

BASF information 2016

October, 2016



Cover story

Performance materials changing the world

Features

Colorful cars start from green

 **BASF**

We create chemistry

Eva von Traitteur (left), Head of BASF Design Center Asia Pacific in Shanghai, and Jimmy Jin from Performance Materials Asia Pacific, BASF were discussing about the lightweight, solar-powered "e-floater", 80% of which is made of BASF composite materials and plastics.

Contents

01 Foreword

02 Figures

04 News

Cover story

- 08 Performance materials: a magician changing the world
- 12 When classic inventions meet modern materials
- 14 Polyamide-6 powder opens a new era in 3D printing
- 16 Design drives innovation
- 19 Lightweight transport

Feature

- 20 Colorful cars start from green
- 23 Precision agriculture in the digital era
- 26 Sustainable materials for innovative buildings

Column

- 28 NAO: accelerating open innovation through successful science collaboration
- 30 Roots Operators: fostering the best apprentice
- 32 Promoting Responsible Care in China
- 34 Dark horses in the laboratory

Science around us

- 36 Flat screens show their true colors

Interaction

- 38 Explore the wonders of chemistry without leaving home



08 Appropriate materials make products cost-effective, energy-saving, safe, user-friendly and nice looking.



26 Building materials play a vital role in increasing energy efficiency and promoting urban sustainable development.



36 A good pigment has a significant impact on the brilliance of the colors the viewer sees on LCDs.

Foreword

I am very glad to welcome you to BASF Information.

Advanced materials have taken on a greater significance since their introduction and have fully demonstrated people's imagination and creativity. This issue's cover story reveals how performance materials are changing the world, and guides you to explore their innovative applications in urban life, experiencing how they promote product design, reform industrial processes and bring all possibilities for modern life and work.

Relevant sustainable contribution is BASF's optimization of the coating process, responsible for various colors on cars, which is one of the most energy- and resource-intensive processes in industrial automotive manufacturing. **Colorful cars start from green** will introduce how BASF, through the R&D of eco-friendly automotive coatings and the optimization of the coating processes, helps automotive manufacturers reduce production costs. This is achieved through the improved energy consumption of paint shops, production efficiency and tackling the severe challenges of balancing economic effectiveness and ecological efficiency.

Improving the energy efficiency of constructions is also critical to the environment and climate. The second phase of the BASF Innovation Campus Asia Pacific (Shanghai), inaugurated last year, is energy-saving and eco-friendly, creating an ecologically pleasant, safe and comfortable working environment. **Sustainable materials for innovative buildings** introduces the secrets behind this sustainable building – the cutting-edge construction materials and solutions by BASF.

This is just a glimpse of BASF's practices in materials and innovation. Over the past 150 years, BASF has collaborated closely with stakeholders to help them cope with challenges through chemical innovation. In future, we will continue to write a new chapter in innovation and cooperation with you, partners and customers.

Sincerely,

Dr. Stephan Kothrade

President Functions Asia Pacific, BASF
President and Chairman Greater China, BASF



World in figures

0.1 millimeter

The entire paint system of a car, at 0.1 millimeter, consists of four layers, which can only be completed after a four-step process, which has very high requirements on the space of the paint shop and energy consumption. See **Colorful cars start from green** on page 20



Resources, environment and climate

360°

At the Tiexi plant of BMW Brilliance, where the Integrated Process developed by BASF is adopted, the original four-step coating process is streamlined to three steps. The paint shop maximizes the utilization of e-coat by turning 360°, helping to save more space and is energy-saving and eco-friendly.



9.6 billion

Today, more than 7 billion people are living on this planet. By 2050, the total number is estimated to reach 9.6 billion. See **Precision agriculture in the digital era** on page 23



Food and nutrition

27 times

Farmers who choose to use BASF's management solution for their grapes have a high return on invested capital, earning 27 times the outlay.



\$ 135 billion

It is estimated that the value of global flat screen market will be 135 billion US dollars for 2020. See **Flat screens show their true colors** on page 36



Quality of life

16.7 million

16.7 million colors are required for high-quality image with true color depth.



38%

A market report shows that selective laser sintering (SLS) is the top 3D printing technology (38%) in 2016. See **Polyamide-6 powder opens a new era in 3D printing** on page 14



Innovation

1 week

Enabled by the new polyamide-6 powder developed by BASF and SLS co-developed with its partner companies, Pan Asia Technical Automotive Center (PATAC) makes it possible to complete the process from 3D printing to testing and adjustment within one week, significantly shortening the development cycle of the key components.



Resources, environment and climate

5 times

Ucrete® flooring system lasts for at least 20 years, over 5 times that of the traditional solution. The maintenance cost and the total cost, therefore, is significantly lowered.



Resources, environment and climate

1/3

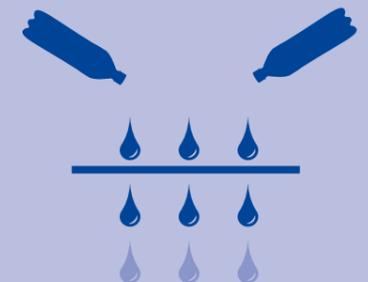
Thanks to the Integrated Process, energy and water consumption, volatile organic compounds (VOC) emission and wastewater discharge at the Tiexi plant of BMW Brilliance were one-third of the average of 10 years ago.



Quality of life

1.1 liters

Elastopave®, a polyurethane binder system yielding air- and water-permeable surfaces, absorbs an estimated 1.1 liters of water (equal to almost 2 bottled water) per second per square meter given suitably absorbent ground, thus to prevent water build-up.

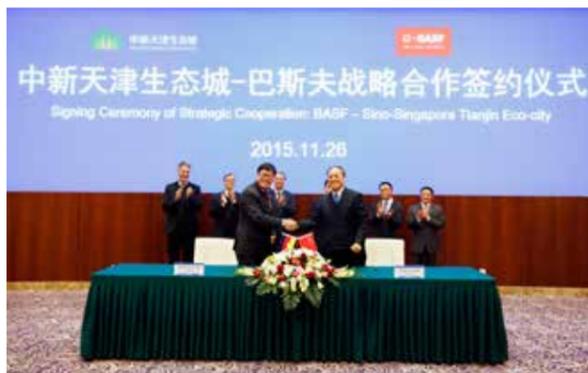




BASF invests in Xinjiang with a local private enterprise

In 2016, BASF and Xinjiang Markor Chemical Industry Co., Ltd. inaugurated a new butanediol (BDO) plant (with an annual capacity of 100,000 tons) and a new PolyTHF® (polytetrahydrofuran) plant (with an annual capacity of 50,000 tons) in Korla, Xinjiang, to deliver commercial products to local customers. The two projects mark BASF's first investment in the western autonomous region with a local private enterprise.

In 2015, BASF signed a strategic partnership agreement with Markor International Home Furnishings Co., Ltd. to drive innovation and the incubation of new technologies and materials, as well as exploring their end applications especially for the home furnishings industry. Under the agreement, BASF and Markor will build an innovation platform to explore more forward-looking business areas, such as nanomaterials, 3D printing materials as well as carbon fiber and smart materials.



BASF and Sino-Singapore Tianjin Eco-city explore sustainable urbanization solutions

In 2015, BASF and Sino-Singapore Tianjin Eco-city signed agreements to jointly develop the world's tallest certified passive house, facilitate sustainable construction, improve air quality and drive water recycling in Tianjin. The agreements are to make the city a better and more sustainable place to live, setting an example of sustainable urbanization in China.

The partners are collaborating to promote the potential and the economic viability of the Passive House concept in China. In addition, they will explore cooperation in solutions in water reservation and recycling as well as clean air, helping to make Tianjin a "sponge city" by realizing the full potential of rain water to reduce the risk of urban flooding, and lessening the urban heat island effect. In the area of water treatment, BASF's ultrafiltration technology with nanoscale membranes yields consistently high-quality drinking water.



BASF starts MDI production in Chongqing

In August 2015, BASF started production of diphenylmethane diisocyanate (MDI) at its wholly-owned site in Chongqing, China. The production will be increased gradually in line with market demand. MDI production will support key industries in the country's western areas.

This MDI site covers an area of more than 50 hectares and includes facilities for 400,000 metric tons per year of Mononitrobenzene, 300,000 metric tons per year of aniline, 400,000 metric tons per year of crude MDI, and a MDI splitter with a capacity of 400,000 metric tons per year. The total investment of the MDI project is RMB 8 billion (approx. €860 million).

MDI is an important component for polyurethanes – an extremely versatile plastics material that contributes towards improved insulation for appliances and reefer containers, provides lighter and more modern materials for cars, and helps save energy in buildings.



BASF breaks ground on new automotive coatings plant in Shanghai

BASF Shanghai Coatings Co., Ltd. broke ground on a new, world-scale automotive coatings plant at the company's Shanghai Chemical Industry Park in Caojing in June, 2016. The new plant represents an investment of about €140 million and is expected to be operational in the fourth quarter of 2017.

As the latest investment of the joint venture between BASF and Shanghai Huayi Fine Chemical Co., Ltd, the plant is an expansion of the automotive coatings plant, which began production in 2014. The expanded production capacity will support the growing demand for automotive coatings in China.

In addition to this new plant, BASF operates a production facility for resins and electrocoat at the same location. The close proximity of the plants allows for more synergies and efficiency. All BASF plants are designed in a high energy efficient and sustainable manner, offering the potential for future expansion and the flexibility to adapt to new production requirements in the years ahead.



BASF inaugurates China's first world-scale isononanol (INA) plant in Maoming

In October 2015, a world-scale isononanol (INA) plant was inaugurated in the Maoming Hi-tech Industrial Development Zone in Maoming. This is the first INA plant in China and will be run by BASF MPCC Company Limited (BMC) as a 50-50 joint venture between BASF and China Petroleum & Chemical Corporation (SINOPEC), marking yet another milestone in BASF and SINOPEC's long-term partnership. With an annual capacity of 180,000 metric tons of INA, the plant will serve the growing demand for next-generation plasticizers.

INA is used for the production of diisononyl phthalate (DINP), a high molecular weight phthalate plasticizer. High molecular weight phthalate plasticizers such as DINP are used to gradually substitute low molecular weight phthalate plasticizers. DINP is widely used as a plasticizer in industrial applications such as automotive, wires and cables, flooring, building and construction.



World's first all-black racing yacht debuts with Paliogen® and Sicopal® functional pigments by BASF

The new racing yacht of fashion house Hugo Boss, the first entirely black IMOCA 60 racing yacht in the world, was launched in September 2015. This was made possible by painting the deck with a coating developed by BASF, which is based on the functional pigments with heat-reflecting properties made by the company. Surfaces painted in dark colors can remain significantly cooler on hot days as they reflect most of the sunlight rather than absorb heat.

BASF is now the official partner of the offshore yacht racing team Alex Thomson Racing, who sails this all-black Hugo Boss racing yacht. BASF and Alex Thomson Racing will work together on the marketing of the pigments and the development of new design concepts.



Many BASF products featured in construction of world's longest rail tunnel

After nearly 20 years of construction, the Gotthard Base Tunnel in Switzerland was officially opened in June 2016. Construction chemical products from BASF helped make the construction of the world's longest rail tunnel possible.

The 57-kilometer Gotthard Base Tunnel was built with about four million metric tons of concrete – roughly 40 times as much as was used in Dubai's Burj Khalifa tower, the world's highest building. BASF supplied concrete admixtures, cement injections to stop water ingress, and fire-protection mortar for the tunnel construction project, helping customers to master the extreme challenges and ensuring the greater safety of the project.

Basotect® reduces noise in modern, high speed elevators

Basotect® melamine foam, which is widely known as a lightweight acoustic insulation material in automotive and interior construction applications, is expanding its application range into the acoustic treatment of elevators.

In a recent project with ThyssenKrupp Elevator and National Elevator Cab and Door, Basotect® was used to reduce the noise levels in the elevator cabins of a high-rise building in New York City. Despite the high speed of the elevators (up to 37 km an hour), the noise level inside the cabin was lower than 50dB, quieter than a conversation between two people.

With its fine and open cell structure, Basotect® not only gives high sound absorption capacity, but also meets other design criteria such as lightweight, fire resistance and thermally insulating.



BASF technology used in first Chinese light duty diesel commercial vehicle to meet Euro 6 standard

The 2018 model SAIC Maxus V80 commercial vehicle aimed at the export market is using BASF's innovative light duty diesel (LDD) emission catalysts. It is the first LDD commercial vehicle developed in China that meets Euro 6 emissions standards. BASF supports SAIC Maxus with local technology development in China, creating new market opportunities in Europe.

BASF is providing SAIC Maxus with an advanced EMPRO™ emissions catalyst system, including: Diesel Oxidation Catalyst (DOC), Catalyzed Soot Filter (CSF), Copper Chabazite Selective Catalytic Reduction (SCR) Catalyst and Ammonia Oxidation (AMX) Catalyst.

BASF works closely with automotive manufacturers to develop leading-edge technologies that can meet their needs for high performance and cost effectiveness, helping OEMs comply with ever-tightening environmental regulations around the world.

Elastopave® supports Hangzhou in becoming a “sponge city”

Elastopave®, a polyurethane binder system yielding air- and water-permeable surfaces, has been installed on Moganshan Road along Hangzhou's famous West Lake. The project is a role model for the city to support its hosting of the G20 meetings in implementing the 2030 agenda for sustainable development and to prepare for the 2022 Asian Games.

As one of the municipal key projects for the city in 2016, the application helps Hangzhou transform itself into a “sponge city” and fulfill its goal to develop modern infrastructure in at least 20 percent of its urban areas by 2020 to prevent flooding from heavy rainfall.



BASF advances science and awareness of Omega-3 in China

BASF held a seminar entitled “Omega-3s for Every Life Stage” in Shanghai, bringing more extensive knowledge on the health benefits of Omega-3 to the Chinese food, beverage and supplement market. Renowned experts revealed insights and findings, highlighting Omega-3 formulations for targeted health solutions including cardiovascular health, cognitive function and the first 1,000 days of life that enable customers to deliver the right nutrition to the right people at the right time.

BASF has received approval from China's National Health and Family Planning Commission to use its high concentrate Omega-3 in supplements and functional foods. This brings new opportunities for tailored health solutions and enhanced compliance through smaller capsule size.

Performance materials: a magician changing the world

How does plastics arouse the passion in people?
How can plastics change people's lives and begin an imaginative era?



The photo was taken in Shanghai, China.

In 1912, BASF set up the first materials testing laboratory in the chemical industry. It was the precursor for materials engineering today, to solve the growing materials-related problems and the associated safety issues.

Since the 1950s, BASF has been in an era of product innovation with plastics. Plastics, a collective term of a wide range of polymers, can be modified to demonstrate excellent physical and chemical properties over conventional materials. These include superior strength, hardness and heat, abrasion and corrosion resistance.

Such plastics are called "performance materials". They have found extensive applications in the transportation, construction, industrial production and application, and consumer goods sectors. They have become indispensable for industrial production and everyday life and are quietly but magically changing the world.

Styropor®, a foamed polystyrene, was only used for wire insulation and lifebuoys when it was first produced by BASF in 1951. Its breakthrough as an insulation material only came towards the end of the 1950s when, due to its excellent insulating properties, Styropor® was increasingly used in the construction industry and for refrigeration. Today, it is the classic among insulation materials.

