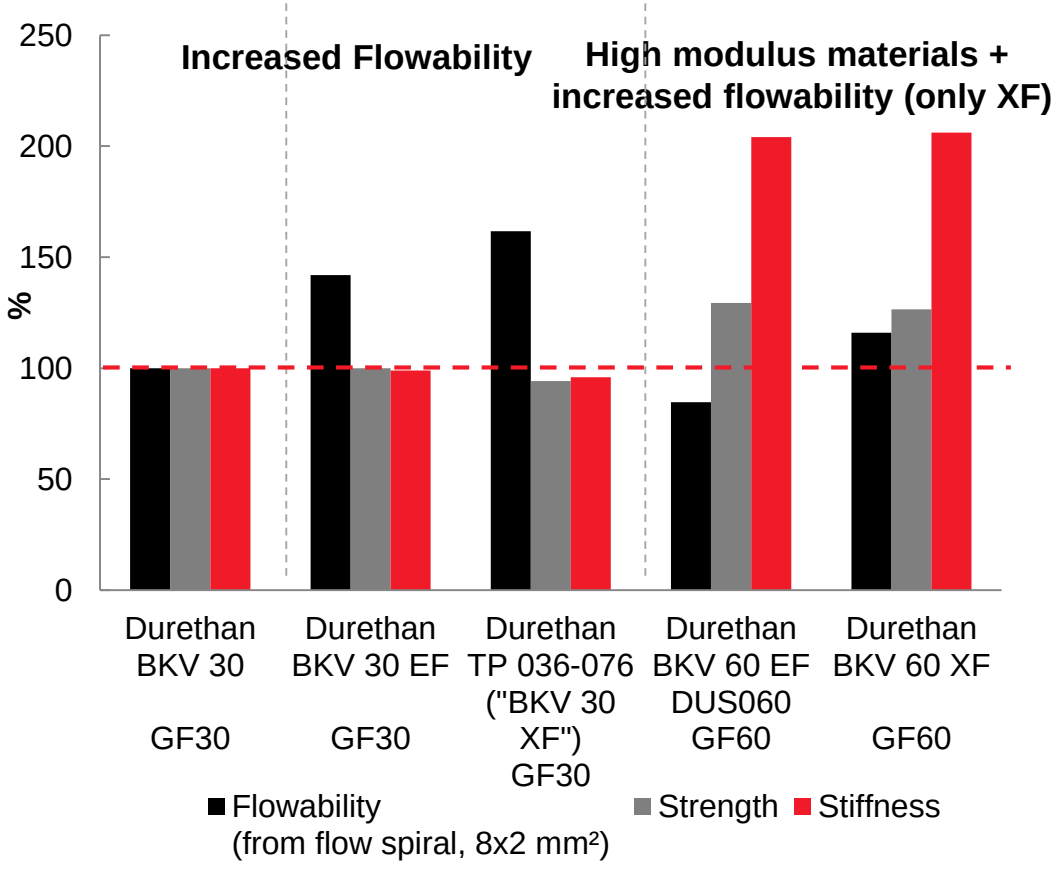
Progression of key properties



Ideal for light weight applications

Polyamide compounds with increased flowability

- Longer flow path
- Reduced cycle time
- Less energy consumption
- Reduced costs
- Enhanced surface quality

Highly reinforced polyamide compounds

- GF and/or CF loading
- Up to 60% GF results in high stiffness (modulus) and strength
- Various heat stabilizations available

Selection of serial/development applications in the alternative powertrain – Battery system

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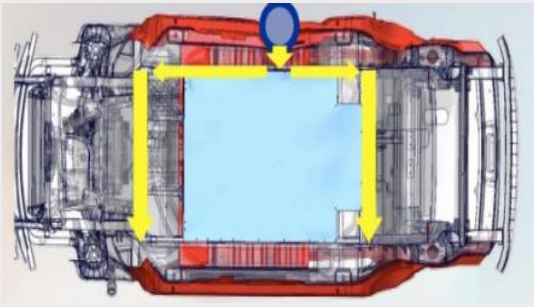
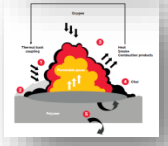
Battery housing: Impact Protection	▪ Durethan® BKV60H2.0EF DUS060 (PA 6 GF60) ▪ Weight reduction/ metal substitution ▪ Function is guaranteed in contact with electrolyte ▪ High mechanical strength (Pole Crush Test)	
Battery housing: Component	▪ Durethan® BKV30FN04 DUSLHC (PA 6 GF30 FR) ▪ Mechanical forces & creeping due to cell breathing ▪ High risk of contact corrosion: Low halide content ▪ V-0, halogen-free, CTI 600	
Cell module: Support structure	▪ Durethan® BKV45FN04 (PA 6 GF45 FR) ▪ Non-halogen FR system (UL94 V-0 at 0.4 mm) ▪ Low warpage and high dimensional stability to assure assembly	

Material and technology development for e-mobility



- Lightweight applications
- **Flame retardancy**
- Thermal conductivity
- Electromagnetic shielding

Fire protection in plastics – Increasing need for flame retardant polymers is expected

