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## FOUNDED ON TECHNOLOGY AND KNOWLEDGE

Toray Group's medium-term management program, "Project AP-G 2019," aims for the creation of new technologies and materials, with particular focus on "Green Innovation" and "Life Innovation" businesses, as well as the promotion of measures to manifest the essential value of these technologies and materials. The company also maintains technological competitiveness by constructing a solid market entry barrier with its intellectual property.

## R&D Philosophy

Since its very inception, Toray Group has continuously carried out R&D on advanced materials based on the firm conviction that R&D provide the key to building Toray of tomorrow. The company has accordingly continued to focus on R&D of advanced materials based on the needs of the times. However, it inevitably takes a certain amount of time to develop and commercialize materials. Accordingly, we focus on maintaining the ability to recognize the value of materials and the will to follow through in development. Our basic policy is pipeline management, management based on R&D with a long-term focus, emphasizing not only on immediate profit-making themes, but the next one, and the one after that as well. The phrase, "The Deeper, the Newer," has been passed down as a key phrase at Toray, and is part of the DNA of our researchers and engineers. The concept underlying this is that when you dig deep into something, the result will be new discoveries and inventions. With this in mind, we continue to challenge the ultimate based on a grand vision for the times and the needs of society, with the goal of creating innovation that has both economic and social value.

## Characteristic of R&D of Toray

### 1 Culture of Commitment to Basic Research

Our culture prioritizes basic research that has to be based on a grand vision of the times, recognizes the value of materials and is unswayed by current trends and so provides a fertile foundation for continuing to create innovative advanced materials like our carbon fibers and reverse osmosis membranes.

### 2 Long-term and Persistent Efforts to Pursue Advanced Materials and Technology to the Ultimate Limits

Our commitment to unceasing pursuit in R&D—exemplified in our strong preference for advanced materials and belief that delving deeper into a single theme yields new inventions and discoveries—has taken root in the form of persistent efforts over the long term. We believe this "super-continuity" approach spurs innovation.

### 3 Specialist Teams in Many Fields

Toray's teams of specialists have abundant knowledge and experience in a wide variety of fields including polymer design, high-function technology, and drug discovery, formulation, and pharmacology, which are applications of our core technologies.

### 4 Undivided R&D Organization

The Technology Center serves as the nexus for all R&D functions enabling advanced materials created in one field to be rapidly applied to other fields.

### 5 Integrating Technologies by Industry-government-academia Collaborative Research

Toray actively engages in technology fusion through external collaboration and open innovation activities with industries, governments, and academic institutions in Japan and overseas with the aim of continuing to create innovative advanced materials.

### 6 Strategic Partnerships with Industry Leaders

Toray produces first-to-market advanced materials in growth markets through collaborations with leading companies and venture companies in Japan and overseas.