The importance of plastics in the transportation industry was discovered through experimentation. In 1964, the auto maker Porsche applied BASF plastic "Palatal" to the exterior of its new model *904 Carrera GT* and successfully reduced the weight by 150 kilograms, hence lowering fuel consumption and emissions. The car became the first lightweight vehicle and caused a sensation worldwide. Today, lightweight has become a major trend in the automotive industry and is of great significance in energy reduction and environmental protection.

Tay Jui Seng, Vice President, Business Management Transportation, Performance Materials Asia Pacific, BASF, explained that today's innovations not only applies to the development of new materials but also on the smart use of existing materials in innovative applications.

"How do we meet customer requirements through the use of existing materials, development of new products and application development know-how is something we always take into consideration," said Tay. "With a broad product portfolio and profound industry expertise, BASF is committed to integrating chemistry, process and market needs to create innovative solutions and address various challenges of urban life."

Cool materials create magic in sport

In March 2016, the adidas NMD sneakers started a worldwide craze. The shoe's biggest highlight is the midsole that uses BASF's revolutionary material Infinergy®, the world's first expanded thermoplastic polyurethane (E-TPU).

Infinergy® is made of expanded thermoplastic polyurethane (E-TPU), which is manufactured by foaming the starting material, TPU granules. After pretreatment with pressure and heat, the individual granules, measuring up to five millimeters each, are blown up like popcorn and their volume increases tenfold to produce oval foam beads with tiny, closed gas bubbles inside.

Therefore, sneakers using Infinergy® are not only lightweight, but can effectively absorb the impact on feet when jogging. In addition, the high-rebound effect of Infinergy® can provide much energy to bring a unique and comfortable experience to runners.

As more and more people have learned about Infinergy®'s uniqueness, its range of applications continues to grow. For instance, Infinergy® has been used in the central part of the rebound racket most recently launched by renowned sports racket manufacturer Dunlop. Its unique foamed microsphere structure makes it an unprecedentedly lightweight high-elastic material and significantly improves the racket's performance and durability, enabling players to make each swing confidently.

Recently, how to provide eco-friendly, safe and durable-sports venues for children has increasingly become a public concern. BASF has not only created modern fashion sporting goods, but also protects children from harm when playing.

BASF's newly developed sports flooring solutions include eco-friendly plus weather resistant polyurethane systems Elastan®, and Elastocoat® combined with E-TPU foam particles, whose formulations and applications don't need any other organic solvent or heavy metal. Eco-friendly materials can pave the way for the health of children instead of causing any harm to them (construction workers included). The use of Infinergy® in a running track can effectively reduce the impact of falling due to its excellent rebound performance to guarantee the safety of children.

In June 2016, the "Limits of the Harmful Substances in the Plastic Surface of School Sports Venues" was officially approved as a group standard for plastic running tracks in Shanghai. By using construction-convenient, safe and harmless BASF sports flooring materials, Dingding Kindergarten

in Shanghai's Minhang district has become one of the first educational institutions in the city to offer safe plastic flooring since the introduction of the industry standard.

Lightweight for safe and eco-friendly

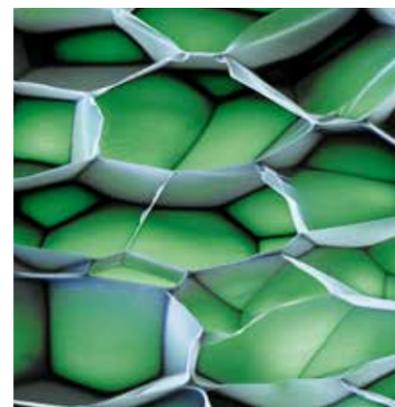
In the 1970s, BASF and Porsche co-developed plastic (polyamide-based) intake manifolds, which broke through the bottleneck of industrial development. The intake manifold, located between the vehicle's throttle valve and the engine's intake valve, distributes the air and fuel mixture to each cylinder inlet.

The reason for the use of plastic intake manifolds is that metal manifolds have a complex forming process. It is difficult to process large hollow parts of such a complex shape using general technology; semi-finished metal products have a low yield and high machining costs. However, plastic intake manifolds may be integrally molded, have a high yield and reduce the overall cost by 20-35% on the premise that the process is workable. In addition, plastic manifolds are 40-60% lighter than metal manifolds and can dramatically reduce vehicle weight, fuel consumption and emissions. When mass-produced, plastics can better demonstrate process, cost and environmental advantages.

"BASF innovatively replaced steel intake manifolds with plastic ones," said Tay. "Its commercial value has been fully recognized, which shed light on lightweight development in the automotive industry."

In recent years, as a raw materials supplier, BASF has closely cooperated with customers and actively participated in their product and process design by fully leveraging the advantages of plastics and constantly developing innovative applications of lightweight components for the transportation sector.

The BMW 5 Series Gran Turismo 550i sedan is the first to use BASF Ultramid® polyamide plastic to manufacture the gearbox beam



The insulating material Styropor® C (XPS) protects buildings from high and low temperatures.

bracket instead of traditional aluminum, reducing the part's weight by 50%. The gearbox beam bracket, as a structure directly connecting the engine and gearbox, needs to bear a greater load. Gearbox beam brackets of good quality can help improve a vehicle's robustness and provide support for the power and torque output of the engine gearbox unit.

In addition to reducing weight, the plastic gearbox beam bracket significantly lowers driving noise, improves crash safety, and enhances safe driving performance. Not long after the BMW 5 Series Gran Turismo 550i was put into production, the gearbox beam bracket manufactured with BASF's ultra-high strength polyamide was awarded the Gold Innovation Award by AVK.

In the aviation field, the combination of the innovative Ultrason® carbon fiber panels and the Ultrason® honeycomb panels produces a synergistic effect and can replace traditional metal materials. They not only make aircraft's structural components lighter, but also guarantee reliable structural strength and bring natural flame retardant properties while meeting strict technical specifications.

Getting lighter but safer, more durable and eco-friendly is exactly the contribution that materials technology development has made to the modern society.

Live Cool

BASF WALLTITE®, a kind of spray-applied polyurethane foam, is an insulating air barrier system. While WALLTITE® and Infinergy®, which is used for the midsole of adidas sneakers, are made of polyurethane, they differ in hardness because of different formulations.

The polyurethane foam used by WALLTITE® greatly reduces the thickness of the insulation layer as its thermal conductivity is much lower than that of other insulation materials. WALLTITE® also creates a comfortable living environment and reduced harm to nature for its higher flame retardancy (carbonization, melting-free), strong air tightness, construction convenience and a long service life.

In addition to the "coats" of buildings, BASF has made great efforts in its "cuffs" and "collars". The Ultradur® co-extrusion reinforced materials produced using the polyurethane pultrusion technology can be used to make door and window sub-frames for energy-efficient buildings. Windows with Ultradur are 60% lighter in weight than metal ones, improving energy efficiency by 15-20%, and reducing indoor heating costs.

Meanwhile, BASF has innovatively applied Elastocoat® polyurethane composites to the auxiliary frames of windows and doors. The Elastocoat® continuous fiber reinforced

composites provide a perfect auxiliary frame system for energy-efficient windows and doors for its outstanding low thermal conductivity while enhancing their mechanical properties, guaranteeing long service life for its excellent corrosion and aging resistance.

These days how to create a "sponge city", with strong water absorption capacity, has become a major challenge for urban life.

BASF Elastopave®, a polyurethane binder system mixed with gravel or stones and yielding air- and water-permeable pavements, provides a solution for future cities to prevent water build-up. Compared to concrete or tar, the high proportion of large and small stone pieces creates interconnected cavities. This feature facilitates water-permeability of roads and public spaces. Its porous structure can achieve sustainable management of rainwater, and absorb up to 1.1 liters of water per second per square meter given suitably absorbent ground.

From ordinary to magic

Innovations based on chemistry require market-oriented research and development that focuses strongly on customer needs. Making ordinary plastics magical through innovation is what BASF's R&D team has been continuously working on.

"Our R&D success factors are creativity, efficiency and integration. Fostering creativity and creating the conditions necessary to achieve it are among the company's most important tasks," said Dr. Martin Brudermüller, Vice Chairman of the Board of Executive Directors and Chief Technology Officer of BASF. "To do this, we need to intelligently combine the competencies of our global Research and Development Verbund while also taking advantage of our external networks."

The foundation of BASF's innovation strength is its global team of highly qualified employees from various disciplines. In 2015, about 10,000 employees were working in Research and Development worldwide. The central research areas – Process Research & Chemical Engineering, Advanced Materials & Systems Research and Bioscience Research – serve as BASF's three global research platforms. They are headquartered in the company's main regions – Europe, Asia Pacific and North America. Together with the development units of the divisions, they form the core of BASF's Know-How Verbund.

The Advanced Materials & Systems Research platform gathers nearly 200 employees at its Shanghai base. Its recent research focus is "Noise, Vibration and Harshness". Here, BASF experts are investigating the possibilities of minimizing unwanted noise and vibrations through material and



"How do we meet customer requirements through the use of existing materials, development of new products and application development know-how is something we always take into consideration."

Tay Jui Seng, Vice President, Business Management Transportation, Performance Materials Asia Pacific, BASF

component design.

With increasing urbanization, more and more people are living in confined spaces. Households not only have more electrical appliances, the equipment is also getting more powerful. The resulting noise and vibration needs to be minimized. An interdisciplinary BASF team of chemists, physicists and engineers is improving various polymer solutions that can be used to optimize frequencies in the range that can be felt and heard: from 1 to 20,000 hertz. Depending on the frequency range and the requirements, the team is able to change the design of components and/or the molecular or foam structure of the materials used (polyamides, polyurethanes, melamine resin foams) through computer simulations.

This is just a glimpse of BASF's technology blueprint that reveals the path of materials technology. The R&D and production of performance materials is only the beginning of the creativity. The innovative collaboration of material design, process design, modern-simulation technology and the global R&D integration is giving infinite magic to plastics. The changing properties of plastics are making our life more interesting and convenient.

Now, it is your turn to imagine ...

1

◀ “Explorator” camp bed

Louis Vuitton invented the first foldable camp bed, the “Brazza trunk”, in 1885.

The designers have been inspired to create a folding camp bed with an extruded Ultraform® (POM) sheet. The springy quality of Ultraform® means that no mattress is needed, and the material is also very easy to clean with water.

▼ Induction dynamo

The first patent for electric bicycle lamps with AC dynamos was in 1886. Since then, bicycle lamps have invariably been electric, supplied by cable.

The designer has devised an innovative light system using a combined front and rear lamp with no cables or plugs needed. An induction dynamo is used. The batteries built into the dynamo charge during cycling with no direct contact with the front wheel, thus making electricity.



2

▼ Work skates

Quad skates were invented in 1863. These pivoting rocker skates could be steered by shifting body weight. Ever since, roller skating has become a popular pastime.

With the designers' rework, roller skates can be used in a modern working environment. The boots can be easily snapped off from the chassis for laundering.



5

▼ “Knurr and Spell” outdoor game

“Knurr and Spell” was very popular in England in the 19th century. The basis for the game was a sprung trap that fired a small ceramic ball into the air. The player then had to wield his bat to hit the ball as far as possible. The player achieving the longest strike won the game.

The designers have devised a contemporary version with modern materials, and inserted a GPS transmitter into the ball to measure the strike distance and traces.

6

When classic inventions meet modern materials

The late 19th century saw not only the foundation of BASF, but also an upgrade in production technologies brought about by industrialization. Numerous inventions emerged and improved the daily lives of people.

BASF is now inviting young designers to draw inspiration from the past and explore how modern materials might be used to bring these products from the 19th century up to date. Here are 12 new interpretations.



3

▲ Bicycle lock

When the first bicycles appeared in 1865, their locks were too big and heavy to carry.

To reduce weight, the designer has thought back to the lasso, a traditional device for stopping something from getting away, and developed this contemporary cord lock. The lock demonstrates the advantages of Ultramid® B yarns: not only are they light and stable, but easy to carry.



4

▲ “Ruhmkorff” lamp

In 1862, the Ruhmkorff lamp was invented. With its chemical battery, it was the first portable electric lamp and forerunner of modern-day torches. Unfortunately, it was too heavy to succeed.

Now, the designers have given it a technological makeover for the present day. The new design consists of a charging station with an orientation lamp and a removable tube with an LED illuminating the transparent plastic rod.

► Ceiling fan

Towards the end of the 19th century, the Punkah ceiling fan found its way to the USA. It imitated the bird's wing in both structure and motion to provide a refreshing breeze.

The designer has rediscovered the pleasant breeze created by the Punkah. Driven by an electric motor concealed inside the blade, the fan can help create a pleasant atmosphere with this quiet and graceful form of aeration.



7

▼ Beehive

A modern form of beekeeping was introduced in the mid-19th century. However, frames in traditional beehives have been stacked awkwardly on top of each other for the past 150 years.

The new design allows easy access by opening drawers. The designers chose high-insulation polypropylene foam with low weight to keep the bee colony warm, making it easier for newcomers to the hobby in particular.



10

BASF material recommendation:

7 **Blade; outer shell:** Elastollan® nonwoven.
Blade; inner lining: Elastoflex®

8 **Bowl:** Ultramid® FC – good stability and certified for contact with foods.
Large gear wheel: Ultramid® Structure LFX – highly durable polyamide with long glass fibre reinforcement.
Small gear wheel: Ultraform® – self-lubricating, low-friction plastic.

10 **Drawers and hive:** Neopolen® – high-insulation polypropylene foam with low weight and good deformation performance.
Sliding rails: Ultraform® for excellent sliding properties

11 **Habitat:** Neopolen® – high-insulation polypropylene foam with low weight and good deformation performance.
Wall mount: Ultramid® Structure LFX for very high strength and low creep.



8

◀ Hand mixer

In the 19th century, the refinement of gear-wheel engineering and kinematics and the mass production of mechanical kitchen appliances, such as apple peelers and meat grinders, made household life easier.

The designer has made a kitchen appliance with elegant, exposed mechanics according to kinematics. With the gear wheel, the machine significantly facilitates the stirring work.

▼ Cooking on wheels

The late 19th century saw shortages in fuel and heating materials. As a result, a box lined with hay was developed for cooking and insulating food. The designer has developed an elegant, stackable set of bowls with outstanding insulation. Partly cooked meals put into the insulating bowls are perfectly cooked and ready when they are delivered to the table.



9

▼ “Darwin” honey bee habitat

The 19th century was not just the age of technology. Charles Darwin, who made a detailed study of bees' honeycomb constructions, also founded a new chapter in the history of biology. With the great recent growth in the popularity of urban beekeeping, swarms were an increasingly frequent sight even in metropolitan areas.

The modern habitat is designed in harmony with the natural architecture of the bees. It is made of modern materials and creates a place for bees to live in an urban environment, offering an alternative to modern beekeeping with modular hives and removable frames.

11



12

▲ Tabletop developer

The patenting of the tintype process in 1855 paved the way for the first photo booths with quick and inexpensive prints. Paying homage to these early machines, the designer has now designed a tabletop developer for smartphones. It uses an APP to convert the image to a negative, then to shine the negative to a photo paper through the lens. Various cartridges of developer, such as stop bath and fixer, are then inserted into the unit, which rocks on its rounded base to help distribute the fluids evenly. Finally, the authentic paper photo print is removed from the developer.

BASF material recommendation:

1 **Frame:** Ultramid® Structure LFX.
Bed Surface: Ultraform® sheet – easy to stamp and to clean after use.

2 **Reflector:** Ultrason®
Sleeve: Elastollan® for high flexibility.
Optical System: Elastollan® LED.