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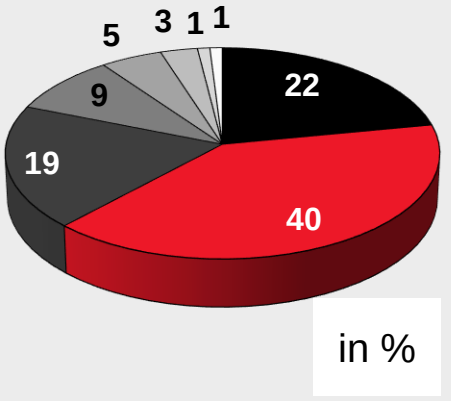
Challenge

- E-Mobility requires more electric parts
- Higher voltage (up to 800 V)
- Increasing fire safety requirements in electrical engineering, electronics and transportation sector
- Eco-toxicological properties gain importance

Reasons for fires in cars



- Leakage
- E+E
- Ignition
- Exhaust system
- Aggregate system
- Ignition of insualtion
- Fires caused by accident
- Unexplained

[Source: SV-Büro Lang, presented at SKZ Kongress „Fuse box meets dryer“]

Increasing FR requirements in vehicles

Main market segments for flame-retardant thermoplastics, today – and tomorrow?

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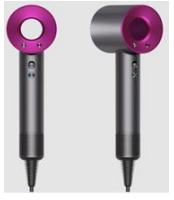
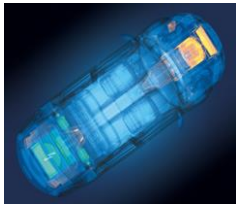
Adaption of E/E standards to e-mobility

Household E/E	Industrial E/E	E-mobility
		
		
GWIT/GWFI	UL 94 V	FMVSS*

Discussion of higher fire safety

* FMVSS: federal motor vehicle safety standards

- E/E: Main fire safety standards have major influence on the grade selection
- Main standards are:
  - UL94V
  - IEC 60695 (GWFI, GWIT)
- With the upcoming trend of E-mobility, fire safety standards are under discussion (e.g. UL-2580 Battery system)

LANXESS portfolio has dedicated answers to increasing need for flame retardant polymers

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Challenge

Increasing demand for FR properties

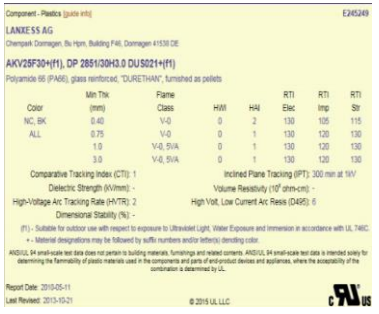
- Increasing fire safety requirements in electrical engineering, electronics and transportation sector
- Eco-toxicological properties gain importance
- Compatibility of flame retardant system and polymer matrix to maintain mechanical properties and processing

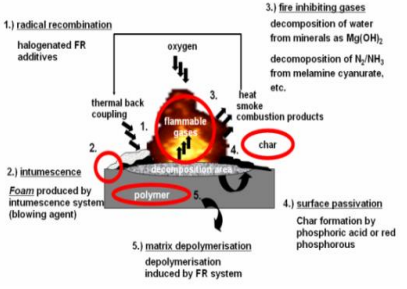
Solution

Wide FR product portfolio for nearly every need

- Powerful product portfolio using effective state-of-the-art FR systems (halogen-free and halogen containing) with **no** red phosphorous
- Tailored solutions for diversity of applications
- Listing at international bodies, like UL, VDE etc. on top of RoHS conformity

		Halogen	Non-halogen
Durethan®	Unfilled	✓	✓
	Filled	✓	✓
Pocan®	Unfilled	✓	✓
	Filled	✓	✓





Selection of serial applications with FR materials in the alternative powertrain

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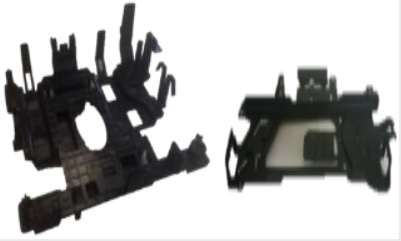
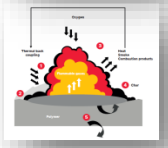
Connectors and cable brackets	▪ Durethan® BKV20FN01 (PA 6 GF20 FR) ▪ Non-halogen FR system (UL94 V-0 at 0.75 mm) ▪ High toughness and surface quality ▪ Chemical resistance according to LV124	
Housing Battery Management System	▪ Pocan® AF4130 (PBT+ASA GF30 FR) ▪ UL94 V-0 at 0.75 mm (halogen containing) ▪ Low warpage ▪ Good mechanical properties (Snap Fits)	
High-voltage connectors	▪ Durethan® BKV45FN04 (PA 6 GF45 FR) ▪ Non-halogen FR system (UL94 V-0 at 0.4 mm) ▪ High mechanical performance (15900 MPa) ▪ Improved long-term heat stability and flowability	

[Sources: VW, Hella, Kostal]