### 7 Advanced Analytical Capabilities

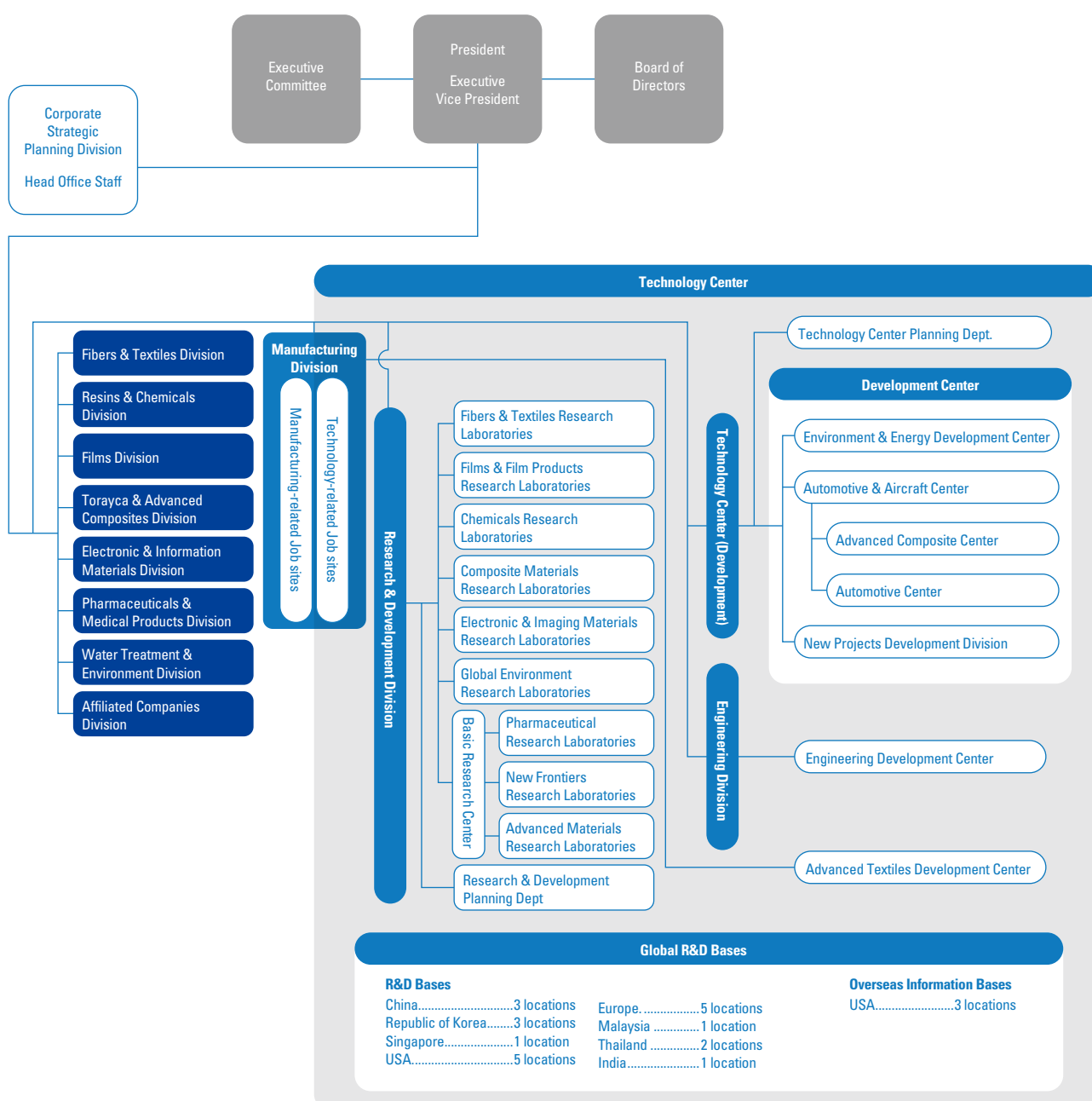
Toray works closely with Toray Research Center Inc., which has extensive achievements in commissioned analysis and research studies, to enhance the Company's analysis capabilities for its R&D and manufacturing technology.

## R&D Organization at Toray Group

Toray has centralized all of its R&D functions into a single organization called the Technology Center. Bringing together specialists from many fields in this undivided R&D organization makes it easier to create new innovations by integrating technologies. Moreover, the system enables the company to exhibit combined strength by actively exploiting techniques and knowledge from many fields to solve problems in a single business area. It also enables to be rapidly applied to various advanced materials and technologies to multiple businesses.