3 **Cord:** Ultramid® B for yarn with Elasturan® HP core.
Excentric: Ultradur® for high rigidity and stiffness.

4 **Housing:** Translucent Ultramid® Balance.
Lightbar/Tube: Elastollan® LED.

5 **Chassis:** Ultracom™ for enormous strength
Rollers: Elastollan® with selectable degrees of hardness
Yarn: Ultramid® B

6 **Ball:** Infinergy® – excellent recovery behavior lets the ball bounce.
Spring: Ultracom™ – light composite with excellent spring properties.

Polyamide-6 powder opens a new era in 3D Printing

In June 2016, aviation giant Airbus launched Thor (Test of High-tech Objectives in Reality), the world's first drone made almost entirely from 3D-printed parts. This quick-to-assemble and extremely light (3.96 meters and 20.8 kilograms) aircraft was introduced to the public at the last Berlin Air Show.

With 3D printing, manufacturing can now be more versatile, economical, energy-saving and efficient.

In China, Mr. Liu, Engine Intake and Exhaust Engineer from Pan Asia Technical Automotive Center (PATAC), a joint venture between General Motors and Shanghai Automotive Industry Corporation Motor (SAIC Motor), has been anticipating the industrial applications of 3D printing and the considerable benefits that come along with it. Over the last few years, Mr. Liu has asked his suppliers if they could provide a 3D printing prototype of the intake manifold for the powertrain R&D project that he is in charge of. Gradually, it has become his habit to try to get answers from industry players and partners, but unfortunately without much luck.

At the end of 2014, at an internal workshop co-organized by PATAC and BASF, Mr. Liu by chance sat beside Dr. Dirk Simon, Business Director Innovation Business Unit

3D printing, BASF. This time, when the same question was brought up, he received a different answer: the BASF 3D printing team based in Germany would be delighted to develop a new material for PATAC to meet the experiment requirements of R&D of the powertrain.

In the following year, through close communication and international cooperation, BASF successfully launched 3D printing engine components made of the new polyamide-6 powder in one shot. Enabled by the new technologies provided by BASF and its partner companies, the PATAC team made it possible to successfully complete the process from 3D printing to testing and adjustment of the key components, significantly shortening the development cycle.

It is made possible by the solution for 3D parts printed by selective laser sintering (SLS) co-developed by BASF and Farsoon Hi-Tech, a manufacturer of SLS and melting to develop integral solutions for 3D printing, in 2015.

"The new polyamide-6 powder developed by BASF is the first raw material that made 3D printing parts, which were successfully used in engine testing, possible," said Mr. Liu. "3D printing components made of PA6 powder could not only carry out product functions, but also shorten the development cycle, save

cost and meet the customized requirements of small volume production."

Today, many plastic parts are produced through injection molding, which is fast and cost-efficient for production of 100,000 parts per year. However, the investment into an injection molding tool makes the production of for instance 10,000 parts per year very expensive. In the development process of products the tooling costs are already avoided by using 3D printing for prototypes.

In addition, individually shaped plastic parts manufactured by 3D printing techniques are gaining increasing prominence in industry with decisive advantages: they enable the production of complex parts, allow individual designs and help lower costs in small scale production; development cycles can be vastly accelerated. Materials currently offered in the market do not satisfy the high requirements for industrial applications for functional components. These requirements include, for example, better material stability under high temperature conditions, and mechanical and chemical stress tolerances.

The new polyamide-6 powder that BASF developed for the SLS process is a comprehensive system solution for reliable sintering to build complex parts with better heat distortion temperature (HDT) properties for functional prototyping and production. It can be adapted with partners and customers of BASF for specific applications. Objects made of these innovative materials are distinguished by higher strength and heat-distortion stability than objects made of the previously used polyamide 12. Besides, BASF's PA6 powder shows good recycling properties: powder not sintered in the production process can be reused to a high degree.

SLS is one of the layer-by-layer additive manufacturing methods used today: following a 3D blueprint, a laser draws the shape of an object in a powder such as polyamide. The material powder hit by the laser beam melts and forms the desired 3D object layer by layer.

The French cloud 3D printing provider Sculpteo lately released a report, *The State*



"BASF will further cooperate with global partners and customers and provide the best solution for this growing market of 3D printing."

Dr. Dirk Simon, Business Director, Innovation Business Unit 3D printing, BASF

Dr. Dirk Simon was introducing 3D printing parts made of PA6 powder at Chinaplas 2016.

of 3D Printing 2016, showing that SLS is the top 3D printing technology (38%), and polyamide is the top 3D printing material. Other materials include resins (26%), metals (23%), sandstones (13%) and wax (8%).

Dr. Simon explained that the successful launch of the 3D printing solution mainly relied on three key factors:

1. Open system

Most 3D printer suppliers today offer closed systems, which means that the operator can only use the materials supplied by the specific 3D printer supplier. This limits innovation and competitiveness. BASF and Farsoon share the opinion that the market will grow much faster with open business models. The R&D team did not confine themselves in the labs during the development of the new PA6 powder. They had in-depth cooperation with Chinese customers and conducted 29 trials enabled by overseas travel between Germany and China.

Currently, BASF operates Application Technology Labs in Ludwigshafen and Shanghai. It is opening a 3D Printing Application Technology Center in Heidelberg. With its global network and strong research capability, BASF is cooperating with a few customers and developing solutions together to meet their needs.

2. Global alliance

Developing new materials for the 3D printing process is not a simple task that could be fulfilled alone. BASF has partnered with Farsoon Hi-tech, a manufacturer of SLS and melting to develop integral solutions for 3D printing. These can be tailored to meet a customer's individual needs. This was recognized as a joint-forces benefit

from the complimentary know-how of the parties in material and formulation as well as technology, machinery and services.

This collaboration is open for potential customers to jointly develop solutions for functional applications where materials, equipment and processing are aligned. Customers interested in a solution for a 3D printed part don't need to worry about receiving all the necessary elements for the solution. They also have the choice to purchase products and services from competition.

3. Broad portfolio and industry insights

As the world's leading chemical company, BASF has a broad product portfolio and formulation know-how relevant for 3D printing. Moreover, BASF is an established supplier of materials used in traditional manufacturing. It is well positioned to help customers and partners to overcome high barriers for growth with its know-how and industry insights.

3D printing offers unforeseen design options for the aeronautical, automotive, health care, intelligent manufacturing, leisure and sports industries. High-end users of 3D printing rely more on accelerating product development and offering customized products and limited series. BASF sees great potential in it and is working on developing new materials for customers to use in the various processes of additive manufacturing.

"In the next three years, the Innovation Business Unit 3D printing will further cooperate with global partners and customers to discover market trends, incubate market opportunities and accelerate business development to provide the best solution for this growing market," said Dr. Simon.

Automotive air intake manifold connector

This is an auto air intake manifold connector printed with PA6, which is used in the design correction and function test of the engine. PA6 material's superior mechanical property and thermal stability enable the connector to operate stably under the normal working conditions of the engine. Part of the surface of this connector can be further treated to meet air-tightness requirements so as to fully reflect PA6 material's advantage in processing flexibility other than its mechanical property and chemical stability.

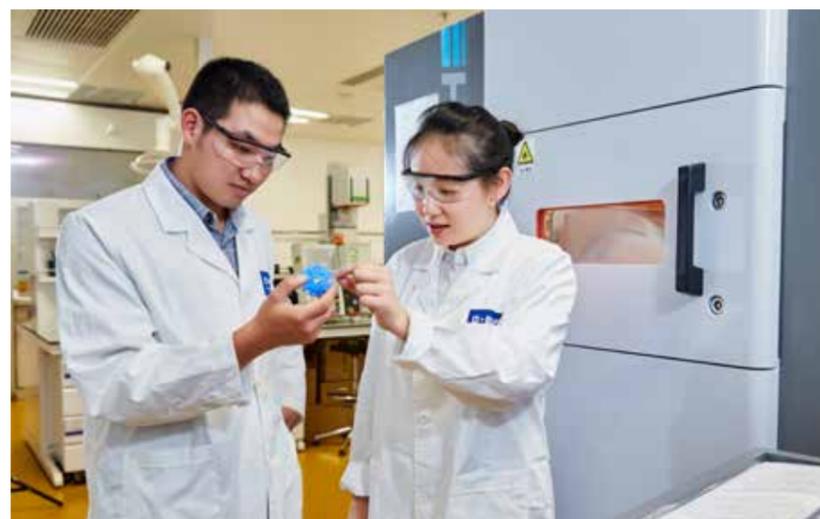


Automotive rearview mirror

This is a model of auto rearview mirror printed with PA6, which is used in the functional verification of digital modeling in early-stage development. Its complicated internal structure and the position of a tightening bolt require precise dimensions and certain strength so as to verify a series of possible problems from manufacturing to assembly in actual use.



Scan the code and learn more about BASF PA6 powder 3D printing material.



Yansheng Li (left) and Xia Meng from 3D Printing Research, BASF, were looking at a 3D-printed plastic ball in a complex structure.



The new BASF Design Center Asia Pacific located at the Innovation Campus Asia Pacific (Shanghai).

Design inspires innovation



“We believe design can further inspire innovation for future.”

**Eva von Traitteur,
Head of Design Center Asia Pacific
in Shanghai, BASF**

How do you select appropriate materials for products to make them cost-effective, energy-saving, user-friendly and nice looking? This is what concerns designers, engineers and developers these days.

In 2004, designers Ronan Bouroullec and Erwan Bouroullec were obsessed with the concept of a “Vegetal Chair”. The Frenchmen dreamed of making chairs that would grow into the shape of organic plants. However, the design structure of the branches directly affected the flowing smoothness of plastics in molds, which made their mass production seem impossible. While such a design demonstrated great originality, the problem was what materials could be used to achieve such a complex manufacturing process with characteristics of comfort and practicality?

To solve the problem of plastic’s fluidity in molds, the pair cooperated with Vitra, the renowned Swiss furniture manufacturer, and BASF, the world’s leading material supplier. BASF’s experts helped them conduct a simulation analysis of materials and found problems in their molds and technological processes. Given that the materials of the vegetal chairs need to be highly liquid, lightweight and durable, the design team

chose to use BASF’s plastic Miramid®. After four years of efforts, the Vegetal chairs debuted at the end of 2008, looking as if they were woven with branches of different thickness albeit very firm and weighing only 5.5 kilograms. The chairs can be used both indoors and outdoors because their color won’t fade in sunlight.

Nowadays, several Vegetal chairs in distinctive colors are displayed at the new BASF Design Center Asia Pacific in Shanghai. The center features resources from many different BASF operating divisions, such as the Concept 1865 bicycle engraved with 24 types of BASF high performance materials. Other items include JOIN tableware made of Ultramid®, a solar-powered e-floater weighing less than 12kg and adidas trend-setting running shoes.

New Design Center leveraging R&D expertise

The function of the new Design Center is to embrace designers from China and the Asia-Pacific region. It is also to provide consultation services, R&D support or simulation and testing devices for them to narrow the distance between the material and design industries. BASF will host design-related activities for coating solutions, care

chemicals, construction chemicals, pigments, leather chemicals and performance materials through this hub for Asia Pacific, and provide advanced solutions for multiple industries including automotive, cosmetics, building and consumer goods.

The Design Center is located at the BASF Innovation Campus Asia Pacific (Shanghai), the company’s largest R&D site in the region and the global headquarters of BASF’s Advanced Materials and Systems Research.

“The Innovation Campus Asia Pacific creates an ideal environment for the Design Center, and promotes cross-disciplinary cooperation”, said Dr. Harald Lauke, President, Advanced Materials and Systems Research, Regional Research Representative for Asia Pacific, BASF. “With our design expertise, we want to translate inventions into daily products that enhance quality of life by connecting industrial designers with BASF researchers, developers and business experts.”

From concept innovation to finished-product manufacturing

Eva von Traitteur, Head of BASF Design Center Asia Pacific in Shanghai introduced that with work experience in different

industries, consultants at the new Design Center are an interface between different disciplines such as chemistry, materials, engineering marketing and design. With experience in furniture, transportation, consumer goods and other industries, and an understanding of market and production, they play an important role in connecting R&D and the business personnel of BASF with external customers.

“Design is the interface between users and the function of a product. Our mission is to be the first point of contact at BASF for all design-driven industries”, said Ms. von Traitteur. “We collaborate closely with teams across R&D and business divisions with diverse materials, processing and industry expertise under the same roof. This makes it easier to develop original solutions with a long-term horizon, in addition to providing ongoing design consultancy for our customers.”

As for designers, a good concept is just the beginning of a creation – they need to know the usage and production modes of materials. The BASF Design Center Asia Pacific therefore plans a set of unique originality processes, reflecting an all-round service from inspiration, ideation to

implementation. Consultants get involved from an early stage of product development.

BASF color designers support BASF Coatings Solutions division, where color is one of our key success factors. The color teams around the world serve different regions. In Europe, the color design team is located in Muenster, Germany. In North America, it is in Southfield, USA. In Asia Pacific, they are here in Shanghai and Yokohama, Japan. All color designers work as ONE global team, analyzing color trends and issuing yearly global and local trend reports and color forecasts. Together with the application team, the color designers develop customer-specific colors.

BASF Care Chemicals division focuses on product experience and customer engagement with sample exploration. To touch, smell and see the product are key elements for success in the market. Experiencing the sensorial aspects with samples are elementary for a precise definition of customer needs. In addition, they test the functional performance and more quantified sensorial aspects in the sensorial lab to characterize successful products.

In 2016, following Ludwigshafen, Germany, and Tokyo, BASF established a new designfabrik® in Shanghai, as part of the new Design Center Asia Pacific with a focus on advance products made out of plastic. Founded in 2006 in BASF’s global headquarters in Ludwigshafen, designfabrik® is a design consultancy institution supporting the BASF Performance Materials division. Its creation was the first time in the plastics sector that a raw materials producer had offered a special platform for a target group of industrial designers.

“At designfabrik® we will assist designers realize even the most daring ideas,” said Andy Postlethwaite, Senior Vice President, Performance Materials Asia Pacific, BASF.

Furthermore, consultants conduct application development by fully leveraging BASF’s expertise in various fields, and material experts in the company enable customers to have a full understanding of the performance of materials.

With the help of computer simulation patent technology ULTRASIM®, BASF engineers can accurately predict the performance of components, calculate the resilience of final-finished products and recommend the



“At designfabrik® we will assist designers realize even the most daring ideas.”

Andy Postlethwaite, Senior Vice President, Performance Materials Asia Pacific, BASF

most suitable manufacturing process. The technology can also help customers solve problems and effectively eliminate the hidden dangers of performance in the stage of tool design, production and post-production. This greatly improves economic efficiency and accelerates the time for products entering the market.

The expert team at BASF is the last step to realizing design concept. With their understanding of material characteristics and professional ability in process optimization, design concept and mass production are both realized.

Design for the Future

So what is the purpose of design? Where is the difference between meaningful design and a meaningless one? This is a problem that BASF faces when it sets out in the design field in the upstream from the raw-material field.

The continuous growth of the global population and urbanization brings great challenges to resources, environment, transportation, food and living quality. Therefore, BASF is committed to seeking better solutions focused on urban living, future living and smart living.

“The Innovation Campus Asia Pacific creates an ideal environment for the Design Center, and promotes cross-disciplinary cooperation.”

Dr. Harald Lauke, President, Advanced Materials and Systems Research, Regional Research Representative for Asia Pacific, BASF



Dr. Harald Lauke with Concept 1865 bicycle.