Material and technology development for e-mobility



- Lightweight applications
- Flame retardancy
- **Thermal conductivity**
- Electromagnetic shielding

Thermally conductive and electrically insulating polyamides

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Motivation

- Higher demand & increasing density in electronics: Increasing use of thermally conducting plastics ~0.8-1.5 W/mK sufficient
- Restricted performance of electrical devices by low heat release in case of temperature sensitive components, e.g. battery cells
- Substitution of metals by thermally conductive plastics enable freedom of design and higher productivity

Converter

HV Battery

Integrated Motor-Generator (Hybrid)

Charging device

[Source: BMW, Bosch]

Basic principles of thermally conductive plastics

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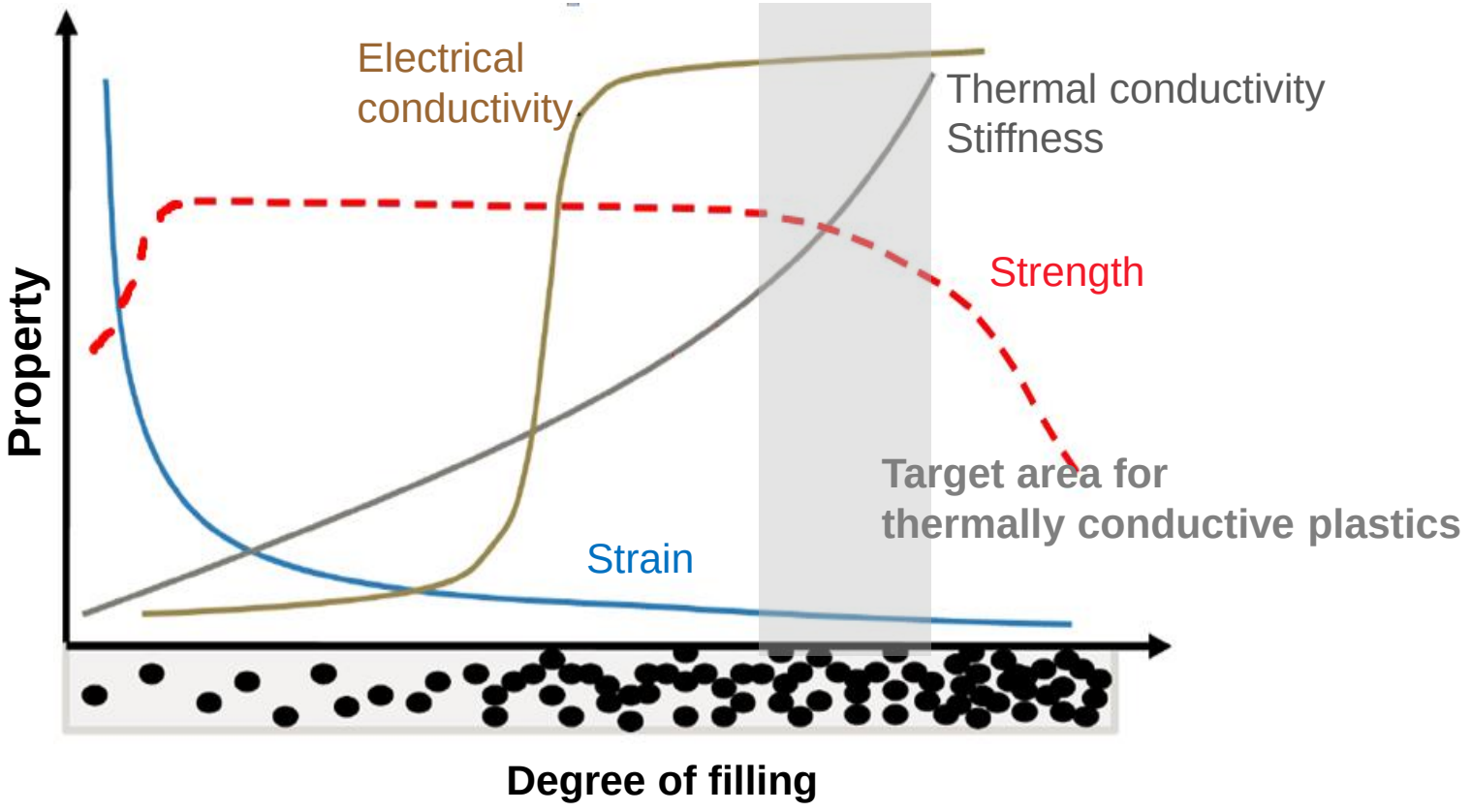
Property dependence of the filling degree



