BASF We create chemistry

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Sustainability Starts in Research

Dr. Melanie Maas-Brunner Member of the Board of Executive Directors and Chief Technology Officer of BASF SE



Cautionary note regarding forward-looking statements

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We live in a time of tremendous challenges...

66 We are leaving the comfort zone of our climate system ... and moving into completely uncharted territory. **77**

Dirk Notz, lead author of IPCC Report 2021



...and we live in a time of groundbreaking innovations



Battery materials





Renewable energies

Quantum computing



Innovation is the key enabler for the sustainability transformation



We operate the industry-leading innovation platform



Global expenditures of **~€2 billion** for research and development, world leader in chemical industry

Approximately **10,000** employees worldwide involved in research and development

Around **950** new patents filed in 2020

8 Academic Research Alliances and 245 university cooperations



New setup to benefit our customers and support the transformation towards sustainability



Act faster on rapidly evolving market trends

Cater to differentiated customer requirements

Bundle capabilities to drive innovation

Our purpose leads the way: We create chemistry for a sustainable future



Circular economy

Sustainable solutions









Methane pyrolysis – process innovation to reduce CO₂ emissions



- Test plant at the Ludwigshafen site in trial operation
- Funding granted by German Federal Ministry of Education and Research
- Key challenges are process technology and control
- Methane pyrolysis requires around 80% less electricity than water electrolysis



Gas fermentation for carbon-neutral and circular products





New biodegradable chemistry – significant acceleration of development through digitalization and automation

Understanding the relationship between structure and biodegradability



Development of new tailor-made biodegradable materials





Chemical industry as enabler for the reduction of CO₂ emissions in other sectors

Greenhouse gas emissions 2019 in Germany by sector¹ million metric tons



- Main greenhouse gas emitters are the energy (32%) and industry (23%) sectors
- Sectors such as transportation and agriculture are also significant emitters and important customer industries for BASF
- Products from the chemical industry can make a significant contribution to help decarbonize customer value chains



The transformation of the automotive industry towards electric mobility is in full swing – with significant opportunities for BASF

30% of new cars BEVs and PHEVs by 2030 Light-duty vehicle production volume, million units Chemical content per car 2.5x higher (by value)¹





BEV

BASF innovations enable electric mobility in various applications



Enabling safe handling of high-voltage components – a portfolio of durable orange-colored polyamides

Innovating plastics and colors used in high voltage components

- Orange¹ is the standard signal color for high-voltage connections in electric vehicles
- Color stability requirement: 1,000 hours at 140°C
- Challenge: Polyamides tend to severely discolor due to heat ageing
- Durable orange color achieved through novel formulation of polyamide and pigment

Comparison of orange color stability in standard and reformulated polyamide





Ensuring passenger safety – a new vehicle architecture requires new safety concepts

Safety requirements of electric vehicles

- Shorter frontends reduce crumple zone
- Need for crash protection of the battery
- Higher overall vehicle weight resulting in higher impact mass

Crumple zone



New material classes for next crash safety level



High-energyabsorbing plastic frontend

3D-formed crash absorbers from polyamide particle foam

High stiffness and energy absorbing pultruded polyurethane and thermoplastic profiles



Thermal management of the battery requires increased volume of liquid coolant

Schematic view of BEV cooling system



Thermal management in battery electric vehicles

- BEVs rely on a thermal management system for optimal operating conditions
- Heat dissipation from the battery pack is typically achieved through cooling plates or pipes
- Coolant volume in BEVs is twice as high compared to internal combustion engines
- Glycol/water-based coolants represent the predominant fluid technology

Coolant's electrical conductivity is a key determinant in minimizing risk associated with hydrogen generation

New BASF coolant achieves significantly lower electrical conductivity



Lower electrical conductivity markedly reduces hydrogen generation

Rate of hydrogen evolution



D-BASE

<u>We create chemistry</u>

New BASF e-coat technology meets OEMs' demand for one paint solution for all platforms and fulfills high sustainability standards

BEVs pose specific coatings challenges





1. Increased reactivity in dip-coating application



2. Fulfills all key sustainability industry standards

- Tin-free
- Free of hazardous air pollutants (HAPs)
- Low volatile organic compounds (VOCs)
- Material efficiency >95%



Meeting novel requirements: A broader baking window enables reduction of energy consumption

Standard technology allows curing only at temperatures of >155° Celsius



New CathoGuard[®] technology enables curing already at temperatures ≥140° Celsius

Metal temperature



Pipeline of selected solutions for electric mobility

	2021 >>>>	2022 >>>>	2023	2024+ >>>>
Plastics	New Elastollan [®] for busbars commercialized	Launch product portfolios for durable orange, new crash absorbers, thermally conductive adhesives	Novel materials for sound optimization of battery electric vehicles	Catalyze battery and vehicle development with high-performance material solutions
Coolants	Launched GLYSANTIN [®] Electrified [™] product family	Add further low electrical conductivity coolants to the portfolio	OEM approvals for low electrical conductivity coolants	
Coatings	Started first serial production with CathoGuard [®] solution 140°C	Launch CathoGuard [®] solution 140°C globally	Global production upscale and registration of 130°C solution	Global market launch 130°C solution



BASF's R&D team is committed to helping our customers become more sustainable.



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