Almost 80% of the lightweight, solar-powered scooter “e-floater” is made of BASF composite materials and plastics, which have excellent vibration-absorption performance and promote the development of sustainable city transportation.

Using BASF’s new foam Infinergy™, adidas has developed a new running shoe with unique spring and cushioning properties. Its midsole is made from a new particle foam, whose high rebound effect provides runners with unparalleled energy return, enabling them to enjoy the fun of running.

Jointly created by BASF and renowned designer Chris Lefteri, the “Living Space Concept” exhibition has moved from Singapore to Shanghai. It displays the design application of BASF’s innovative materials in furniture, consumer-electronic equipment and household appliances. The exhibition highlights the trends, challenges and living spaces of future residents in different stages of life – but creativity is more than this.

BASF is inviting people who love innovation to join in, encouraging designers to draw inspiration from BASF materials, develop cooperation and jointly solve the challenges of urban living through design competitions and cooperative projects among universities. It aims to make design and innovation help to provide a more healthy, intelligent and sustainable life for the society.

“BASF’s innovation in materials is the main source of inspiration of outstanding products, which is best interpreted and transferred by a good design work”, said Dr. Lauke. “We will continue cooperating with customers and partners in the region to jointly explore more innovative and sustainable solutions.”

Selecting appropriate materials for products is always the most challenging decision for designers, engineers and developers. “With BASF Design Center Asia Pacific we offer a platform to solve that problem”, said Ms. von Traitteur. “The design thinking process in the Design Center Asia Pacific reflects the combination of technology, demand and materials. Many excellent designs, which couldn’t be achieved in the past due to choosing the wrong materials or production methods, can now be implemented. We believe design can further inspire innovation for future.”

Lightweight transport



Katja Krauser

Less than 12 kilograms, stable, durable and safe with an exciting and functional design – this is e-floater®, an ultra-lightweight, solar-powered electric scooter.

Ultramid® B3ZG8
For structural parts that have to resist crash loads, the impact-modified Ultramid® B3ZG8 offers a fine balance between stiffness, toughness and durability.

Ultralaminat B3WG13 and Ultramid® B3WG12 COM
With the thermoplastic laminate and customized over molding, BASF provides comprehensive support in the designing and processing of glass fiber reinforced parts.

Ultramid® B3M6
This mineral-filled polyamide is used for parts where minimal warpage is crucial.

Elastollan®
Tires and handlebars are made of this thermoplastic polyurethane, ensuring good grip and a smooth ride.

Ultramid® B3G10SI
This material provides high-surface quality constructed with a high glass fiber content.



e-floater lives up to its name because it provides users with the feeling of being almost weightless. This becomes possible through composite and plastic materials from BASF, making up 80% of the scooter. In March 2015, BASF and Floatility, a startup with offices in Hamburg and Singapore, entered into a partnership for the

development of the e-floater. The electric scooter offers a new and environmentally-friendly solution for short distances in urban traffic and bridges the gap between the residence or city center and the next public transport stop. In future, e-floater will be available through an app-based rental system in a simple and uncomplicated way.

Rolling into the future

Oliver Risse is both a pioneer and businessman. As founder and CEO of his own startup Floatility, he has set himself the goal of initiating the future in motion.

BASF information: How did you come up with the idea to build the e-floater?

I have lived in Asia for many years where short-distance transport is one of the very big problems. I got the idea for the e-floater while jogging. With it we hope to make urban mobility better and more attractive.

What is the last mile? Why not go on foot or ride a bicycle instead?

The last mile means the distances that are too short to drive with cars, but too long to go on foot. From the front door of home to the next metro station would be an example of such distances. In warmer

weather, especially, people will drive cars. Therefore, electric mobility is very important because only in this way can we optimize the use of time and reach our destination with minimum effort. The frequency of this solution stands analogous to the simplicity of the solution offered: fast and efficient driving with short distances to the nearest rental station is an important prerequisite.

Why use plastics?

Plastics have many advantages. On one hand, they offer the freedom of design. On the other hand, it saves weight and costs potentially. Especially in mass production, savings can be achieved in injection molding and the production process is very flexible. In addition, the combination of different BASF materials is very exciting. Plastics are softer

than aluminum, which also affects the driving behavior. On the road surface, there is quite a lot of unevenness, which can be better mitigated with a softer material. Moreover, the better attenuation property creates the ‘floating’ feeling and the design is interpreted through this flexible material: the e-floater can be controlled by weight transfer.

What role will the e-floater play in five years?

Currently, we see three main scenarios for the use of the e-floater: in local public transport systems as the next generation of bicycle rental; in trips for city tourism or in factory traffic of big companies. The rental system will supplement other mobility solutions in future and be integrated into the existing system.



Photos: BASF



Colorful cars start from green

BASF provides efficient and eco-friendly automotive coating solutions for BMW X1.

On elevated expressways, cars coated with gorgeous paints can make a city more vibrant and colorful.

While it may have never occurred to you, the coating process, which is responsible for the various colors on cars, is one of the most energy-intensive processes in industrial automotive manufacturing. It also emits a large number of volatile organic compounds (VOC) and CO₂. The former is the main source of PM2.5, while the latter is one of the main causes of global warming.

As one of the leading automotive coatings suppliers in the world, BASF has had extensive and in-depth cooperation with car manufacturers around the globe, not only in research of color design and trends to make cars look fashionable, but also in being actively involved in the coating process, exploring eco-friendly automotive coatings, coating processes and solutions. This is to help car manufacturers tackle the severe challenges of balancing economic effectiveness and ecological efficiency.

Located in Shenyang, Liaoning, the Tiexi plant of BMW Brilliance is one of the most eco-friendly and sustainable paint shops in the world, albeit with the lowest energy consumption. As one of the major coating suppliers of Tiexi plant, BASF provides advanced and eco-friendly e-coat

and waterborne basecoat. Through the streamlined Integrated Process (IP), BASF helps the Tiexi plant reduce production costs and the consumption of raw materials and energy, effectively control the emission of VOC and CO₂ and increase productivity.

Integrated Process: the wisdom of subtraction

The entire paint system of a car, at one tenth of a millimeter, is no thicker than a human hair but consists of four layers, including e-coat, primer, basecoat and clearcoat. Generally, it can only be completed after a four-step process, which has very high requirements on the space of the paint shop and energy consumption.

As there are no set rules in the world, why not find a win-win solution that cuts both costs and protects the environment? BASF loves such challenges. Based on study of the whole coating process, BASF found that primer could be reduced. If feasible, the original four-step coating process can be streamlined to three steps.

However, it is not a simple question of four minus one. The effects of primer need to be considered. The UV light in the atmosphere can penetrate layers of clearcoat and basecoat and make light-sensitive e-coat crack and peel. Primer helps protect e-coat from UV light and flattens the surface of coatings to prevent it from stone chipping,

Based on such considerations, BASF innovated and optimized the coating process, developing the IP, incorporating part of the functions of primer into the waterborne basecoat system. With the innovative e-coat CathoGuard® 800, the primer and drying steps are saved with the same effect of the original four-step process.

Compared with the standard process, the streamlined IP effectively shortens the production line and coating process. It reduces the use of raw materials, cuts up to 20% energy consumption and CO₂ emission, and minimizes the use of solvents and thus the VOC emission. It also helps car manufacturers increase productivity and improve the balance between energy consumption and eco-system conservation. In terms of both profit-making and environmental protection, the IP has significant advantages.

The Tiexi plant of BMW Brilliance is the second BMW plant in the world to implement the IP. Thanks to the IP, both initial investment and labor costs were reduced by around 30%. In addition, energy and water consumption, VOC emission and wastewater discharge were one-third of the average of 10 years ago, all of which were major breakthroughs in sustainable development.

From construction to start-up, BASF not only provided the overall coating solutions

but also sent experienced engineers to the site. They were involved in the installation, implementation and testing together with the BMW Brilliance team and other suppliers until the Tiexi plant started production successfully. This ensured the continuously stable production of the paint shop.

“Innovative technologies and building up partnerships with suppliers are very crucial to BMW Brilliance,” said Chen Weihua, the paint shop director at the Tiexi plant of BMW Brilliance. “We are so impressed that BASF is customer-oriented, offering professional technologies and services and striving for excellence.”

“Dedicated to continuous innovation, BASF delivers advanced automotive coatings solutions with the best-in-class services to our customers. We will continuously support their long-term, sustainable development,” said Dr. Thierry Herning, General Manager, BASF Shanghai Coatings Co., Ltd.

Paint shops of car manufacturers plants newly established in these two years can directly adopt the IP, while for existing plants, primer and basecoat processes can also use the IP after certain reconstruction. In addition to the Tiexi plant of BMW Brilliance, many major car manufacturers in China have adopted BASF's IP.

Eco-friendly CathoGuard® 800

E-coat is indispensable in the coating process of automotive bodies. It provides the bodies in white with the primer coat, which is the basis for the following layers of coating and efficiently protects surfaces, edges and cavities from corrosion. The IP without primer requires e-coat to be more powerful. This is

where BASF's CathoGuard® 800 (CG800) demonstrates its value.

BASF's CG800, a leading e-coat around the world, is not only rust-resistant, but also low in solvent and free of heavy metal and HAP. Therefore, it won't cause air pollution and is very environmental-friendly. More importantly, its optimized distribution of the film resulting in a homogenous thickness saves material. The multi-metal compatibility of CG800 means fewer touch-ups on the car body and ensures high quality and reliable technical process during manufacturing. Moreover, the coating does an outstanding job on any substrates and can be combined with state-of-the-art pretreatment technologies, including the new nickel-free “nano” pretreatment.

Since its launch in 2009, CG800 has been widely applied across the world. Its superior features include eco-friendliness, energy efficiency, excellent throwing power, high-corrosion resistance and high-surface quality. With its wide applications around the world, CG800 has been well recognized by car manufacturers.

In 2011, BASF introduced CG800 into China and soon won the recognition of major car manufacturers. Shanghai GM was the first car manufacturer in the country to adopt CG800.

At the Tiexi plant of BMW Brilliance, as part of the IP, the paint shop maximizes the utilization of CG800 by turning 360°. This helps to save more space in the paint shop and is energy-saving and eco-friendly. Due to the reduction of wastewater discharge and energy consumption, the production cost of each car is significantly reduced.



Tiexi plant of BMW Brilliance

Located in Tiexi Economic and Technological Development Zone, Shenyang, Liaoning Province, the Tiexi plant of BMW Brilliance is the 25th in the BMW Group and was officially opened on May 24, 2012.

The Tiexi plant has fully realized industrial intelligence in four major shops, i.e. stamping, body, painting and final assembly, and sets new examples in terms of energy saving and emission reduction. With a footprint of 50,000m², the paint shop of the Tiexi plant started production on July 1, 2013. It has now achieved the goal of saving water by 30%, energy by 40% and cutting emissions by 20%. It is one of the most eco-friendly and sustainable paint shops with the least energy consumption in the world.

E-coat: 40 years of success

Early 1960s: Anodic E-coat replaced conventional dip coating. With this process the body and the coating were electrically charged, with the body receiving a positive charge and the coating a negative charge.
Mid-1970s: With cathodic E-coat, the poles were reversed.
Late 1970s: BASF supplied the paint for the first E-coat line for small parts used in the European automotive industry.
Late 1980s: BASF launched the CathoGuard® technology. The product's exceptional features include its optimized edge protection, flow and throwing power. CathoGuard® 300 to 500 were the first lead-free E-coat products.
Today: CathoGuard® 800 and 900 are tin-free, have a low percentage of solvents (low VOC), are HAP-free and comply with the latest environmental legislation.

The Tiexi plant of BMW Brilliance is the second BMW plant in the world to implement the Integrated Process, which effectively increases productivity and improves the balance between energy consumption and eco-system conservation.



“Tiexi plant is the first BMW plant in the world adopting CG800. Since the successful launch in 2013, the e-coat tank continues to improve the quality of our products and contributes to our sustainable development.”

Chen Weihua,
paint shop director at the Tiexi plant of
BMW Brilliance

“BASF’s CG800 can fully meet the most demanding requirements of BMW Brilliance on automotive coating,” said Chen. “Tiexi plant is the first BMW plant in the world adopting CG800. Since the successful launch in 2013, the e-coat tank continues to improve the quality of our products and contributes to our sustainable development.”

A leader in the China automotive industry for improving eco-efficiency

Eco-efficiency in the global automotive

industry plays an increasingly important role. China is the world’s largest car production market, while regulations and emissions standards in the automotive industry are continuing to tighten. Since 2012, the Chinese government has put waterborne primer and waterborne basecoat as a mandatory requirement for new sedan manufacturing. In 2015, the Beijing municipal government issued an “Emission Standard of Air Pollutants for Painting of Automotive Manufacturing Industry”. It is considered the world’s most strict local standard of VOC emission for industrial painting so far.

Over the past few years, BASF has conducted a comprehensive Eco-Efficiency Analysis of the application process, looking at the environmental impact in proportion to the cost-effectiveness of painting production and painting technologies. Such analysis helps quantify and visualize sustainable development. It also allows BASF to provide its customers with the best possible advice with consideration to both ecological and cost efficiency. It identifies further potential for improvement in automotive painting processes and contributes to sustainable development.

The study shows that compared with solvent-borne paints, waterborne processes involve significantly lower emissions of VOC and therefore show overall good results with respect to eco-friendliness. Benefiting from the eco-efficiency analysis, BASF has continuously developed waterborne, solvent-reduced or solvent-free paint systems, pioneering in waterborne paints in automotive OEMs. BASF was the first coatings supplier to introduce



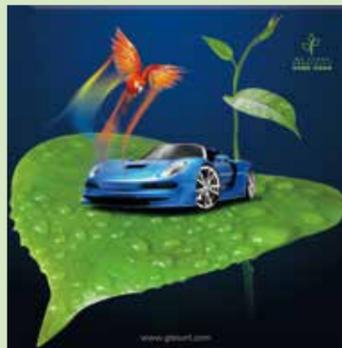
“With our latest technologies, innovative and eco-friendly paints, coating solutions and processes, BASF will help our clients to achieve a balance of cost and eco-efficiency, and support the growing automotive industry in China.”

Dr. Thierry Herning,
General Manager,
BASF Shanghai Coatings Co., Ltd

waterborne basecoats to China in 2005.

“With our latest technologies, innovative and eco-friendly paints, coating solutions and processes, BASF will continue to work together with our clients to achieve a balance of cost and eco-efficiency, and support the growing automotive industry in China,” said Dr. Herning.

Glasurit and China's premium bodyshops support “Plant a Billion Trees” program in China



Recently, Glasurit®, a premium brand of BASF, has launched “Glasurit Bodyshop Emissions Program” in China, supporting the Yunnan Green Environment Development Foundation (YGF)’s participation in the global “Plant a Billion Trees” campaign. Conceptualized by The Nature Conservancy (TNC) and supported by YGF, this campaign aims to restore severely degraded forests by planting a billion trees globally and help mitigate the impacts of climate change.

Under the “Glasurit Bodyshop Emissions Program”, selected bodyshops who use the premium Glasurit 90 Line waterborne refinish paint are invited by BASF to join the program. All donations will be aggregated by BASF and then donated to YGF, which will use the funds to plant trees. The first batch of trees

funded by BASF has been planted by YGF in August 2016, and YGF will also be responsible for tending the trees after they are planted.

Glasurit® is a global leader in driving sustainability in the automotive refinish industry with innovative water-borne paint solutions. For over 100 years, Glasurit has stood for professional solutions and first-class quality.