Thermally conductive Durethan grades

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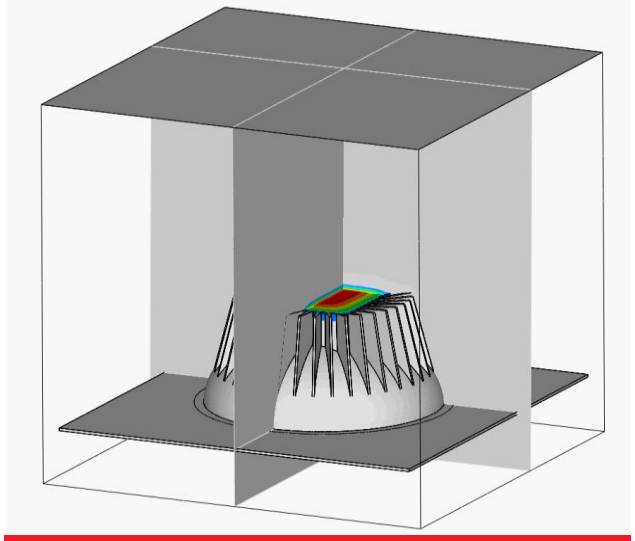
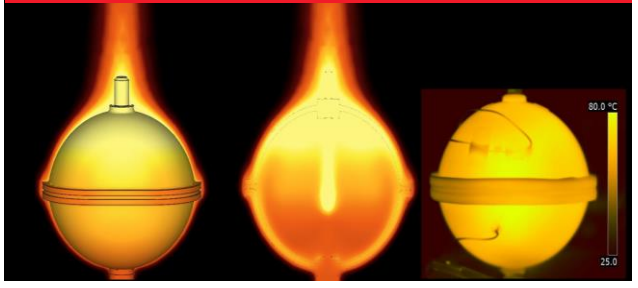
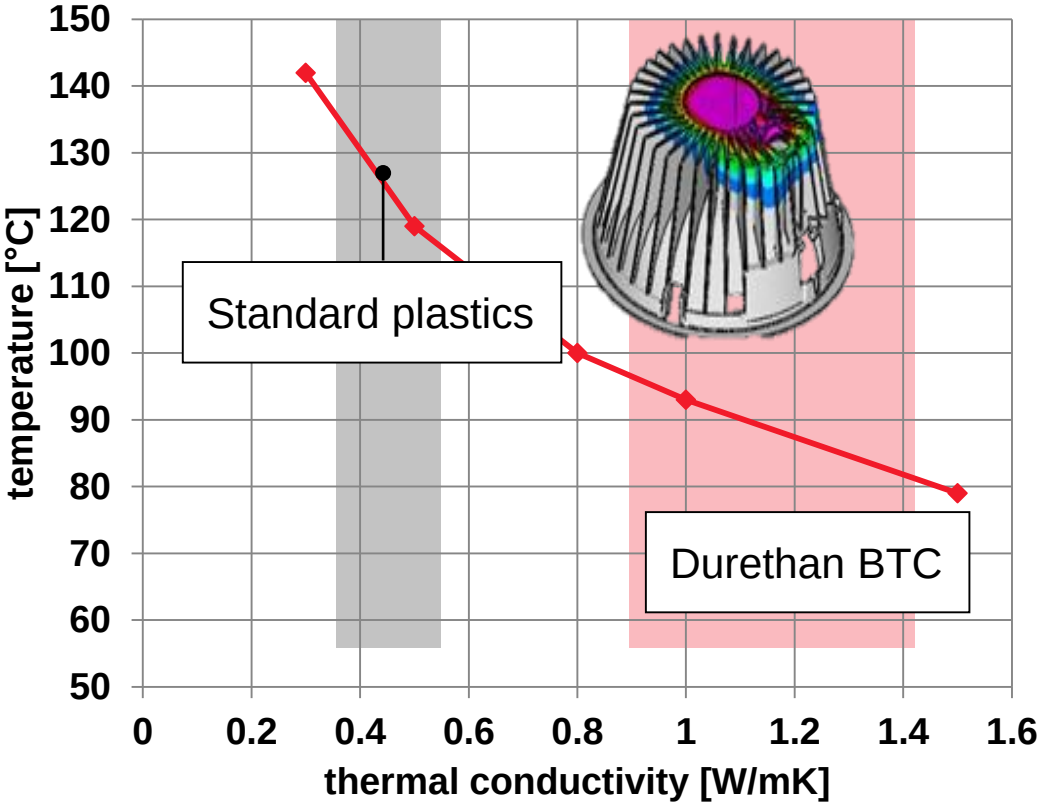
Transient CFD analysis



Simulation of heat transmission





Exemplary temperature reduction depending on thermal conductivity

Thermally conductive and electrically insulating polyamides – LANXESS product portfolio

LANXESS Energizing Chemistry

Product description

- BTC65H3.0EF (PA 6 MD65)
- BTC75H3.0EF (PA 6 MD75)
- Injection molding
- Thermal conductivity (through-plane) up to 1,0 and 1,4 W/mK, respectively

Product description

- TP723-620 (PA 6 MD68 FR)
- Thermal conductivity up to 2,5 W/mK (in-plane)
- UL94 V-0 at 0.75 mm
- Reflectivity > 90% (at 450 nm)
- Copper- and halide-free heat stabilization (to avoid contact corrosion

Thermal conductivity

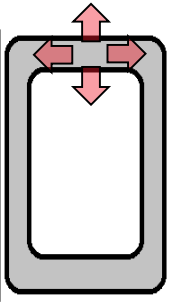
	BKV 30	BKV 60 EF	BTC65 H3.0 EF	BTC75 H3.0 EF	TP723-620
	PA 6 GF30	PA 6 GF60	PA 6 MD65	PA 6 MD75	PA 6 MD68 FR
Thermal conductivity					

