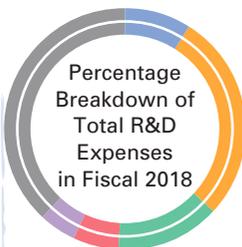
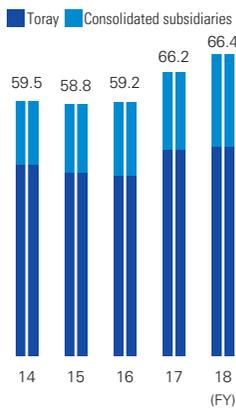


# R&D

Fiscal 2018 R&D Expenses

¥66.4 billion

R&D Expenses (Billion yen)



Fibers & Textiles business

9%

Performance Chemicals business

28%

Carbon Fiber Composite Materials business

14%

Environment & Engineering business

6%

Life Science business

5%

Corporate R&D

38%

## Fiscal 2018 R&D Achievements

### Fibers & Textiles

Using our innovative composite spinning technology, we have developed Primeflex<sup>®</sup>, a material composed of two-component, bimetal thread that has the smallest diameter in the world at 0.8dtex. In addition, we have developed Deep Color Nylon<sup>™</sup>, a UV-blocking nylon textile that features deep, vivid colors, superior color fastness, and is composed of a fiber structure with minimal amorphous components, which cause colors to fade. We have also developed "Ultrasuede<sup>®</sup> BX," an ultra-microfiber non-woven fabric with suede texture that is about 30% made of plant-based raw materials, realizing the highest proportion of plant-based raw materials—Polyester and Polyurethane—in the world.

### Performance Chemicals

Using our proprietary precise control alloy technology, we have developed a new polyphenylene sulfide (PPS) resin that boasts the world's highest level of flexibility while featuring strong thermal and chemical resistance. We have also developed a solar control film that possesses one of the world's highest levels of heat reflection properties with respect to infrared radiation from the sun. This film also further deepens our nano-layering technology while maintaining glass-like transparency. In addition, we developed the world's first waterless offset printing equipment that does not use VOCs and capable of reducing power consumption by around 80% compared with conventional printing methods.

### Carbon Fiber Composite Materials

We have developed the TORAYCA<sup>®</sup> MX series, a new carbon fiber that improves tensile strength by around 30% while retaining the equivalent tensile modulus to conventional carbon fibers through the application of technology to improve the orientation by closely controlling the graphite crystal structure in a nano order. We also have developed prepreg (resin-impregnated carbon-fiber sheets) for primary structural components of aircraft that applies new molding technology without using autoclaves that was developed in the previous fiscal year.

### Environment & Engineering

We have developed technology that limits the resistance of the feed water and purified water flowing through the reverse osmosis (RO) membrane to the minimum, thus boosting the velocity of flow of feed water. Consequently, we have succeeded in improving water recovery by as much as twice. In addition, we have successfully created a polyvinylidene fluoride (PVDF) ultrafiltration (UF) membrane that further deepens pore diameter control technology, effectively separates micro substances, and features a high level of water permeability.

### Life Science

We have created a new fibrous adsorbent for purifying blood that applies synthetic fiber spinning technology to selectively eliminate bio targets such as cells and proteins. In addition, we are accelerating the development of TRK-950 antibody drug currently undergoing Phase 1 clinical testing with the aim of gaining approval early as a cancer treatment. We have also begun a Phase 1 clinical trial in the United States for TRK-250, a nucleic acid drug jointly developed with BONAC Corporation. TRK-250 was granted an Orphan Drug Designation by the U.S. Food and Drug Administration (FDA) for the treatment of idiopathic pulmonary fibrosis.

## Fiscal 2018 Topics

### Toray Creates Innovative UV Blocking Film by Deepening Nano-multilayer Technology

The use of OLED displays has been spreading rapidly. However, according to some reports, such displays have been found to be sensitive to UV damage, even in the 400 nm range, close to visible light, leading to calls for further improvements in durability. Given this, Toray successfully developed an innovative UV blocking film that, while being thin, blocks 99.99% of UV rays, maintains transparency, and is capable of cutting UV up to around the 400 nm range. The new product, "PICASUS<sup>®</sup>UV" is a laminated film comprised of several hundreds to thousands of nano-scale layers, representing a greater depth of our proprietary technology that works to individually design the thickness and layout of these layers, and to precisely control the wavelength bands of reflection and transmission. Toray aims to mass produce this film from 2020, and going beyond displays, anticipates various other applications for automobile, building and construction material, agriculture, electronic material, and special packaging in the pharmaceutical and other fields.

### Development and Commercialization of High-performance Positive Photosensitive Siloxane Coatings Recognized with the CSJ Award for Technical Development

Toray has been honored with the 67th (2018) CSJ Award for Technical Development by the Chemical Society of Japan. The award recognizes this innovative technology for its realization of high degrees of resolution and sensitivity with the positive-tone photosensitive properties of siloxane, a hybrid organic and inorganic material that offers exceptional transparency and heat resistance. The award also highly evaluated the technology for its high degrees of design and property freedom with, such as refraction index control and calcined silicates, which can lead to significant contributions to higher performance of displays, touch sensors, image sensors and other optical devices.