Glasurit today works actively with bodyshops to master the sustainability challenges of the future. Its pioneer initiative, “Glasurit Bodyshop Emissions Program” in Australia, has planted thousands of trees in partnership with emissions reduction organization Carbon Neutral Australia.



Precision agriculture in the digital era

The internet is playing a key role in the transformation of industries. What new opportunities is the agriculture industry facing with in the digital era?



“BASF will continue to offer services in every part of the value chain of agricultural products. Our commitment to helping farmers improve the quality of farming, produce and competitiveness will never change. We will strive to help farmers maximize their profits.”

Jiang Weiqi, Manager, Marketing, Fungicide and Specialty Crop, Crop Protection, BASF

Today, more than 7 billion people are living on this planet. By 2050, the total number is estimated to reach 9.6 billion as people will be living longer as well. As economic development brings more wealth, people want and demand better-quality food. Such factors require higher efficiency in agricultural production, produce yields and quality.

In China, agricultural production has satisfied people's basic needs to survive. High-quality agricultural products, however, are in short supply, despite infrastructure and farmers' knowledge expected to grow.

The internet is playing a key role in the transformation of industries. In Internet + Agriculture, mobile internet is becoming more and more important. In rural areas smart phones are much easier to use than computers. So how to use digital technologies to boost the development of planting capacity and infrastructure construction? How can the agricultural development of China be speeded up? How can the quality of products and benefits for farmers be improved? Such questions have been put on the table of many internet giants and plant protection companies.

In March 2016, BASF launched its innovative “BASF Leading Grower” App to better serve farmers in China – helping them to improve their growing skills and productivity and starting a new precision agriculture model for the digital age.

Boost for China's agricultural transformation

Agricultural production in China is still,

generally, in a primary stage, with a number of problems to be solved.

Wheat and corn production areas in the north of the country have large land holdings, but farmers in the south are mostly individuals who manage their own small fields and buy agricultural supplies from retail stores. Take crop farming and protection for example. As retail stores are driven by profit, seldom do they offer to-the-point guidance to farmers whose demand volume is relatively low when they buy products for their crops. Faced with a great number of crop protection products, in addition to farming technical services that vary in quality, farmers need a way to choose products and services that are right for them.

Farmers with smaller-sized fields usually focus on short-term profit, so they often irrationally choose crops to grow based on the market trend of the year. They may easily plant the same crops or blindly change them. The consequence will be that they harvest but they don't profit. Farmers need to have their target crops well planned for longer term, as well as know more about the marketing channels of agro-products to really get both high yields and profits.

Technologies in agriculture, meanwhile, have been left behind for a long time and there are no efficient channels for communication and marketing. Agricultural profits, therefore, are so far below expectations that farmers leave their fields to work in cities. It is said that those born in the 1970s are reluctant to farm; those born in the 1980s refuse to farm; while those born in the 1990s don't even mention farming now.

In recent years, national policies have been issued one after another to encourage and support land transfer, home-based farms and large-scale growing. The number of large-scale farmers is increasing rapidly. Many far-sighted entrepreneurs born in the 1980s have also sensed the great opportunities in agriculture and have devoted themselves to it. Crop growing is no longer gloomy as more and more farmers are engaged in it.

According to Jiang Weiqi, Manager, Marketing, Fungicide and Specialty Crop, Crop Protection, BASF, these farmers are 35 to 45 in age, well-educated and with the best know-how in crop farming across the country. They are not just beneficiaries of land policies but also executors and leaders of modern agriculture in China. As the “cool” generation in agriculture, they are open-

minded and willing to try more channels and platforms to learn new crop-farming technologies and products, and to conduct scientific planning in farming so as to improve productivity, quality and profit.

As smart phones have become necessities in people's lives, the BASF Leading Grower App will be able to provide and deliver in-time, comprehensive and precise agricultural and technological services to meet the needs of large-scale farmers. They will be able to manage planting more efficiently. Through their phones, farmers will receive weather reports, learn about agricultural technologies and pest control and be able to consult with BASF experts through long-distance guidance about agricultural problems.

“It is a systematic job to help farmers improve quality and profits,” said Jiang. “BASF will continue to offer services in every part of the value chain of agricultural products. Our commitment to helping farmers improve the quality of farming, produce and competitiveness will never change. We will strive to help farmers maximize their profits.”

Good tool for farmers

Pest control is the most common and stable operation in daily farming, independent from the changing climates each year. Fungicides, therefore, are most relevant to the quality of produce among all crop protection technologies as they strengthen a crop's resistance and immunity to changes in the environment.

As a leading supplier of fungicides, BASF has helped Chinese farmers by launching two or more high-performance and innovative fungicides in each of the past three years. Take grapes from Jiaxing, Zhejiang, for example. Grape farmers who use the BASF farming protection solution have reduced pesticide use by 50% in terms of dosage and frequency, saving on manpower costs but harvesting more and better fruits. These grapes are healthier in their looks and of better quality, so they sell for higher prices. In general, farmers who choose to use BASF's management solution for their grapes have a high return on invested capital, earning 27 times the outlay.

In the past, BASF promoted its products and usage tips through face-to-face meetings with farmers. The farmers attending such meetings numbered just a few dozen, while BASF's investment in manpower and capital is quite a lot. Most farmers didn't

have access to such information, know the benefits, or communicate their problems in using the products.

Now, the BASF Leading Grower App not only promotes products and services more efficiently but also gathers information that farmers are most concerned about. They can get to know micro climates in their own fields, crops' growing stages, the pest control in each of them and practical cases for reference. Farmers can also learn about the latest crop farming technologies and solutions, make decisions and adjust operations according to weather conditions and growing cycles.

For example, a farmer in Huizhou, Guangdong, can select his village and crops via the BASF Leading Grower App, set the technology to monitor the weather in his fields and different stages (seedling, flowering and growing) in growing and pest control. The App can also serve as an automatic reminder. The farmer may be the only farming expert in the family but when he is thousands of miles away from home, he can still arrange for his family to use plant protection products and take care of the crops.

“The BASF Leading Grower App is easy to use, like a teacher and friend to farmers by their side,” said Jiang. “Through smart phones, farmers can obtain crop protection solutions and products from us 24/7 in different locations. They are farming in scientific ways and can manage their business anytime, anywhere.”

Big data in future agriculture

By collecting, integrating and evaluating the backstage data of the Leading Grower App, BASF is able to strengthen its farmer-relationship management. According to Jiang, when farm information is accumulated to a certain scale, big data will come into play. In future, information about farmers, field locations and yields retrieved from this App will help BASF provide services to directly connect farmers with sales terminals and lower the risks caused by incorrect marketing information that would hurt farmers' benefits. It will be another service BASF intends to provide to Chinese farmers.

In Hainan Island where mangoes grow, as farmers do not have relevant marketing information prices for the fruit are manipulated by resellers. Farmers sell their mangoes at one to two yuan per kilogram. After being transported by resellers and logistics carriers,

such mangoes will be sold at 10-20 yuan per kilogram in tier-one cities such as Shanghai. In future, once farmers are able to deal directly with end users on the same platform, all information about supply and demand will be public and both farmers and consumers can benefit from such transactions.

As the BASF Leading Grower App is further promoted and used, hundreds of thousands of farmers will contribute to the database that will provide detailed information on produce such as variety, place of origin, when they are planted and harvested. If farmers could directly connect with fruit stores and supermarkets, brand new marketing channels would be established. Farmers who used to grow the same crops en masse can, in future, avoid such scenarios by knowing market trends, making smart planning in scientific ways and selecting the right crops to plant.

In addition, other records of farming, pesticides and residues will be also saved in the BASF Leading Grower App database. “This valuable data is not only strong proof of the product's high quality but also basic support to track agricultural production in future. In this way, food safety can be guaranteed. We are looking forward to all of these prospects,” said Jiang. “We have just started and it takes time to promote the BASF Leading Grower App. But BASF is already in the leading position of our industry.”

BASF BanCare project

As a leading fungicide supplier in China, BASF launched its BanCare project in 2016 for banana farmers who have purchased BASF products. When hit by typhoons at level-14 and above (wind velocity>=41.5m/s), these farmers will be compensated with BASF products of certain value for free so that they minimize their losses and gain more benefits after such disasters.

The BASF BanCare project covers areas in Guangdong, Guangxi and Hainan during the typhoon season from mid-June till November in 2016.



Scan the QR code to download and log on to the “BASF Leading Grower” App. Invitation code: 888888.



Sustainable materials for innovative buildings



“The second phase of the BASF Innovation Campus Asia Pacific (Shanghai) is a great example of BASF successfully balancing the economic benefits and social and environmental responsibilities.”

Ma Shouwang,
Senior Manager of Industry Team
Construction China, BASF

Urbanization makes cities prosper and life more easy than ever before. But buildings, as the main body of a city, are one of the biggest energy guzzlers, accounting for a quarter to a third of total energy consumption. Research by the McKinsey Global Institute shows that four out of five of the most cost-efficient measures to lower greenhouse gas emissions are energy saving measures for buildings.

It is for this reason that the concept of sustainable buildings has come into being as the key to saving energy and reducing emissions for cities, to protect the environment and to promote sustainable development. Building materials play a vital role in increasing energy efficiency and promoting urban sustainable development.

With its own strengths in construction chemicals, BASF actively participates in

and contributes to the development of the sustainable construction industry worldwide, committed to creating a sustainable future for our planet. At the 2010 Shanghai World Expo, BASF provided an insulation solution for Hamburg-house, the first passive house in China.

In November 2015, the second phase of the BASF Innovation Campus Asia Pacific (Shanghai) was inaugurated. Using the DGNB¹ and LEED² standards in design, construction and operation, the project has fully leveraged BASF's innovative construction materials to create a sustainable building at the BASF Greater China headquarters in Pudong.

“The second phase of the BASF Innovation Campus Asia Pacific (Shanghai) adopted a series of cutting-edge construction materials and solutions by BASF, creating an eco-friendly, safe and pleasant working environment for our employees,” said Ma Shouwang, Senior Manager of Industry Team Construction China, BASF.

Safe and durable from the top down

As roof waterproofing quality impacts the durability of an architectural structure and the life of a building, it is a significant process in construction. BASF's MasterSeal[®] waterproofing system does an excellent job on the roofing of the new R&D building in the second phase of BASF Innovation Campus Asia Pacific (Shanghai) and the Cube Canteen. MasterSeal[®] system forms a monolithic membrane that is fully bonded to the roof substrate after curing, protecting the building like a huge umbrella without leakage.

Produced with BASF raw materials, the MasterSeal[®] spray applied polyurethane waterproofing system was created in an environmentally friendly nature. It has excellent elasticity, UV resistance and weather resistance, and can withstand corrosion and structure movement caused by exposure to bad weather. A building, therefore, will have



BASF's advanced construction materials and solutions are used in the second phase of the BASF Innovation Campus Asia Pacific (Shanghai).

longer life and lower needs for maintenance. Even when the membrane is damaged somewhere, water will not track underneath and the leak can be quickly found, improving maintenance efficiency and lowering maintenance costs.

Leaking in bathrooms is one of the most common problems found in buildings. The new R&D building and the Cube Canteen use MasterSeal[®] cementitious waterproofing coating. It adapts to a wet substrate and provides a good interface for tiling and other decorative coatings. It also has the flexibility to resist structure movement caused by temperature changes and other factors. It is ideal for waterproof application in bathrooms, kitchens, balconies and pools, like a reliable dam for the building.

With chemistry labs on the premises, the new R&D building has a special and cautious need for a flooring system. According to Ma, chemistry labs require outstanding performance in resisting corrosive chemicals, impact and wear load. They should also be slip-resistant and easy to clean; a traditional flooring system won't qualify.

Ucrete[®], an industrial flooring system that is more than 40 years old, is popular within the industry. It is often known as “the toughest industrial flooring in the world”. Not only does it meet the above-mentioned criteria but also satisfies all emission requirements for indoor flooring systems in Europe. Ucrete[®] is durable, environmentally friendly and thus being used on the grounds of the new R&D building.

Moreover, Ucrete[®] performs brilliantly in slip resistance. Since it does not cause biodegradation or breed bacteria or fungi, it can be as clean as stainless steel. Therefore, the floor of the Pudong Cube Canteen uses Ucrete as it is easy-cleaning, attractive, safe, reliable and comfortable to walk on.

The Ucrete[®] flooring system has attracted

the attention of the food and beverage industry in recent years, in addition to the chemical and pharmaceutical industries. As the food industry requires a clean and germ-free manufacturing environment, chemical substances are often used to clean floors and hot water to kill germs. Traditional floors, as a result, have to be replaced and renovated every year or two.

Ucrete[®], with no such worries, has been very important in the food safety system. In China, it has been chosen by well-known companies such as Coca-Cola, Pepsi, Yurun Group, Charoen Pokphand Foods, Nestle Group, Want Want Group, Wanglaoji and Yili. Meanwhile, Ucrete[®] is highly valued in the pharmaceutical and chemical industries and others that require durable flooring.

Comfortable and green inside and outside

The Finestone[®] wall thermal insulation and finishing system was used on the exterior walls of the second phase of the BASF Innovation Campus Asia Pacific (Shanghai). The multi-layer thermal insulation system is not only highly decorative but is protective with good thermal insulation and weather resistance. In addition to functionality, it comes in a wide range of textures, colors and patterns.

The Finestone[®] rock wool thermal insulation system is applied to the exterior walls. In winter heat is prevented from moving outward, while in summer heat is shielded from the outside, making the building energy efficient for all seasons with low energy consumption and carbon emissions. This innovative thermal insulation system also meets Grade A fire prevention requirements: it will not combust, even in a fire, making a building much safer.

During the construction process, thermal boards are glued to exterior walls with the Finestone[®] Adhesive & Base Coat. The product is highly capable of being adhesive, flexible, efficient, air-penetrating and waterproof.

The exterior wall finishing of the Innovation Campus features Finestone[®] STONELOOK coating products, which take on a stone-decoration appearance yet lower the consumption on natural resources. It also avoids pollutions to the environment brought by stone processing, and saves a large amount of manpower and facilities that may be needed in stone installation.

The interior walls of the building use the latest Finestone[®] water-based coating, which is not only anti-bacterial and anti-fungal but also emits zero-VOC (volatile organic compound) and formaldehyde³. It is odorless and environmental friendly, ensuring the health and safety of employees. Moreover, Basotect[®] acoustic insulation foam should be given credit for the quiet and comfortable environment inside the building since its brilliance in sound absorption and fire resistance improves the acoustic environment inside the rooms.

Balance and optimization to set an example

The R&D building in the second phase of the BASF Innovation Campus Asia Pacific (Shanghai) is the first research laboratory building in China that has been constructed according to the DGNB standard and LEED certified. To be certified as a green building, however, is not the only goal of this project.

According to architect and DGNB auditor Rolf Demmler, Director of SoftGrid (Shanghai) Co, Ltd, the DGNB standard is a tool to optimize the design, construction and operation of a building. It focuses holistically on evaluating the ecological, economic, functional, technological and social performances of a building as its major goal.

“DGNB focuses on the integration and optimization of architectural projects, and prefers balancing among all indexes,” said Demmler. “BASF products are not only outstanding and environmentally friendly but are also equipped with a series of complete and professional systematical documentation, which is extremely helpful to the implementation and application of DGNB certification of the Innovation Campus in Shanghai.”