Almost isotropic thermal conductivity

1,4 W/mK[2)]

1,7 W/mK[2)]

Housing cross section



- Fast heat dissipation in all directions

[2)] Durethan® BTC75H3.0EF, special machine and tool protection required

Selection of serial applications with FR materials in the alternative powertrain

LANXESS Energizing Chemistry

Air Blower Component

- Durethan® BTC75H3.0EF, PA 6 with 75 % special mineral filler
- Improved thermal conductivity enables temperature reduction at electronic device by 8 °C / prevents overheating
- Operating temperature: - 40 °C to 80 °C, peak temperature: 120 °C
- Improved flowability
- Halide free formulation prevents contact corrosion

[Source: Bosch]

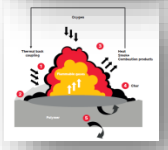
Passive cooling element in HV-connector

- Durethan® TP723-620, PA 6 with 68 % mineral filler
- Passive cooling element in direct contact with high voltage
- Electrically insulating
- Thermal conductivity >1 W/mK
- Thin walls
- Fire protection, classification V-0

[Source: Audi]

[Sources: VW, Hella, Kostal]

Material and technology development for e-mobility



- Lightweight applications
- Flame retardancy
- Thermal conductivity
- **Electromagnetic shielding**

Innovations in the field of alternative powertrain – Electromagnetic shielding (EMS)

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Electromagnetic shielding of plastics

Drivers and trends:

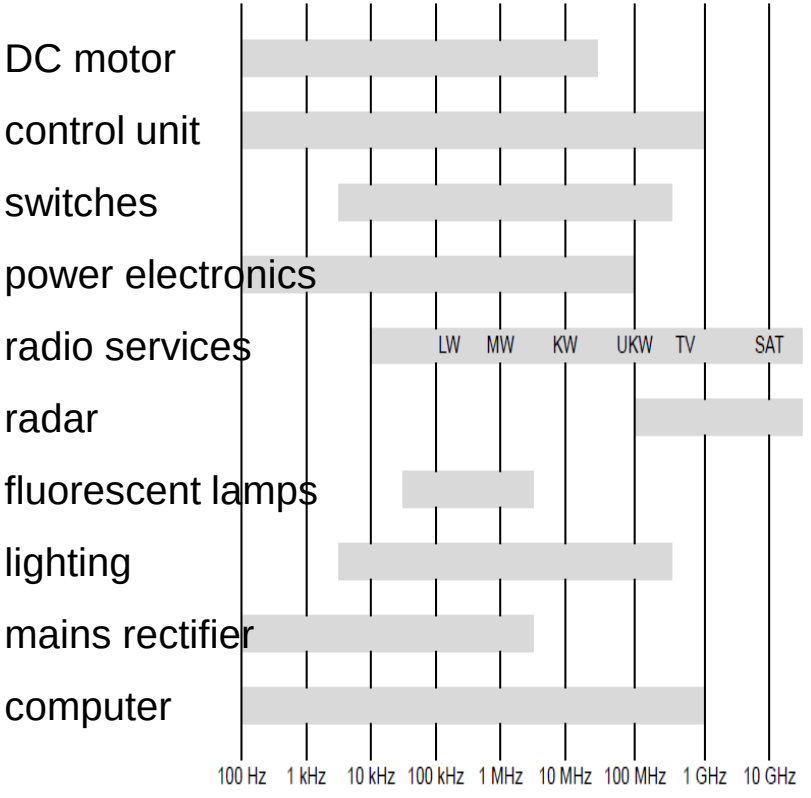
- Increasing miniaturization, use of digital assemblies
- Growing amount of sensitive electronic components

Requirements:

- Restrict electromagnetic interferences (EMI) to protect electronic devices
- Main applications for EMI
  - Battery system
  - Power electronics
  - E/E components

Duplication of EMI level every 3 years[1]

Frequency range of some EMI sources



EMI in the near- as well as far-field range

[1] Estimation of Schaffner EMV AG

Tepex® bridges the gap between high end composites and cost-effective production for high volume applications