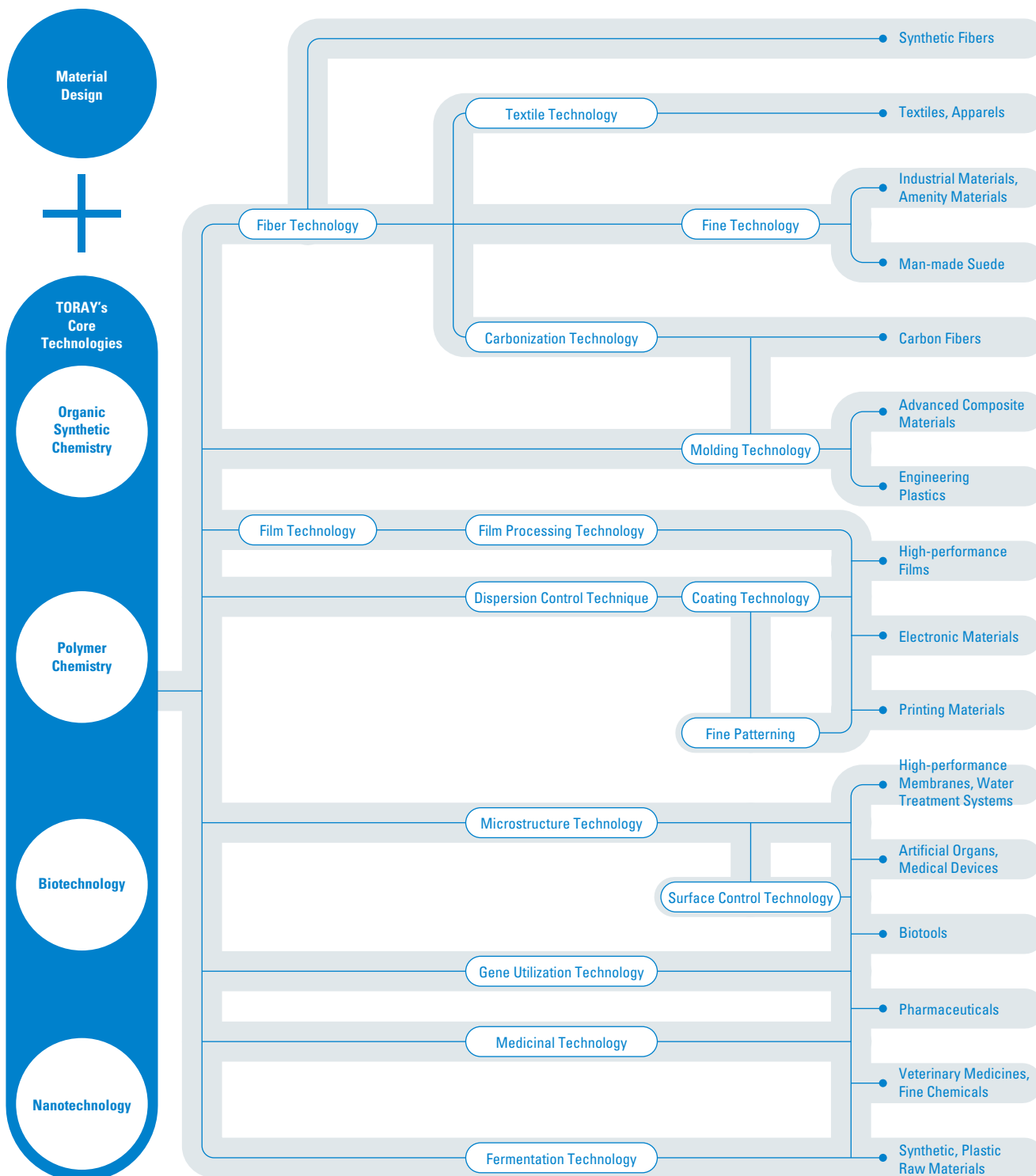
On the other hand, under the direct control of the Technology Center are the Automotive & Aircraft Center, which develops advanced materials for automobiles and aircraft applications, and the Environment & Energy Development Center, which focuses on technology cooperation in the environment and energy fields. Through these organizations, the company is promoting open innovation with its customers, business partners, and external organizations.

In addition, the Life Innovation business is led by the Life Innovation Business Strategic Planning Department, which promotes close cooperation with, in addition to bases in Kobe and Minnesota (US), domestic and overseas medical institutions, diagnostic centers, medical device firms, not to mention the Technology Center.



## Toray's Technical Fields — Development of Advanced Materials by Integrating Toray's Core Technologies

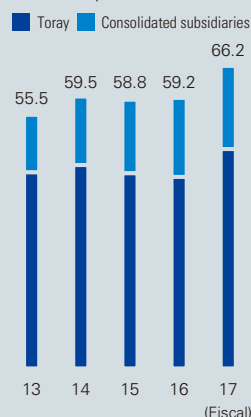
Toray Group's core technologies are "organic synthetic chemistry," "polymer chemistry," "biotechnology" and "nanotechnology." Based on these, we are working toward greater depth and fusion of fundamental technologies such as polymerization, yarn-making, fibers application processing, film processing, and organic synthesis, while expanding our operations from fibers and textiles to films, chemicals, and plastic resins. We are also creating advanced materials and developing businesses in the fields of electronic & information materials, carbon fiber composite materials, pharmaceuticals, medical devices, and water treatment.



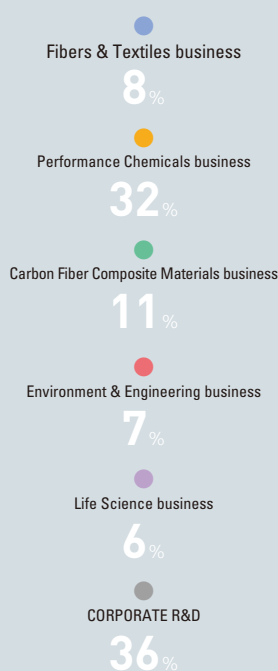
## Fiscal 2017 R&D Expenses

¥66.2 billion

### R&D Expenses (Billions of yen)



### Percentage Breakdown of Total R&D Expenses in Fiscal 2017



## Fiscal 2017 R&D Achievements

### Fibers & Textiles

Using our unique oil-resistant processing technology, we have developed the LIVMOA™ 3500 series, a limited-use chemical protective clothing, to resist external oil penetration. We have also developed WithRelief™, a high-functional, skin-friendly insect-resistant textile, which is a quality that previous high-functional insect-resistant materials did not possess. In addition, we have developed a high-permeability type ENTRANT™, a high-performance textile with water resistance and moisture permeability that is also about 50 times more breathable than previous products.