With a premise that the project is reasonable in budget, achievable in schedule and safe in operation, the second phase of the BASF Innovation Campus Asia Pacific (Shanghai) has optimized ecological performance, achieved a high level of energy saving and environmental protection results and created a comfortable and healthy architectural environment.

The application of BASF building materials, meanwhile, has changed traditional construction methods so that construction efficiency has been greatly improved and post-phase maintenance costs are reduced.



“BASF products are not only outstanding and eco-friendly but are also equipped with a series of complete and professional systematical documentation, which is extremely helpful to the implementation and application of DGNB certification of the Innovation Campus in Shanghai.”

Rolf Demmler,
architect and DGNB auditor, Director of
SoftGrid (Shanghai) Co, Ltd

In terms of comprehensive performance and cost perspectives, the second phase of the BASF Innovation Campus Asia Pacific (Shanghai) features more advantages than ordinary buildings.

While the Ucrete[®] flooring system costs more than the traditional solution, for example, it lasts for at least 20 years, over 5 times that of the latter. The total cost, therefore, is significantly lowered.

“Thanks to a series of advanced BASF chemical building materials solutions, energy consumption and carbon emission have been greatly reduced,” said Ma. “The second phase of the BASF Innovation Campus Asia Pacific (Shanghai) is a great example of BASF successfully balancing the economic benefits and social and environmental responsibilities.”

¹ DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen e.V., i.e. German Sustainable Building Council) is a system describing and evaluating building sustainability developed jointly by German Federal Ministry of Transport, Construction and Urban Development.

² LEED (Leadership in Energy and Environmental Design) is a green building certification program established and implemented by the United States Green Building Council.

³ Zero-VOC and formaldehyde: no volatile organic compound or free formaldehyde is tested based on the standard of GB18582-2008.

NAO: accelerating open innovation through successful science collaboration



“Entrepreneurship, creativity and collaboration are the main factors of successful innovation.”

Dr. Harald Lauke,
President, Advanced Materials & Systems Research, Regional Research Representative Asia Pacific, BASF



BASF fully utilizes its strength as the world's leading chemical company to continuously invest in innovations to introduce sustainable solutions into the market. To expand research and innovation in Asia Pacific, BASF is closely collaborating with the region's top universities and institutes within the platform of the Network for Advanced Materials Open Research (NAO). Established in March 2014 in collaboration with leading universities and research institutes in China, Japan and South Korea where this BASF Postdoctoral Research Center in Asia Pacific initiates, NAO negotiates and establishes the legal framework of R&D collaborations with the universities thus facilitating the access between BASF researchers and academia in Asia.

Open Research – a triple win for participants

As part of BASF's global collaborative network with the scientific community, NAO aims to foster open innovations by providing a regional platform for BASF scientists to work together with academics from top Asian universities on material science, modeling and synthesis methods.

"Entrepreneurship, creativity and collaboration are the main factors of successful innovation," said Dr. Harald Lauke, President, Advanced Materials & Systems Research, Regional Research Representative Asia Pacific, BASF. NAO integrates the three factors, supports and promotes close collaboration in the field of advanced materials research, enabling all partners to extend their scientific horizon to develop sustainable solutions.

An important aspect of the open research concept is that BASF is connecting experts from different countries to form a dynamic collaborative platform for exchanging ideas and co-creating new solutions. For academic researchers, BASF's know-how of the industry and market trends, as well as its rich experience in translating research results into products and processes, means a lot to them. "Open Research provides a channel between industry and academia," said Prof. Yongfeng Men, Changchun Institute of Applied Chemistry (CIAC), Chinese Academy of Science. "Collaborating with BASF helps in the justification of our research directions, and translates research results to products and industry processes. This brings a great

sense of achievement for people from academia."

Claudia Staudt, Senior Manager of Scouting and Open Research Center Asia Pacific, said her work aiming to build a strong regional cluster with interaction between industry and academia. "Frequent discussions and face-to-face meetings like the biannual NAO days enable us to provide an ideal surrounding for post-docs further developing themselves in a highly motivated community that accelerates the transfer of innovation to products," said Claudia.

With hands-on experience through the NAO projects, postdoc students have the opportunity to discuss and exchange ideas with BASF researchers and professors from top universities and institutes, helping lay the foundation to become potential industry researchers. Xiaohui Li had successfully developed his scientific and personal competencies within NAO during his postdoc, and was hired at BASF in Shanghai in January 2016. "NAO is like a bridge between the universities and the company, also connecting my past experience with future career opportunities," he said.

Fruitful results with broad prospects for cooperation

Over the last two years, professors, postdoc students and BASF researchers have been working together on 28 projects through the NAO platform. In a project with Hanyang University, Seoul, for example, researchers worked on the fatigue life prediction of wind turbine blades of composites to provide an effective analysis tool for blade design in the wind industry. Another project with the Chinese University of Hong Kong aimed at developing a novel process to produce non-sticky solid particles from a liquid, which will be useful for the construction industry.

In 2014, the first transfer of the key results from some projects to the business units was completed. Currently, there are 13 active projects operating with focus on coatings, composites, functional polymers and additives.

Experts in polymer physics modeling from Fudan University, for example, are working on a collaborative project with BASF in the field of nano-hybrid PU/Polyacrylate systems. The project team has already reached a significant milestone and developed a powerful tool to optimize formulations for coatings and insulation applications. This multidisciplinary approach combining modeling and experimental work was the key factor for success.

"An important source of innovation, cooperation with outstanding scientists via the NAO platform, enables BASF to gain access to new technologies and explore new business areas," said Dr. Sébastien Garnier, former Senior Manager of Scouting and Open Research Center Asia Pacific, BASF. "NAO has become an important bridge between BASF and the academic community in Asia Pacific. I believe with our continuous efforts we are expecting more creative and viable ideas from this network in future."

"I really appreciate our partnership in the NAO project. BASF shows the commitment and dedication of long-term vision, and an open mindset towards diversity," said Prof. Feng Qiu from the Department of Macromolecular Science of Fudan University. "I look forward to a long-term collaboration between my department and BASF. I believe this will bring win-win to both parties."



“I look forward to a long-term collaboration between my department and BASF. I believe this will bring win-win to both parties.”

Prof. Feng Qiu,
Department of Macromolecular Science of Fudan University

Nurturing close cooperation with leading universities and institutes around the world is essential to BASF. The BASF Postdoctoral Research Centers around the world are proven to be effective in connecting external expertise with BASF researchers.

BASF Postdoc Centers

- "California Research Alliance" (CARA) in the United States
- "Joint Research Network on Advanced Materials and Systems" (JONAS) in Europe
- "North America Center for Research on Advanced Materials" (NORA)
- "Network for Advanced Materials Open Research" (NAO) in Asia

Discover, connect and develop: professors and students sharing experience at NAO

BASF information: What are the benefits of Open Research and the NAO platform?

Prof. To Ngai, Chinese University of Hong Kong: Open Research provides a very good opportunity to initiate cooperation between academia and the industry. It motivates scientists, postdocs and students to contribute their value and work together to discover solutions to real and important problems. Postdocs and students can develop their skills and become better prepared for their future career through their experience working with BASF.

Prof. Feng Qiu, Fudan University: Our NAO project gives our students great training to learn the standard operation procedure of solving technical challenges within a business context. It also offers a

great opportunity for them to learn how to effectively communicate and collaborate with a cross-function team and stakeholders. Such experiences are critical to preparing the students to move from an academic role to an industry role smoothly.

Huanhuan Gao, a postdoc student participating in a project at Fudan University for six months at NAO: I cherish the opportunity to connect with BASF scientists and be part of experiments from raw materials to final products in BASF labs, which is very different from the academic labs and theoretical models that I am familiar with. I am working in an interdisciplinary and cross-country team for this project where cooperation and idea exchange are keys to the success.

Luliia Konko, a new member of the NAO family who is conducting a postdoc research project at Changchun Institute of Applied Chemistry: the project I am working on perfectly matches with my

scientific expertise. I am highly motivated to drive innovation in applied research and have decided to move from academia to industry. I hope to work on a wider range of topics and to solve real-world challenges.

BASF information: How do you think of BASF as an innovation partner?

Prof. Mitsuo Sawamoto, Kyoto University: BASF is a very good partner for us with its longstanding interest in fundamental research applied for particularly innovative products.

Prof. Yongfeng Men, Changchun Institute of Applied Chemistry (CIAC), Chinese Academy of Science: BASF is a great innovation partner. Scientists at BASF know exactly what the most important pre-competition research topics are, and how to translate the research results into the industry processes with communication with the research partners in the university.

Roots Operators: fostering the best apprentice

Clad in working suits, moving among the various devices, students of the 2015 BASF Class were having a lesson on chemical devices operation when we visited the Shanghai Petrochemical Academy (SPA). In a large area were devices and equipment that usually can only be seen in the chemical factories.

On a summer afternoon, Ruan Jialei, a post-95 boy who had just finished his practical training session, smiled and asked, "Do I look like rustic in the working suit? But I have great sense of achievement every day."

Dual-track vocational education forges craftsmanship spirit

In September 2015, 21 young people, all of a similar age to Jialei, joined BASF's new operator apprentice program at SPA in Jinshan District, Shanghai. At school, teachers usually call them students of BASF Class. At BASF, the program goes by the name Roots Operators.

Roots Operators is the second Roots program introduced by BASF in China following Roots Laboratory. It aims to recruit students from petrochemical schools with two years of fundamental study experience. It provides them with one year of further studies on production-related topics defined by BASF and a one-year internship at the BASF site. Qualified candidates will be hired as BASF production operators after finishing the program.

"The idea for the Roots Operators apprentice program is based on our long-term need for a great number of well-trained production operators, especially for the new investment projects we are currently planning and implementing in Jinshan and Pudong, in addition to the needs of the existing plants," said Dr. Xue Congjun, Vice President Operations and Site Management, at the Pudong and Caojing sites, Greater China. "It is estimated that Roots Operators will supply five percent of the fresh blood for the front-line production operator team of BASF Pudong site and Caojing site every year."

"Through the Roots Operators program, we will support more young talents who are committed to operations in the chemical industry by providing them with a professional education that also includes a lot of practical training

elements," explained Dr. Lars Reichmann, the former Vice President, Human Resources, Greater China, BASF. "Like a tree with strong roots to grow and gain stability, they can start a long and stable career in BASF and become the foundation of BASF's safe and highly efficient production network in China."

Although vocational education is no longer novel in China, the quality of vocational education varies in different places around the country. In Germany, however, vocational education has enjoyed a long history. Helmut Kohl, the former German Chancellor, even called the dual-track vocational education mode the secret weapon of the country's post-WWII rise. This cooperation between companies and schools can cultivate students' specific skills based on companies' needs, combine practical skills and technical knowledge required by companies with theories and general knowledge taught by schools, and therefore, stably provide good professional talent. This valuable experience in Germany could be leveraged in China to make up the gap between school education and company needs as well as address the possible unemployment of graduates.

Roots Operators is a tailor-made, dual-track vocational education program jointly undertaken by BASF and SPA. It fosters young production operators for BASF through training, combining theory with practice. "Leveraging the same philosophy of the renowned apprentice programs in the Ludwigshafen headquarters and other international BASF sites, Roots Operators provides both theoretical and practical training, preparing all candidates for a future job in one of the BASF's modern chemical sites in China," said Dr. Reichmann.

"We believe Roots Operators can make more Chinese students experience German 'craftsmanship spirit', that is dedication and continuous improvement," added Dr. Xue. "The program can not only create an all-win situation for BASF, the school and students, but also sets a good example for vocational education in China."

Internationalization of school-company cooperation



"Roots Operators can make more Chinese students experience German 'craftsmanship spirit', and set a good example for vocational education in China."

Dr. Xue Congjun, Vice President, Operations and Site Management at the Pudong and Caojing sites, BASF Greater China

The successful collaboration between BASF and SPA dates back more than a decade, when a BASF Class was initiated in 2005 and 2006 at SPA with courses especially designed for BASF to support the ramp-up of the Caojing site.

Now, based on previous cooperation with SPA, BASF engages bbz Chemie (a BASF's specific education institute in Germany) to design training modules of Roots Operators. The training takes into consideration differences between the German and Chinese education systems with the focus on BASF's needs and in integrating the experiences and teaching methods of the German apprentice programs that are focused on practical experiences.

In addition, with the coordination of BASF, SPA and bbz Chemie, teacher exchanges are regularly held to broaden the teachers' horizons and to continuously improve the tailor-made lessons and their international levels. Students can gain more practical operating experience and be confident that they will become qualified operators after completing the training.

By example, materials for "Chemical English" are jointly compiled by BASF and SPA. They cover both intensive reading and extensive reading and highlight those related to devices and technologies of BASF. The Chemical Device Operation course is a practical training session especially designed on the discussions among BASF, SPA and bbz Chemie. This close collaboration enables students to acquire professional skills needed in practice through

lessons in the classroom and helps them better adapt to a multi-language and multi-culture work environment in the future and develop a more international mindset.

According to Victor Lv, who is responsible for daily operations of the Roots Operators program, over the past year of the program's implementation, in adhering to the concept of "inviting in and extending out" BASF has been active in cooperating and communicating with SPA and bbz Chemie to facilitate the smooth development of the Roots Operators program. BASF keeps in close contact with SPA and follows up on the dual-track training quality of both teachers and team leaders from BASF. Production experts from BASF and employees graduated from SPA will go to the campus every month to audit the lessons of the BASF Class, discuss the teaching program with teachers, share with students the device operating principle and give them a general introduction about BASF. Education officials from Jinshan District and teachers and students from SPA are also invited to visit the BASF Caojing site so that they can experience the clean production environment and the latest news of the site personally. These activities in China will also be updated to bbz Chemie via regular conference calls during which the feedback from bbz Chemie is received.

"We hope to invite some industry experts from companies with high professional levels who are enthusiastic about vocational education to come to our school and give lectures or participate in the school's academic construction," said SPA Principal



"We hope to invite some industry experts from companies with high professional levels who are enthusiastic about vocational education to come to our school and give lectures."

Lin Guoxin, SPA Principal

Lin Guoxin, "This will facilitate the healthy development of all training sessions, accelerate our education level towards internationalization and better cultivate professional talents."

According to Mr. Lv, in addition to recruiting schools from SPA, BASF is also proactively exploring ways to re-educate its employees. This summer, 30 operators working at the BASF plant took part in a summer camp organized by SPA especially for BASF, for further education and development at school.

From cocoon to a butterfly

As the new generation pays more attention to their career development when choosing a job, salary is no longer the sole criterion. They dare to voice their ideas and face unknown challenges, which is no doubt helpful to improving their status of technical talents and creating a broader platform for their growth.

Speaking of why he chose the Roots Operators program, Jialei said that apart from BASF's reputation as a global leading chemical company, he was attracted more by the training models and all the possibilities in his future career with the company. Dr. Xue noted that some of the students of the BASF Class from 10 years ago have now become senior engineers and assistant managers – the backbone of BASF.

"BASF's emphasis on safety impresses me most. Every person in charge of every device will highlight safety rules and regulations," added Jialei. "We must wear personal protection equipment properly in strict accordance with EHS requirements before entering plants. The international level of BASF is fully revealed in detail."

"Operators attached great importance to the company's safety standards and life-long learning opportunities," said Dr. Reichmann. "BASF's employee learning and development programs, as well as experienced colleagues, will support these young talents from the Roots Operators program to further develop themselves. They also have the opportunity to transfer to other production sites that BASF has around China."