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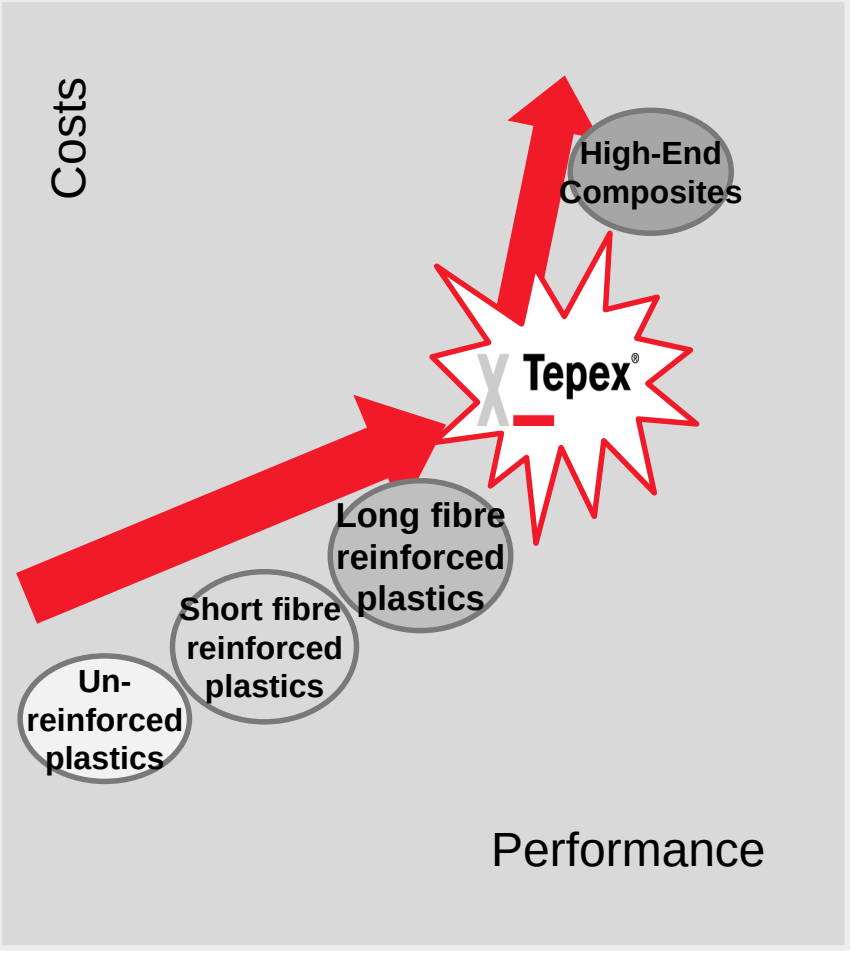
Advantages

- Tailored fibre orientation
- High stiffness and strength
- Reliable processing enabled by fully automated manufacturing process of Tepex® sheets and parts manufacturing
- Combination with injection moulding
- Short part production cycle times (< 60 sec.)
- Recycling
- Unlimited shelf-life

Tepex®

Cost effective thermoplastic composite solution for mass production

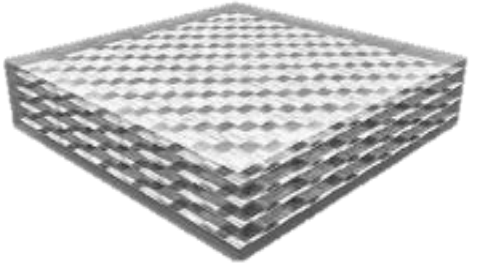
Price-Performance Ratio



What is so special about Tepex®?

Plain, semi-finished product (sheet)
based on a thermoplastic polymer (matrix)

Reinforcement is a fabric or
any kind of other continuous fiber
made of glass, carbon (or aramid)



Material is fully impregnated and consolidated, i.e.:
- **the fibers are completely coated with the polymer**
- **there is no remaining air inside the material**

This is the difficult and important bit!

Advantages

- Short cycle time (<60s)
- Highly reproducible process
- High functional integration possible
- Recycling easily possible
- No storage issue
- parts without post-processing after moulding

Innovations in the field of alternative powertrain
Electromagnetic shielding with plastic materials

