BASF – We create chemistry

- Our chemistry is used in almost all industries
- We combine economic success, social responsibility and environmental protection
- Sales 2016: €57,550 million
- EBIT 2016: €6,275 million
- Employees (as of December 31, 2016): 113,830
- 6 Verbund sites and 352 other production sites
BASF’s five business segments
Thirteen operating divisions

Chemicals
- Petrochemicals
- Monomers
- Intermediates

Performance Products
- Dispersions & Pigments
- Care Chemicals
- Nutrition & Health
- Performance Chemicals

Functional Materials & Solutions
- Catalysts
- Construction Chemicals
- Coatings
- Performance Materials

Agricultural Solutions
- Crop Protection

Oil & Gas
- Petrochemicals
- Energy & Catalysis
- Construction Chemicals

We create chemistry
Research and Development at a glance

Champion in the chemical industry

- High R&D expenditures
- Strongest innovation power*
- €10 billion annual sales with products launched on the market since 2011 that stemmed from R&D activities
- Around 3,000 running research projects, 10,000 employees worldwide in R&D and 850 new patents filed in 2016

R&D is a major growth driver for BASF

* No.1 in the Patent Asset Index™
Three global Technology Platforms headquartered in key markets Europe, North America, Asia-Pacific

Close connection with the development units in the Operating Divisions

Global Know-How Verbund and global network with around 600 universities, research institutions and companies
Enhanced innovation approach with the aim of increasing our company’s power of innovation and securing long-term competitive ability

BASF Innovation Approach

- **Content Focus**: Focusing research topics
- **New Methods**: New scientific processes and methods
- **Optimized Structures**: Globalizing research and strengthening regional competencies
Global R&D presence in key markets

BASF R&D sites with proximity to customers and markets

- San Diego, United States
- Wyandotte, United States
- Research Triangle Park, United States
- Iselin, United States
- Lemförde, Germany
- Muenster, Germany
- Ludwigshafen, Germany
- Mumbai, India
- Amagasaki, Japan
- Shanghai, China
- Suwon, South Korea

Around 70 BASF R&D sites globally
Advanced Materials & Systems Research

- Construction & Coating Materials
- Performance Materials
- Dispersions & Colloidal Materials
- Structural Materials & Systems
- Polymer Processing & Engineering
- Care Materials
- Material Physics & Analytics
Bioscience Research

- White biotechnology
  - Methods to produce more efficient products while consuming fewer resources
  - Targeted change metabolism of microorganisms
  - New, sustainable processes for mass producing microorganisms
  - Chemical manufacturing from renewable resources

- BASF Enzymes
  - Patented and proprietary technology for the discovery of novel, unique enzymes
  - Comprehensive protein engineering tools
  - World-class facilities for enzyme scale-up

- Enhancing crop efficiency
  - Transfer of genes with desirable traits into crops for:
    - Better yield and stress tolerance
    - Improved herbicide tolerance
    - Better disease and pest resistance
Process Research / Chemical Engineering

- Process and application design innovation
  - Constantly developing and improving the synthesis of various basic chemicals, intermediates and fine chemicals as well as monomers, solvents and aroma chemicals
  - Process engineering: solids and fluids processing; high temperature engineering; safety engineering; fluid mechanics

- Catalysis research
  - Heterogeneous and homogeneous catalysis

- Electrochemistry and batteries

- High throughput experimentation

- New materials and systems
  - Metal organic frameworks (MOFs)
  - Nanomaterials
  - Mineral processing
BASF’s Key Technology Capabilities
- 7 focus areas

Selected Key Technology Capabilities reflect where BASF requires continued effort and resources to safeguard today’s and tomorrow’s excellence in innovation.

The Key Technology Capabilities are bundled in seven Focus Areas:

- Biotechnology
- Catalysis
- Polymer Technologies
- Materials
- Production Processes
- Biodegradable & Bio-based Materials
- Enabling Methods
**BASF New Business** is BASF’s organization to build up business “beyond core” by using Venture Capital and Start-up like structures.

New markets based on new technologies and adapted business models (Transformational Innovation).

### Scouting & Incubation
- Dedicated teams for foresight, scouting and incubation
- Identify market needs for BNB and BASF
- Evaluate fit with BNB or BASF and incubate minimum viable product (first check in the market)

### Business Build-Up
- Generating business
- Innovation Business Units (“internal start-ups”) with marketing, sales and technology responsibility
- Responsibility for
  - E-Power Management
  - Organic Electronics
  - 3D-Printing

### BASF Venture Capital
- Access emerging technologies from outside to support business build-up
- Build strategic business options via investments
- Identify acquisition targets for BNB and BASF
- Financial Return
- Spin-off of BASF technology
Drive Digitalization in R&D

By integrating digital technologies into BASF’s everyday R&D operations we will boost effectiveness of research, increase efficiency and open up new innovation opportunities.