Roots Operators is only the first stop of the professional careers for these young people. Soon, Jialei and his classmates will enter the real battlefield. He has pictured his future blueprint in his mind for long, "I will study hard and become be a production supervisor as soon as possible!"



"Like a tree with strong roots to grow and gain stability, these young talents committed to operations in the chemical industry can start a long and stable career in BASF."

Dr. Lars Reichmann, the former Vice President, Human Resources, Greater China, BASF

To 2015 "Roots Operators"

BASF information: What do you expect of the first graduates from the Roots Operators program during their internship and future career at BASF?

SPA Principal Lin Guoxin: For SPA, we hope they can become qualified and outstanding employees at BASF where they can demonstrate their professional skills and create more value for the company.

Dr. Xue Congjun: I hope they can make full use of the one-year internship to earnestly learn professional knowledge and skills and complete the transition from students to operators. In addition, they must strictly comply with operating regulations and recognize BASF's corporate culture. I hope they can all join BASF in the next year and through hard work they will be able to independently undertake more important jobs.

Dr. Lars Reichmann: We expect them to continue to learn during their journey with BASF. They have already shown their good performance and their eagerness to learn during the time at school and now they will learn in a new environment in our sites, with our colleagues. If they will be as committed to learn and engage in the BASF activities and from experienced and committed BASF colleagues at the sites as they were in SPA, this will be a very successful start into their BASF career. Our colleagues will be more than happy to have them around as new and well-qualified members of the BASF family.

Promoting Responsible Care in China



“More and more companies in China’s chemical industry have realized the contributions made by Responsible Care, and have committed to the system. We feel very much encouraged.”

Charlie Zhang,
Head of Responsible Care, Greater China, BASF

The deadly explosion at Tianjin port in 2015 did a great deal to raise public awareness in fire prevention and safety management in China.

Yet, 30 years ago, the international chemical industry was already thinking about the impact of industrial chemical accidents on the environment. In 1985, the Canadian government initiated the idea of Responsible Care. In 1992, the International Council of Chemical Associations (ICCA) gradually started promoting this concept worldwide; multinational chemical companies, one after another, began incorporating Responsible Care into their business-development goals and business policies.

Responsible Care is a program voluntarily initiated by the global chemical industry where participating companies are committed to improving their performance in protecting environment, health and safety (EHS), as well as disclosing information about their products and processes to stakeholders, thus building a new image of the chemical industry in the society, and driving the sustainable development of the global chemical industry.

As a practitioner and advocator of Responsible Care, BASF leads by example in China, practicing the principles in the company’s daily operations. Moreover, BASF assists relevant government agencies and communities in

building a strong emergency response team to further promote the implementation of Responsible Care in the China chemical industry.

The start of Responsible Care in China

As a co-initiator of the *Responsible Care Global Charter*, BASF was among the first multinational companies to share the concept with the Chinese government and the nation’s companies.

In 2008, Zhang Dejiang, who was the Chinese Vice Premier at that time, visited BASF in Ludwigshafen during his visit to Germany. Dr. Jürgen Hambrecht, who was Chairman of the Board of Executive Directors, BASF SE, introduced in detail what the company had achieved in regard to Responsible Care.

In the 1960s and 1970s, Germany’s Rhine River was polluted by industrial waste water. Mannheim and the Ruhr Industrial Site were shrouded in fog and haze, and incidents occurred frequently at chemical plants.

With the adoption of the concept of Responsible Care by BASF and other German chemical companies as one of their key development strategies, the polluted water began to become clear, and the once-hazy sky turned blue gradually. The casualty rate in incidents at BASF plants decreased, from an average of more than 20 fatalities annually in the 1970s to zero after 2000 due to the process safety.

Vice Premier Zhang showed strong interest in Responsible Care after listening to the BASF presentation. Upon returning to China, he started, and eventually facilitated, the China Petroleum and Chemical Industry Association (CPCIF) to launch and promote Responsible

Care in the country’s chemical industry.

As a key member of the CPCIF, ICCA and the Association of International Chemical Manufacturers (AICM), BASF actively promotes Responsible Care in China. It plays an important role in the areas of emergency response, dissemination of chemical-related laws and regulations, and public communication. BASF’s outstanding performances have been recognized by the relevant authorities throughout the country.

In 2014, BASF was granted the “Responsible Care Organization Award” by CPCIF. The following year, BASF received the “Responsible Care Chairman Award” by AICM. In Taiwan, a BASF site received an award from the local municipal government for its great contribution to Responsible Care, while a site in Shanghai was named the “Advanced Enterprise for Energy Saving and Emission Reduction”. That same year, the BASF site in Nanjing was nominated by Nanjing Chemical Industrial Park as one of the most advanced units in the area of safety.

In September 2015, Dr. Kurt Bock, Chairman of the Board of Executive Directors, BASF SE, presided over the Responsible Care Global Charter Signing Ceremony in Shanghai. Documents signed by more than 400 Chinese chemical enterprises were delivered from CPCIF to ICCA, underlining the collective commitment of Chinese chemical companies to Responsible Care.

“Responsible Care has helped to establish the standards in the global chemical industry,” said Charlie Zhang, Head of Responsible Care, Greater China, BASF. “Through years of efforts made by BASF, more and more companies in China’s chemical industry have realized the

contributions made by Responsible Care, and have committed to the system. We feel very much encouraged.”

Care about neighbors and communities

Increasing community awareness is important for practicing Responsible Care in the chemical industry. BASF actively communicates with the community where it operates, maintains information transparency, conducts open dialogues, supports the construction of communities, and assumes social responsibilities.

BASF has 84 Community Advisory Panels (CAPs) globally, primarily at larger production sites. Consisting of individuals who live near a chemical facility and who represent the fabric of the community, a CAP is a forum for open and transparent dialogue between citizens and plant management. In Greater China, BASF supports CAPs in Shanghai, Chongqing, Nanjing and Taiwan.

Through CAP, BASF regularly conducts open dialogues and Site Open Days. In addition to project briefings and operations introductions, BASF also organizes discussions on topics relating to the interest of local communities, such as environment, safety and employment, maintaining relationships with local communities and enhancing mutual trust.

BASF has a stringent EHS self-supervision and appraisal system and a sound emergency response system. It regularly conducts internal training on dangerous goods emergency response. Moreover, it has established a long-term and extensive exchange mechanism with the external environmental protection authorities, fire prevention authorities and chemical industrial parks, sharing its EHS management and practice experience with peers and neighboring chemical companies. In 2015, for example, BASF shared best practices in Responsible Care with EHS management from multiple Chinese chemical companies in the Shanghai Jinshan Second Industrial Zone.

“BASF actively fulfills corporate social responsibility and supports government authorities in the areas of safety and environmental protection,” said He Xinyuan, Chief Representative, Shanghai, BASF (China) Co., Ltd. “We hope to lead the implementation of high EHS standards in China’s chemical industry, improve transparency and communication with our neighbors, improve emergency response capabilities, and benefit the industrial parks where we operate and the residents of the neighboring communities.”

According to Zhang, in order to exchange BASF Emergency Response know-how, as well as to foster further cooperation within the Transportation Accident Information and Emergency Response System – a network formed by government entities and companies in Germany – BASF invited delegates from the Shanghai Administration of Work Safety to visit BASF Ludwigshafen in 2015. There, they shared the rich experience of BASF’s fire-control team with more than 100 years’ history and exploring the emergency response mechanism for chemicals.

When they returned to Shanghai, the delegation immediately began working on the implementation of the emergency response mechanism, and asked BASF to provide relevant support to improve the knowledge of dangerous chemicals and emergency-response capabilities of relevant personnel.

With the support of the Shanghai Fire Department, BASF cooperated with Shanghai Chemical Industry Park Administrative Committee and its fire brigade to establish its own professional fire prevention team within the plant, experimenting with new measures and approaches, and establishing best practices in emergency response.

In September 2015, a national-level comprehensive drill on special equipment safety was conducted at BASF’s Caojing site. It was the first time that the Shanghai municipal government had held such a synergistic drill between government and companies in a chemical production facility. More than 100 participants, from the Shanghai Chemical Industry Park (SCIP) Emergency Response Center, Medical Rescue Center and BASF, attended.

Advanced equipment makes contribution

In 2015, BASF donated a specially designed environmental protection vehicle equipped with specific instruments to monitor air pollutants to the Shanghai Chemical Industry Park (SCIP) in Caojing, supporting the SCIP Administrative Committee to conduct better daily environmental monitoring and emergency handling.

In Chongqing, BASF donated a brand new hazmat truck – a firefighting engine customized to handle different types of hazardous materials – to the public firefighting station at Changshou Economic & Technological Development Area (where BASF Chongqing MDI plants are located) for containing, collecting and cleaning up hazardous materials, particularly dangerous chemicals. It was the first such vehicle owned by a public firefighting station in Changshou.



“We hope to lead the implementation of high EHS standards in China’s chemical industry, improve transparency and communication with our neighbors, improve emergency response capabilities, and benefit the industrial parks where we operate and the residents of the neighboring communities.”

He Xinyuan,
Chief Representative, Shanghai, BASF (China) Co., Ltd.

Furthermore, BASF fully leverages its technical know-how and keeps innovating in fire-fighting and fire protection to improve fire protection capabilities globally.

Fire prevention helmets made of Ultrason® and Ultramid® thermoplastics are light and comfortable to wear. This helmet has a working temperature of up to 220°C, has excellent inherent flammability properties and good impact strength, helping to protect the head and neck of firefighters from falling debris, hence protecting their lives. Thanks to Ultrason’s high light transmission, firefighters can see the surroundings clearly through the transparent face mask even in harsh conditions.

The high-pressure firefighting hose made with BASF’s Elastollan® thermoplastic polyurethane lasts longer and resists punctures and abrasions. Elastollan® is applied on the top and hot-melt lining layers of the hose. Elastollan® provides an impressively high burst-pressure rating, yet it also ensures a high degree of flexibility for kink resistance and ease of coiling. It can also be stored wet without rotting and can resist exposure to sunlight and chemicals.

“Advanced and reliable technical equipment ensures the improvement of emergency response handling capabilities,” said Haibing Yue, Manager, Emergency Response, Responsible Care, Greater China, BASF. “Only in this way can the emergency response team have good protection and handle emergencies more effectively.”



Dr. Kurt Bock presided over the Responsible Care Global Charter Signing Ceremony in Shanghai.

Dark horses in the laboratory



“What I really like about this idea is the team spirit behind it. Their proposal succeeded because of its originality and interdisciplinary collaborations.”

**Dr. Piyada Charoensirisomboon,
Vice President, Innovation Campus Asia
Pacific (Shanghai), BASF**

For both BASF and Adam Lu, who joined the company three years ago, 2015 marked a year of opportunities and challenges.

An invitation letter from Germany at the end of last year still lies in Adam's email box. Along with his teammates, Adam was invited by BASF's top management to attend the final pitch for the Urban Living Idea Contest in Ludwigshafen, the company headquarters in Germany.

The contest was a co-creation program launched by BASF during its 150th anniversary year, where employees around the world were encouraged to submit creative ideas on the topics of “air, transport and water”. After a round of voting, followed by idea selections by a panel of experts, 10 teams qualified for the final pitch wherein they would present their ideas directly to the jury composed of the BASF board of executive directors and Presidents.

The idea proposal of “how to save water during washing”, submitted by Adam and his team members, stood out among the 142 ideas collected globally. On the stage during the final pitch, they were the youngest team on the day. Their idea, however, was recognized and appreciated by the audience, winning not only the highest honor but also the financial sponsorship to implement their project.

The team regarded their experience of participating in the celebration of BASF 150th anniversary as an incredible adventure. Their success from “just an abstract idea” to “a

dream coming true” may be recorded in the BASF history.

Cross-department cooperation

Adam attributed his inspiration to a common experiment conducted during his daily routine. After discussion with Lucy Cai, Scott Shuai and Jerry Shen, who also worked in the Shanghai lab, they hit it off instantly and decided to start preparations of the proposal for the Idea Contest.

“The team atmosphere of our lab has always been good. We love to discuss the problems and difficulties during our R&D work,” said Jerry. “Others’ directions can often enlighten you.”

Encouragement for the project was in abundance. Sébastien Garnier, former Senior Manager Care Materials Research, BASF, had greatly encouraged his teams to participate in the Idea Contest from the beginning and supported its further development. He helped the team improve their proposal and the planning of the next step. “We should evaluate the commercial feasibility of the overall business model of this project and technically focus on the product development with a more specific direction,” said Garnier.

After passing the preliminary selection, they immediately involved more colleagues from the Care Chemicals business unit and researchers in Singapore to perfect the proposal. “During the preparation, our close cooperation and communication with colleagues from the business unit provided us lab technicians with the opportunity to get to know first-hand market insights of products. It broadened our horizon and mindset and made our proposal more consistent with the market requirements with more business prospects,” Jerry said.

“We were like dark horses in the lab,” Adam said of the win. “We are certainly lucky, but I believe it is not pure luck. We studied relevant documents and made great efforts after our daily routine work in the lab. Our colleagues from different departments also helped a lot. The award belongs to the whole team.”

After Adam and his team won the contest,

150 years of BASF

Innovation, based on knowledge and technology, has been the driving force in the growth of BASF during the past 150 years. From the revolution in food production brought about through the Haber-Bosch process to our most recent research efforts on energy-efficiency optimization, we help all industries to meet the demands of today and tomorrow with science and innovation.

To celebrate 150 years of BASF, in 2015 we organized an around-the-world tour bringing together the creativity and minds of scientists, customers, employee and partners to explore and discuss cutting-edge trends in science to “co-create” solutions to tackling future challenges.

a busy time began: three workshops took place in Shanghai, Wyandotte and Ludwigshafen to gather ideas on how to save water during washing. “It was amazing how many colleagues worldwide contributed with their ideas and expertise, in order to support Adam and his team”, said Claudia Staudt, Senior Manager Care Materials Research, BASF. “Together, with the colleagues from the business unit, we will foster evaluation and clustering of the ideas to enable the team starting with the technical feasibility.”

“What I really like about this idea is not how perfect it has been, but the team spirit behind it,” said Piyada Charoensirisomboon, Vice President of Innovation Campus Asia Pacific (Shanghai), BASF. “These young colleagues are really leveraging our regional research platform to connect with people and get inspired. Their proposal succeeded because of its originality and interdisciplinary collaborations.”

Interaction among platforms

In addition to becoming the superstars of the Urban Living Idea Contest, the team, who usually can be found in the labs, actively took part in many of the other activities celebrating BASF's 150th anniversary.

3 themes: Urban Living, Smart Energy, Food

Global tour:

- 6 Creator Space™ tour stops: Mumbai, Shanghai, New York, São Paulo, Barcelona, Ludwigshafen
- 3 Science Symposia: Ludwigshafen, Chicago, Shanghai
- 1.4 million visitors at 50 co-creation activities in 25 countries

The global corporate volunteering contest “Connected to Care”, an important part of Creator Space™, connected ideas, discussions and activities during the anniversary year. In the competition, BASF employees teamed up with colleagues, friends, family members and a non-profit organization to propose local, charitable projects related to one of the three anniversary

“Taking part in activities that seem not relevant to our daily work truly benefitted us a lot,” said Jerry. Both Adam and Jerry joined the preparations for the Shanghai session of BASF's Global Science Symposium. “Taking a break from pure product R&D helps us to know other aspects of the industry. This is also an opportunity that BASF gives to young people.”