### Performance Chemicals

We have developed a PET film with a smooth and durable surface that is resistant to scratches thanks to a hybrid coating formed through the combination of super hard nanoparticles and a functional polymer dispersing agent. We have also successfully developed a biaxially oriented PET film with the world's highest level of thermal conductivity—about 2.5x the level shown in previous products. In addition, for non-destructive X-ray testing and mammography applications, we have developed an X-ray scintillator panel that produces clear and high-spatial resolution X-ray images.

### Carbon Fiber Composite Materials

Toray's newly developed fabrication technology for carbon fiber reinforced plastic enables both improved dimensional accuracy and the saving of energy. The company has also decided to introduce process development equipment to create a high-performance carbon fiber for the next generation. With this equipment, we will develop the world's strongest yarn and innovative technologies to improve productivity, and aim to achieve balance with further high performance and low costs.

### Environment & Engineering

In collaboration with RIKEN, the company has developed innovative technologies aimed at analyzing the phenomenon in which contaminants under a variety of conditions will adhere to and clog reverse osmosis membranes. This analysis contributed to our development of new low-fouling membranes. As a method for treating and reusing sewage and industrial wastewater, we have also developed basic technologies for converting aeration energy of the membrane separation activated sludge process to highly efficient cleaning energy. The company was also awarded from the Japan Chemical Industry Association the 49th (fiscal 2017) JCIA Technology Award (Grand Prize) for the development of high performance reverse osmosis membranes.

### Life Science

The company has developed orally disintegrating decay (OD) tablets that can be taken with or without water for anti-itching medication TRK-280. The company also obtained approval for the domestic manufacture and sale of REMITCH®\* OD Tablets 2.5µg and started selling them. Moreover, phase I clinical testing of the company's TRK-950, an antibody drug for cancers, was carried out in the US and France. Toray also developed Prelina II Rich™, a bifocal contact lens that improves focus correction.

\*REMITCH® is a registered trademark of Torii Pharmaceutical Co., Ltd.

## Fiscal 2017 Topics

### Developing CFRP Fabrication Technologies to Achieve Improved Dimensional Accuracy and the Saving of Energy

Toray has developed innovative fabrication technologies for carbon fiber reinforced plastics (CFRP), which are usually molded by placing prepreg (an intermediate material in sheet form) on a mold and cured using hot air heating. However, hot air heating has the disadvantage that it suffers from inefficient heat transfer and it requires time to heat up. There is also dimensional accuracy problem after hardening in large, complex-shaped parts with varying thicknesses.

However, the newly developed fabrication technology achieves an energy savings of about 50% by placing a predetermined number of sheet heaters on the mold's surface, with contact heating taking place under vacuum pressure. The application of optimum temperature distribution to each part allows parts to be fabricated into a shape and dimension closer to the original design, and also requires less time. We will verify this new technology and expand its use to for aircraft, automotive, and general industrial-use applications.

### Development of an X-ray Scintillator Panel Enabling Clear X-ray Images

Toray has developed a pixelated X-ray scintillator panel for delivering X-ray images that are 2-4 times higher spatial-resolution than those produced by previous panels. In previous X-ray scintillator panels, images could be blurry as visible light created from the X-rays was spread in all directions and detected by a wide range of sensor pixels. To overcome this issue, we applied our unique high-definition barrier rib formation technology. Also, the new X-ray panel uses technologies filling a barrier rib with scintillator material uniformly and improving efficiency of light utilization, which partitions the scintillator into the size of the pixel of a sensor, allowing limits on the spread of visible light. This in turn allows the panel to produce even higher spatial-resolution images.

This product can be used for X-ray mammography and non-destructive X-ray evaluation, which could contribute to the early detection of breast cancer and improved product safety through the detection of small defects and foreign matter in electronic components, aircraft components, lithium-ion batteries, and the like.