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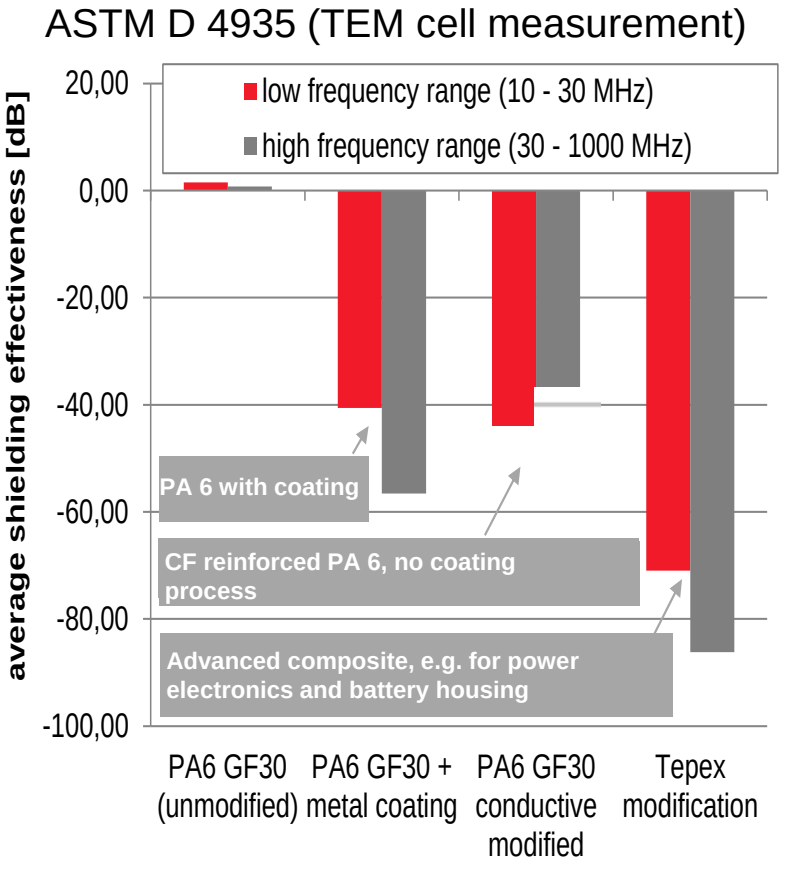
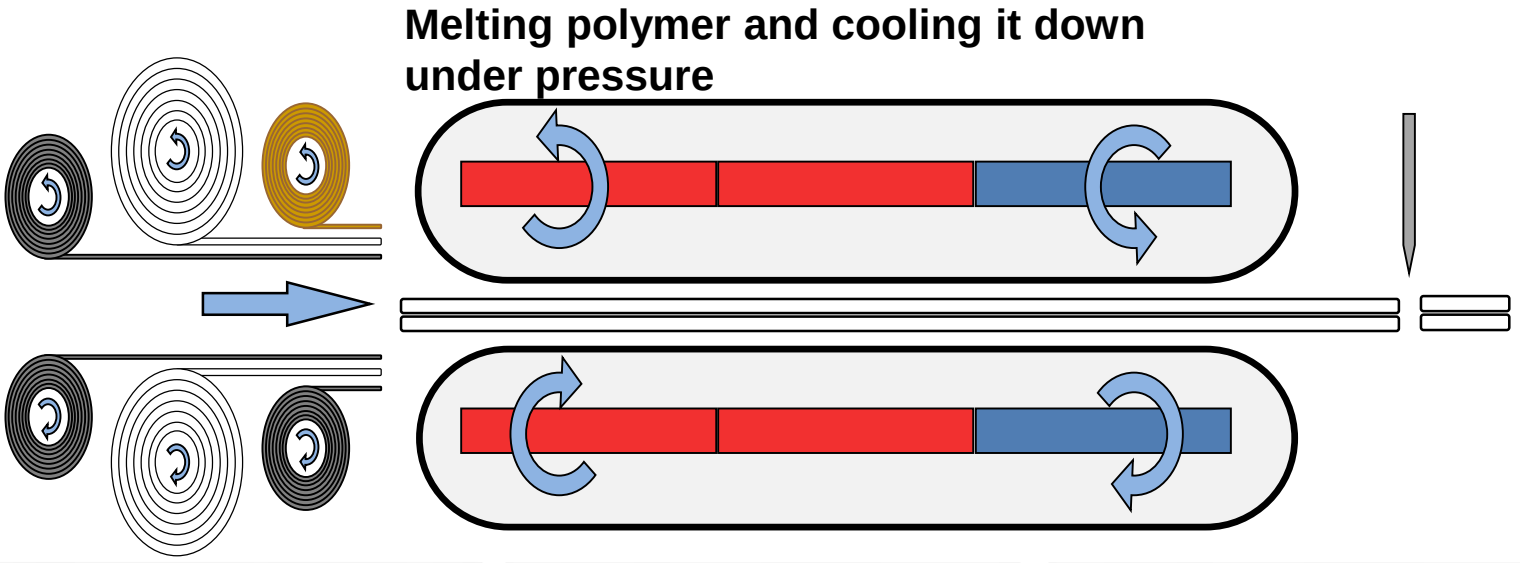
Potential solutions

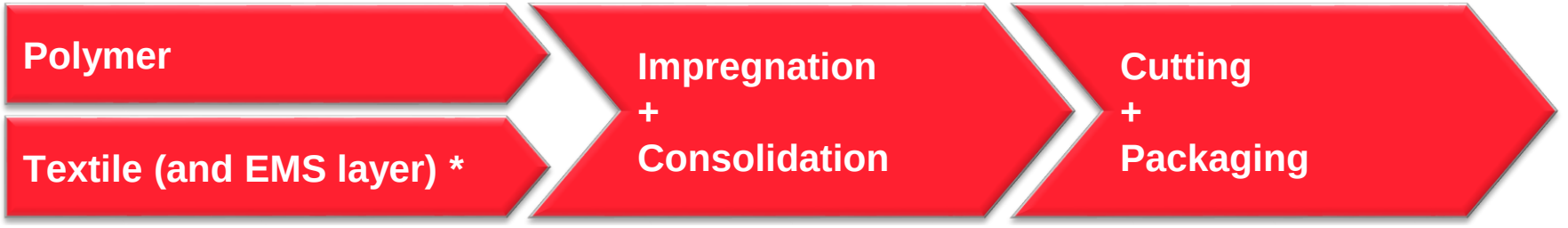
- **Compounds**
  (carbon fibers, metal coated CF, CNT, steel or metal fibers, aluminum flakes)
- **Coatings**
  (thermoplastic resin containing graphite or metals, galvanization, PVD, flame spraying)
- **Continuous fiber reinforced thermoplastics** with EMS layer
- **Advanced processing**:
  - In-Mold-Decoration (IMD)
  - In-Mold-Labelling (IMD)
  - Insert-Molding (IM)