### Successful Execution of National Project with Toray DNA Chip

Toray has developed its DNA Chip "3D-Gene<sup>®</sup>" that is 100 times more sensitive than conventional products. And based on this technology, Toray enabled the super sensitive detection of microRNA in blood. Until fiscal 2018, Toray has been promoting a large-scale national project with the National Cancer Center, the representative cancer research and clinical center of Japan, and other organizations. As a result, Toray carried out a study involving 1,000 cases, using serum samples from, such as breast cancer or colon cancer patients, and good results were obtained. Deepening the cooperation with related organizations, Toray will continue to concentrate all power and aim at the early application for marketing authorization and its approval.

# Intellectual Property



## Basic Policies on Intellectual Property

Toray Group has formulated and executes the following four intellectual property strategies as its basic policies on intellectual property.

### 1 Intellectual property strategies, as a part of the strategy trinity, that conform to management principles

Toray Group regards intellectual property as one of its vital management resources. We integrate our intellectual property strategies mutually and organically with our business strategies and R&D strategies, and as part of this "trinity," we designate intellectual property strategies as one of the most important elements of our management strategies.

### 2 Promoting the procurement of rights

In order to protect Toray Group's products and technologies and to ensure profits in terms of intellectual property, we hold as many useful patent rights as possible and build patent portfolios. At the same time, we pay close attention to efficient patenting by raising the quality of each patent and not making needless applications.

### 3 Respecting the rights of others

Toray has operated a system for comprehensively investigating the relations between its own products and technologies and patents owned by other companies, and we thoroughly educate employees to prevent infringement on patent rights of other parties.

### 4 Rightful enforcement of our own rights

When Toray Group's patent rights are infringed upon by another party, we take proper steps depending on the circumstances by exercising our patent rights, such as demanding that infringement cease, receiving monetary profits from licensing, and using our patent rights for cross-licensing with the patent rights of other parties.

## Intellectual Property Strategies in Line with Our Management Strategies

### 1 Promoting global intellectual property strategies of Toray Group

We will promote Toray's patent applications and patenting in countries other than Japan, particularly in those growth countries and regions where we aim to achieve business expansion in the future. Together with this, we will support global business growth by working to strengthen patent applications and patenting from overseas subsidiaries and affiliated companies to ensure the appropriate protection of inventions created in our bases in each country. We will also establish Group-wide intellectual property strategies that bind Toray Group's research and technology development for each business field. In addition, we will establish and strengthen patent and trademark management systems at each company in Toray Group.

### 2 Firmly maintaining our technological advantage through strategic patent applications and other such efforts and rolling them out at subsidiaries and affiliated companies in Japan and overseas

At Toray Group, we are working to build patent portfolios with emphasis on the "Green Innovation Business Expansion (GR) Project" and "Life Innovation Business Expansion (LI) Project" while avoiding careless disclosure of technical information through the publication of patent applications. We expect these initiatives to support our businesses in the growth fields as a powerful barrier against entry in the future. We will also spread these efforts to our subsidiaries and affiliated companies in Japan and overseas.

### 3 Executing intellectual property strategies that are organically linked to our business

In order to promote the execution of intellectual property strategies linked to our individual business activities, Toray Group will strengthen participation in the patent activities of business divisions, and together with this, will work on intellectual property education according to the needs of the individual business divisions.

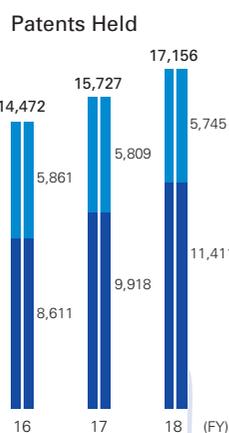
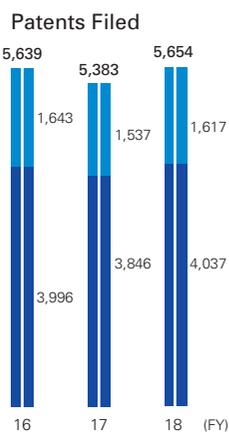
### 4 Strengthening utilization of our brand and trademarks

Together with our aim to enhance the value of our technology through technology brands, we will deal strictly with imitation products and other infringements of Toray Group's trademarks amid surging growth in the number of online transactions.

### 5 Developing human resources to support global intellectual property activities

Toray carries out multifaceted and multilevel education for everyone from management to new employees and front-line sales representatives, covering domestic and overseas patent systems and practice. Additionally, at the Intellectual Property Division, together with encouraging the acquisition of patent attorney qualification, we actively support staff in their efforts to strengthen their foreign language capabilities and dispatch staff to overseas subsidiaries and affiliated companies.

We are also making concerted efforts to provide the same kind of intellectual property education at subsidiaries and affiliated companies in and outside of Japan. Moreover, we will assign intellectual property specialists to companies actively engaging in R&D and work to improve education for researchers and engineers.



■ Domestic  
■ Overseas

### Toray Selected as One of the 2018-2019 Top 100 Global Innovators

Analyzing trends in intellectual property based on proprietary data, Clarivate Analytics, based in the U.S., selects and celebrates the world's 100 most innovative companies and institutions. This is the third time that Toray has been selected for the list, following 2015 and 2017.