Focus areas:
- Scientific modeling and simulation based on high-performance computing
- Integrated data and knowledge management including statistical applications
- Cognitive approaches to derive knowledge

Boosting innovative power
BASF’s success factors for innovation

Continuous commitment to R&D

- Establishing R&D in key markets
- Strengthen R&D Verbund with external partners
- Foster creativity, strengthen key technologies and increase efficiency by optimized structures
- Drive digitalization by modeling, simulation, knowledge management and cognitive approaches
- Co-creating to develop solutions for complex challenges
- Managing innovation to optimize speed

Around 3,000 projects in research pipeline
Working with External Partners

- Long history of successfully working with external partners
- Currently ~ 600 collaborations globally with universities, government labs and institutions but many are one-offs

Shift to a more structured approach

- Technology briefs as a route to understanding the core expertise of universities and federal labs
- BASF Venture Capital engages with startups
- More meaningful, sustainable relationships are preferred
- UNIQUE program with 15 universities, of which 6 in the US
  Based on scientific quality, relevance and fit
- 6 Postdoc centers, of which 2 in US
BASF collaborations

CALIFORNIA RESEARCH ALLIANCE by BASF

University of California, Berkeley
Materials science, bioscience & advanced materials characterization

Stanford University
Materials science, computational chemistry, applied physics

University of California, Los Angeles
Materials science

Texas A&M University
Chemistry, agricultural science & chemical engineering

Harvard University, Cambridge
Nanotechnology & soft matter science

Massachusetts Institute of Technology, Cambridge
Materials science & engineering

University of Massachusetts, Amherst
Polymer chemistry & food science

Stanford University
Materials science, computational chemistry, applied physics

University of California, Los Angeles
Materials science

Texas A&M University
Chemistry, agricultural science & chemical engineering

Harvard University, Cambridge
Nanotechnology & soft matter science

Massachusetts Institute of Technology, Cambridge
Materials science & engineering

University of Massachusetts, Amherst
Polymer chemistry & food science
Chemicals – a growth industry
Global annual growth rate of ~3.6%*

Agriculture  Health & nutrition  Energy & resources  Construction & housing  Consumer goods  Transportation  Electrical & electronics

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Chemistry as enabler to meet current and future needs

- ~10bn people by 2050
- 70% of the world population will live in cities by 2050
- 50% more primary energy consumption by 2050
- 30% more food needed by 2050

* Average annual real change 2017-2019; BASF Report 2016 p.121
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BASF Needs: Additives

- Fast-fusing sustainable plasticizers for flexible PVC applications
- Halogen free flame retardants for polyolefins / thermoplastics
- Antioxidants with chemical resistance to chlorine oxidizing in plastics
- New antioxidant chemistry and/or technologies beyond traditional phenols, phosphites, amines, sulfides
- Self forming barrier layers with physical resistance to chlorine oxidizing agents in plastics
- New light stabilizer technologies beyond existing hindered amines; e.g. tetramethylpiperidines; piperizinones
- New light stabilizer technologies beyond existing UV absorbers; e.g., hydroxylphenylbenzophenones, hydroxylphenylbenzotriazoles, hydroxylphenyltriazines; nano ZnO; nano TiO2
- Flame retardant polymers or halogen free polymer additives especially those that do not act as plasticizers
- Adhesive technologies (PUs and acrylics for adhesives, must be flame retardant)
- Additives for composite materials: - Toughening (films, powders, fibers)- UV resistance- Flame retardance; incorporated clear and soluble (not particulates)
- Flame retardant polyethersulfone (PESU) and polyphenylsulfone (PPSU) (in addition to intrinsic properties)
BASF Needs: Adhesives

- An adhesive that adheres well to low energy substrates for TPO roof coating
- Improvement of adhesion on critical and challenging surfaces (polyolefines, metallized foils, unclean surfaces, wood…)
- Adhesives with barrier properties (i.e. O₂)
- High refractive index, UV stable TPU with optical clarity
BASF Needs: Agro (Crop Protection)

- Technologies for better weed control
- Technologies to simplify weed control (formulations, automation, detections, robotics, etc.)
- Approaches to overcome weed resistance
- Tools for farming based on Sensors for drought, heat, nutrition, data analytics
- Technologies for small farms (urban farming, developing countries, vertical farming, etc.)
- Technologies to overcome insecticide/pesticide resistance
- All technologies for insect control beyond classical chemistries and biologicals
- Modeling at gene, organ, plant, crop and field levels
- Molecular sensors for drought, heat, plant nutrition status
- Chemistries to improve water usage in agriculture (excluding irrigation systems)
- Coating to prevent crop protection formulations from drying/flaking in bulk containers, possibly super hydrophobic coating (issue with precipitates forming as water evaporates)
- Novel approaches for insect, nematode, and pest control in agriculture
BASF Needs: Coatings

- Novel initiators (UV-LED triggered initiators for packaging for improved stickiness of the surface (oxygen inhibition)
- Low density, film forming polymer concrete admixtures
- UV stable pigments, polymers, films, etc. for outdoor applications (i.e. exterior facades of buildings)
- Cost effective water-based resins with preferably low temperature application for: basecoats, adhesives, finishes and coatings
- Methyl methacrylate alternatives for low-odor clear coating applications
- Thermal barrier coatings
- Flexible, tough clear coating materials
- Antireflective optical coatings
- Optical filters made out of coatings
- Reflective coatings i.e. mirror effects
- Conductive transparent coatings
- Chromic (color changing) materials via mechanical, thermal or electric stimuli
BASF Needs: Dyes, Pigments, and Colorants

- Smart Materials for high tech greenhouse agriculture: light sources and growing strategies (recipes) for plant growth in greenhouses and plant factories -- technologies for light and heat management in greenhouses and energy management technologies in greenhouses -- color conversion, IR reflection
- Controlled retention properties of coatings (i.e. color, biocides, etc.)
- Improved platelet orientation
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