Innovative LANXESS material



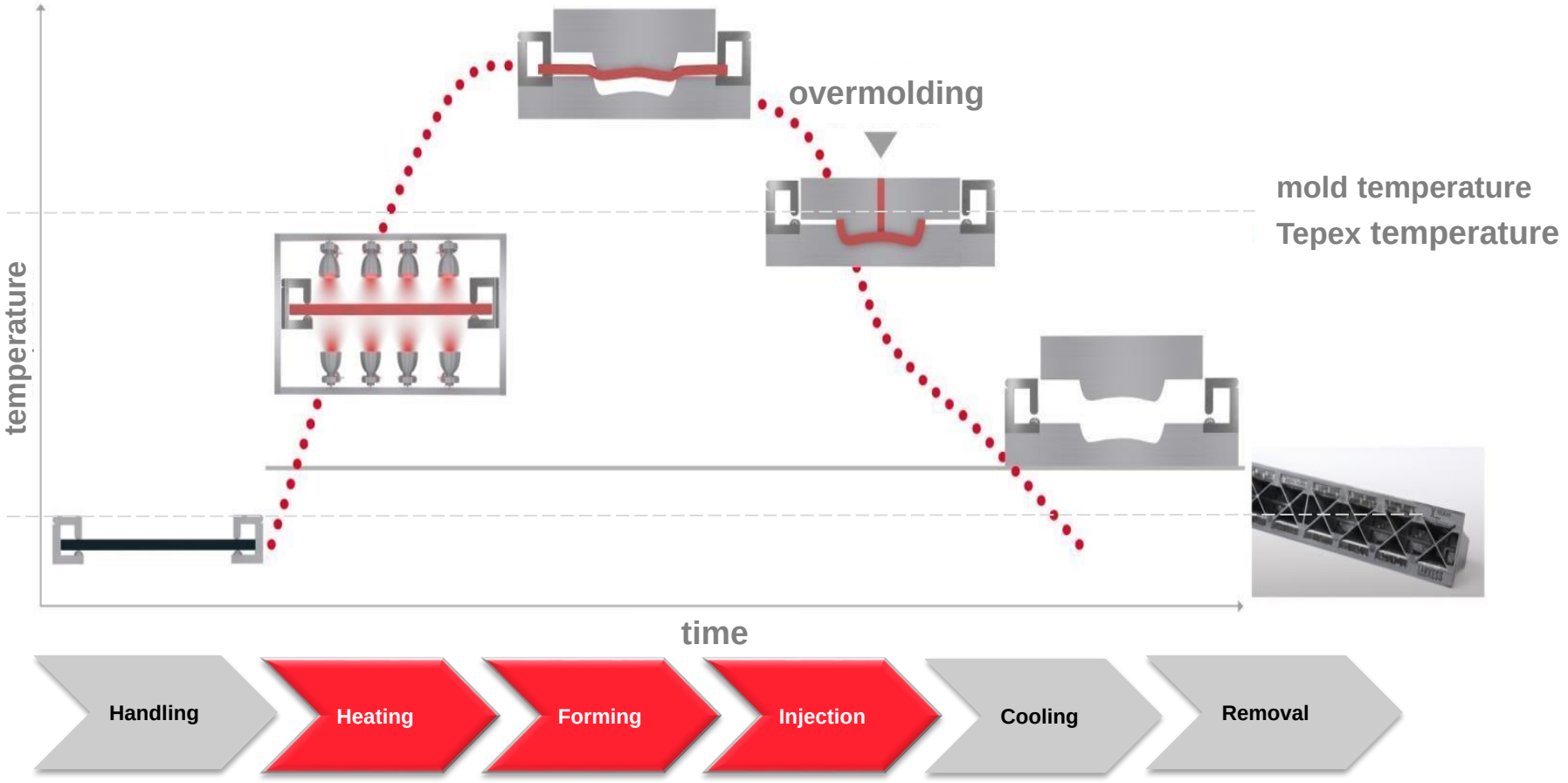
Technology development projects – TEPEX® with electromagnetic shielding properties





*EMS layer: Metal mesh (Cu, steel), metal film (Al, Cu, MuMetal), carbon fleece or shielding fleece

Integration of composite sheet into the injection molding process



Potential and short to mid term very promising applications for thermoplastic composites in Automotive

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Selection

Interior

Airbag housing

(Electronics) Carrier

Seat pan /structure

Door module

Pedal box

Car body / mounted parts

Trunk well

Frontend

Spare wheel well

Car body / mounted parts

Underbody protection

Many projects in development, Several mass productions targeted, ranging between 5000-300,000 pieces/a

LANXESS innovative solutions for alternative powertrains

- Electrified vehicles implicate novel applications with complex requirements
- Experience from thermoplastics in E/E and automotive industry applications can be transferred to automotive NEV products
- Solutions already available e.g. for FR, TC…
  Investigations done: E.g. resistance against electrolyte, EMS
- Already applications for e-powertrain in the market

Please contact us at:

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