At BASF Creator Space™ science symposium, top scientists and urban designers gathered in Shanghai to share and exchange their latest insights on sustainable urban life. “This is the first time for me to meet so many academic giants. There were even Nobel Prize winners. The spirited discussion provided us with a lot of inspiration,” Jerry said. “Interaction among multiple platforms also expanded our connections, which helped us to participate in the Idea Contest and become the final winners.”

Grow with BASF

After being crowned the winners of the Urban Living Idea Contest, the team has now been granted with the financial support to make the project move forward. “Loads of work still needs to be done to make our vision come true. We need to conduct a deeper market research,” said Adam. “Numerous



themes. About 35,000 employees worldwide voted on more than 500 projects to generate 150 winners. Eight projects from Greater China were among the winners.

The “IBIN smart dustbin” project, co-developed by BASF employees and IFINE, a Shanghai-based non-profit organization committed to promoting waste management in cities, was one of the winners. The team designed a smart dustbin with a voice-recognition module to coach people on how to segregate waste correctly and to raise their awareness and develop their habits in waste segregation. In June 2016, the smart dustbin was produced and debuted to the public.

challenges lie ahead. However, with the necessary resources and support, we are all very optimistic about its future.”

BASF is committed to fostering a culture of innovation in Asia Pacific by constantly expanding its research facilities. In 2012, the Innovation Campus Asia Pacific in Shanghai was inaugurated and in November 2015 completed its phase II expansion. With the research focused on advanced materials and systems, it is emerging as an important global research hub that connects with local customers and academia partners.

“We have been encouraging our researchers to better utilize the labs and world-class facilities at the Innovation Campus to hatch ideas, and to form interdisciplinary partnerships for creative solutions,” said Piyada. She believes that Asia Pacific will present more innovative ideas and solutions to meet the regional and global common challenges in the near future.

“These innovative products will probably be launched to the market in a few years,” said Adam. “I will be proud to tell my family and friends that this is the result of my work very soon after I began my career at BASF.”



Winner team of the Urban Living Idea Contest (from left to right): Scott Shuai, Jerry Shen, Shushu Ding, Dr. Parag Kulkarni, Lucy Cai and Adam Lu.



Dr. Hans Reichert (center), head of colorants research at BASF, reviews application samples of the red color filter pigment with colleagues Ger de Keyzer (left) and Dr. Roman Lenz (right).

Flat screens show their true colors

Innovative pigments from BASF improve television image quality

16.7 million colors are required for high-quality screen images with true color depth.

135 billion US dollars is the estimated value of the global flat screen market predicted for 2020. Source: fmi (future markets insight).

40 nanometers about a thousand times smaller than the diameter of a human hair: the size of each color particle.



A few grams of a red DPP-based color filter pigment immediately after synthesis in the lab. The pigment is produced by the ton following a production scale-up.

Cathode ray tube television sets have long had their day. Flat screen TVs now provide energy-efficient, low-emission entertainment in three out of four German households, according to the Federal Statistical Office. And this figure is rising, Germans are estimated to have purchased eight million flat screen television sets in 2015, most of which are LCDs. LCD technology is also the basis for many other contemporary communication devices, including smartphones, laptops and tablets. After all, with experts forecasting six percent

global annual sales growth for flat-panel displays until 2020.

LCD stands for liquid crystal display. Liquid crystals form the basis for billions of flat-panel displays. The American, George H. Heilmeyer, unveiled the first monochrome LCD monitor to the expert community in 1968. Commercialization of the first color monitors took another 20 years. Flat screen TVs started sweeping the world in the 1990s, mainly because of the availability of high-performance color filter materials.

The images on a liquid crystal display with the standard resolution are made up of about two million picture elements, better known as pixels. The color filter pigments attached to the liquid crystal cells are what give each pixel its color. Screen contrast and color purity remain a challenge, however.

Pigment properties make all the difference

Red, green, and blue: Every pixel contains

these three primary colors. The colors are composed of tiny crystals about a thousand times smaller in diameter than a human hair. The crystals act as a filter for the white backlight and only allow light waves from a selected range of the visible spectrum to pass through. These light waves show one of the three colors in its purest possible form. The filters block all the other wavelengths. “A good pigment has a significant impact on the brilliance of the colors the viewer sees,” said Dr. Hans Reichert, head of colorants research at BASF.

“Although perfect color selection is not feasible with absorbing materials, we come fairly close to perfection with our red filters.” Color purity also has an impact on the range of colors available. The greater the purity of the three primary colors, the more permutations that can be achieved by mixing them – and the more colorful the image.

The basic principle is simple. When the color red appears on the screen, the corresponding subpixel lets the red portion of light pass through and absorbs the rest. The other two subpixels – for blue and green – are deactivated when this happens. If, on the other hand, light penetrates through the red and green subpixel while the blue is deactivated, the colors combine to give a rich yellow. Fine-tuning the portions of the three primary colors in this manner produces millions of hues.

The liquid crystals fine-tune the blend of colors by twisting the plane of oscillation of the light waves. “This determines the brightness and color of the subpixels,” said Ger de Keyzer, in charge of applications engineering for color filter materials at BASF. “The liquid crystals change direction, and in that way alter their optical properties depending on the voltage applied.” They rotate the plane of oscillation of light waves to allow the light to pass through the second polarization filter. When an electrical field is applied, however, the crystals prevent some or all of the light from getting through.

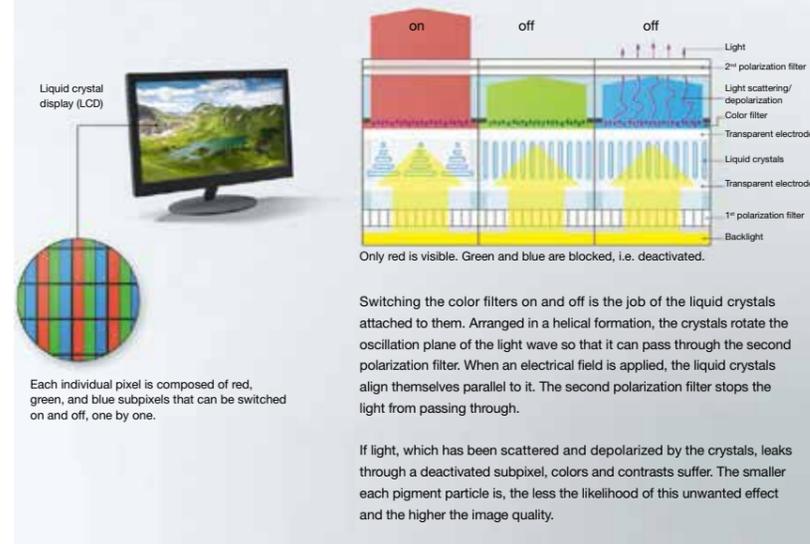
To ensure that subpixels switch on and off the way they are supposed to, it is essential to prevent interferences from the color filter pigments. Any interferences resulting in scattering and depolarization of light will allow the light to pass uncontrolled through the filter. This contaminates the colors and compromises the contrast.

Smaller the better

“A good rule of thumb is: The smaller and more regular the crystals, the lower the scattering and the better the LCD image quality,” de Keyzer said. Researchers

How a pixel gets its colors

A single display contains millions of picture elements, better known as pixels.



control the process mainly by managing the conditions in which pigment crystallization takes place. The underlying molecular structure is what determines which parts of the color spectrum are filtered out.

The organic red pigments that BASF manufactures consist mainly of carbon, nitrogen, and oxygen, and belong to the class of diketopyrrolopyrroles (DPPs). Blue and green pigments are phthalocyanine metal complex compounds. The raw product produced through chemical synthesis is mainly composed of irregular particles. They must then be brought into the ideal size and shape. This is done by a process called pigment finishing. Crystals that are too small are dissolved and precipitated onto the larger crystals. Crystals that are too large are broken into smaller pieces by a mechanical process until the balance is right. Dr. Roman

Lenz, BASF lab team leader in charge of new color filter material synthesis, explained: “Our technology gives us color particles of 20 to 40 nanometers – small enough to reduce light scattering to an absolute minimum but large enough to provide a high degree of stability.” BASF has honed the technology almost to perfection with its products. The color particles in the latest generation of the Irgaphor® Red product suite are smaller than 0.00004 millimeters, and have double the contrast performance of their predecessors.

Tomorrow's television screens will have to meet even higher expectations in terms of resolution and color purity. In anticipation of the new demands, Lenz and his colleagues are taking their lab experiments one step further. Their aim is to find new materials that will show colors in an even more natural light.

“The energy efficiency of LCDs is a product of the art of chemistry”

Interview with Dr. Christian Bosshard, President, Thin Film Optics, Swiss Research and Development Center CSEM, Neuchâtel, Switzerland.

Energy efficiency is an important issue with smartphones. How can pigments help liquid crystal display devices to use less power?

The greater the capacity of color filters to cut out a selected part of the color spectrum and let that light pass completely through, the more they will help in cutting electricity consumption. If, say, only 50 percent of the

color gets through, more white backlight needs to travel through the pigment to be able to get an intense color experience. Energy consumption rises. Ultimately, energy efficiency is a product of the art of chemistry.

What part does chemistry play, exactly?

The molecules forming the color-filtering crystals need to be distributed such that they absorb exactly the light that they're supposed to. However, they should not scatter any light, because scattering is one of the ways light gets lost. This means designing nanoparticle synthesis conditions inhibit crystal growth. The smaller and more regular the particles, the less scattering you get. A sphere would be ideal, but

Some technical terms about liquid crystal display technology

The resolution is a measure of image sharpness, based on the total number of pixels. Full HD (high definition) TV screens have a resolution of 1920 x 1080 pixels, or more than two million red, blue, and green pixels.

Liquid crystals are substances that combine some of the properties of liquids and crystals. Their alignment is controlled by electrical fields. Liquid crystals control the color accuracy of the display.

The contrast is the difference between the brightest and darkest possible state of a subpixel. To achieve high contrast, a subpixel needs to be as dark as possible when switched off.

LCD stands for liquid crystal display and is a collective term for liquid crystal displays in devices of all kinds, including watches, TVs, smartphones, and tablets.

LED stands for light-emitting diode. Most LCD televisions on sale today use LED as the white backlight for the screen. Even if the screen is completely black, the backlight still shines.

A light wave is an electromagnetic wave emitted by a light source. It oscillates in all directions.

A pixel is also known as picture element. Pixels are the smallest image elements in displays. They contain red, blue, and green pigments in their subpixels. The more pixels, the sharper and more detailed the image.

A polarization filter only lets light waves through whose electrical field oscillates in a particular direction (polarization).

A subpixel is the smallest possible unit of a liquid crystal display. Each pixel is composed of three subpixels, one for each of the three primary colors – red, blue, and green.

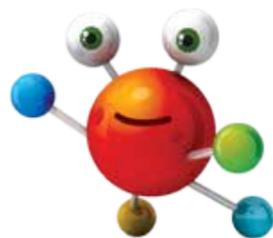
Ultra-HD stands for ultra-high definition. This technology is also known as 4K. Ultra-HD devices deliver four times more pixels than HD displays – about eight million.

you can't create a sphere with crystals.

What new challenges will the television of the future bring?

The color filter materials for the new 4K TVs are 40 nanometers in diameter, which is already small enough and homogeneous enough to produce high-quality images. Performance expectations will probably be even higher for the next generation of 8K TVs, the first prototypes of which have been unveiled. Still, we have to ask ourselves where the limits are. Improvement in one area often entails deterioration in another. The smaller the color particles, for instance, the less stable they will be. At the end of the day, it's all about finding the right balance.

Explore the wonders of chemistry without leaving home



Since its 2002 debut in China, the BASF Kids' Lab has become a must-go event each summer for children aged 6 to 12. In a cozy and safe atmosphere, children do new experiments by themselves, discover the wonders of chemistry, and learn how to protect the environment in a creative way and improve quality of life.

Building on the enthusiasm, to offer children throughout China the chance to experience the fun of chemical experiments anytime and anywhere, the Virtual Lab was launched in June 2016.



Welcome to the BASF Virtual Kids' Lab!

I have prepared three popular Kid's Lab experiments for you.

They are Cleaning Dirty Water, the Red Stain Devil and Looking for the Sender.



- In Cleaning Dirty Water, you will gain knowledge of the water-recycling process and learn about the importance of saving water.
- Red Stain Devil explores the secret of laundry and how color-care detergent functions.
- In Looking for the Sender, you can act as detectives to find who has sent an anonymous invitation with the help of chromatography.

The experiments in the Virtual Lab will be updated continuously.

Let's explore and have fun in the world of chemistry!



Scan the code to find out more about BASF Virtual Kid's Lab. Get a better experience on a tablet.



Feedback

From kids:

- Looking for the Sender is the most fun. I learnt how to separate different colors, just like a detective.
- I have done the experiment Cleaning Dirty Water in the Science and Technology Museum. In the Virtual Lab, however, I can do the experiments any time I want. It is like I am having my own laboratory. And after completing different levels, I can get a badge. This is more fun and rewarding.

From parents:

- Experiments in the Virtual Lab are all based on real ones. Kids are guided with interesting stories. Children can learn from the fun. Good!
- When I accompanied my kid to participate in Kids' Lab in the past, I could only wait and watch him. Now with this online version I can do the experiments with my kid, refresh my chemistry knowledge and grow up together with him. Thanks for this big surprise and all the efforts BASF has made in promoting science education to a young generation.

Game recommendation: Looking for the Sender



You have received an invitation to a birthday party. Unfortunately, the sender's name is not on the invitation. So how do you know who has invited you? You have three candidates. Can you find out who is the sender based on their pens?

Preparation

Please prepare: three felt-tip pens, a pair of scissors, a shallow glass bowl, a large beaker, a stick and paper clip, a pipette and filter paper.

Step 1: Get the pen color from the paper

Cut the invitation into small pieces and put it in the water-filled container. The color will separate from the paper and float in the water.

Step 2: Dot the filter paper

Make a dot on the filter paper with each of the felt-tip pens. Then drizzle a bit of color from the invitation next to it.

Step 3: Wet the filter paper

Wet the paper with the beaker so that it becomes saturated with water. You can affix the filter paper to the beaker with the stick and the paper clip.

Step 4: Look at the color pattern and find the sender

The felt-tip pen colors are water-soluble. If they come into contact with water the individual colors will dissolve, run across the paper with the water and form unique patterns. If the patterns are the same, they come from the same pen.

Find out more

If you would like to know more about the topics covered in this issue of BASF information, please use the following links.



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Simply fill out the questionnaire and be entered in a draw to win a flash disk specially designed for Lunar Year of Monkey.



Access to online questionnaire: on.basf.com/2bDuOoR

Prize draw terms and conditions:

On submitting a completed entry, you will automatically be entered into a draw for this prize. The winner will be notified by email within 28 days of the closing date. The closing date for entries is December 31, 2016. The competition is not open to employees of BASF or participating companies. No cash alternative will be offered. No responsibility can be accepted for entries lost, delayed or mislaid. Entry in the prize draw is restricted to entrants of 18 years of age or over. BASF's decision is final and it is a condition of entry to any competition that the entrant agrees to be bound by these rules.

**We create
chemistry
that makes
more power
love a cleaner
drive.**

The price of increased mobility is higher emissions. While people won't be slowing down any time soon, chemistry is getting us from A to B with a cleaner footprint.

One way we are improving the ecological impact of cars is with fuel additives that reduce emissions while increasing fuel efficiency. We also develop materials that give electric car batteries a higher energy capacity, to ensure that e-mobility is becoming a more attractive way to travel.

When better performance also means lower impact, it's because at BASF, we create chemistry.

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