



Column The Idemitsu Group's Technologies Underpinning Innovation

Initiatives for Material Issues

In its Medium-term Management Plan, Idemitsu has outlined expansion of growth businesses, creation of next-generation businesses, and harmony with the global environment and society as priority topics. To promote the creation of new business in particular, we established the Next Generation Business Department, which promotes business development that addresses social issues and meets customer needs, in November 2019; the Digital Innovation Department, which promotes the use of digital technologies, in January 2020; and the Innovation Strategy Planning Department, which promotes technology-driven business development, in April 2020. We have crafted strategies that consolidate company-wide technologies and actively draw on external technologies with the aim of quickly achieving the creation of new businesses with an eye toward changes in society, diversifying customer needs, and decreasing environmental burden.

Technological innovation is indispensable to achieving the goals of the Paris Agreement, which is an international framework related to climate change. The Idemitsu Group is using the technological development capabilities it has developed over many years of operations to continue generating innovation that will help solve various social issues, including climate change.

R&D Structure

Our R&D system is composed of Advanced Technology Research Laboratories, which responsible for corporate R&D, and research laboratories in each department. Each of them carries out specialized development. In addition, we established the Research & Development Committee as a company-wide organization to not only examine the direction of research and development, strategies, and issues throughout the organization, but also to deepen cooperation among laboratories and to strengthen technological capabilities.

■ Functional materials segment ■ Power and renewable energy segment ■ Resources segment

Research field	Name of laboratory	Japan	Overseas	Outline of Initiatives
Corporate R&D	Environment & Energy Research Laboratory	●		Development of technologies to reduce GHGs and recycle resources (biofuels, bio-chemicals, and CO ₂ recycling) and bio-materials
	Frontier Materials Development Laboratory	●		Development of advanced functional materials
	Advanced Battery Materials Research Laboratory	●		Development of advanced battery materials related to all-solid-state lithium ion battery and lithium recovery technology
	Thin Film Device Laboratory	●		Development of high-performance inorganic thin-film semiconductors and devices
	Analytical Technology Center	●		Providing advanced analysis and solutions to a wide range of fields throughout the Group
	Idemitsu Kosan Collaborative Research Cluster for Advanced Materials	●		Creating next-generation materials, enhancement and expansion of technologies
Production engineering	Technology & Engineering Center	●		Technology development in the area of engineering design, construction, operation, quality control & assurance, and asset integrity & reliability Technology-driven contribution to existing and new businesses
Lubricants	Lubricants Research Laboratory	●		Research and development of lubricants and tribology (lubrication technology)
	Idemitsu Lubricants America Corporation R&D Center		●	Local-based research and development of lubricants
	Idemitsu Lube (China) Co., Ltd. Research & Development Center		●	Global development of lubricants products and technologies with the Lubricants Research Laboratory (Japan) as the mother research center
	Idemitsu Lube Asia Pacific Pte. Ltd. R&D Center		●	Rapid product development and provision of technical services to meet local needs overseas
	NIPPON GREASE Co., Ltd. Technical Research Laboratory	●		Research and development of grease, rust prevention oil, cutting oil, etc.
Advanced materials & performance chemicals	Performance Materials Laboratories	●		Development of advanced materials through high-value-added petrochemical raw materials Research and development of special polycarbonate resins and functional coatings
	Idemitsu Unitech Co., Ltd. R&D Center for Plastic Products	●		Research and development of molded plastic products
	LION IDEMITSU COMPOSITES CO., LTD. Composite Materials Research Laboratory	●		Design, development, and analysis of customer grades of composite materials that meet customer needs
Electronic materials	Electronic Materials Development Center	●		Research and development of OLED materials
	Idemitsu OLED Materials Europe AG		●	
	Inorganic Electronic Materials Development Group	●		Research and development of oxide semiconductor materials
Bitumen	Technology Section	●		Basic and applied research on asphalt and its applications Development of high performance asphalt
Agri-bio	Agri-Bio Technology Section	●		Development of active ingredients for pesticides and feed additives derived from microorganisms and natural products
	SDS Biotech K.K. Tsukuba Research & Technology Center	●		Development of safe and useful products for the protection of livestock and plants and prevention of diseases
Lithium-ion battery materials	Battery Material Development Center	●		Development of sulfide-based solid electrolytes for practical application in all-solid-state lithium ion batteries
Photovoltaic power generation	Advanced Product Development Section	●		Research and development aimed at enhancing the performance and reducing the cost of existing CIS solar cell products as well as developing next-generation products
	Solar Frontier K.K. Kunitomi Plant	●		Research and development aimed at commercializing the recycling of solar panels, including silicon-based panels
Coal and the environment	Coal & Environment Research Laboratory	●		The only private research institute specializing in coal Provision of technology services that anticipate needs and development of clean coal technologies to meet the needs of a low-carbon society



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R&D Investment Record

We conduct R&D related to petroleum, functional materials, and resources as well as new business creation. Under our R&D system, our departments pursue R&D activities in close mutual cooperation.

FY2019 R&D Investment Record		(Millions of yen)
R&D expenses		19,436
	Petroleum	2,356
	Basic Chemicals	0
R&D expenses by Business Segment		
	Functional Materials	12,166
	Power and Renewable Energy	538
	Resources	232
	Others	4,142

Promotion of Open Innovation

To strengthen and expand the functional materials business and create next-generation businesses, we promote open innovation that actively leverages external knowledge.

1. We participate in funds that are run by material-oriented venture capital and strive to discover technology seeds owned by ventures and startups in Japan and overseas.
2. In April 2020, we established the new Innovation Strategy Planning Department with the mission of consolidating company-wide technologies and accelerating and promoting external cooperation. Within the department, we established the Open Innovation Promotion Group.
3. In April 2020, we opened the "Idemitsu Kosan Collaborative Research Cluster for Advanced Materials" at the Tokyo Institute of Technology. This research center is working to create next-generation materials and develop human resources by promoting large-scale comprehensive collaborative research centered on polymer and composite materials.

External Evaluation of Idemitsu Group's Technologies

Our technologies are highly appreciated by the international community. As an example, Idemitsu and Showa Shell have been ranked 1st and 3rd respectively in the world among the industry subgroups* for three consecutive years since 2017 in the "Opportunities in Clean Tech," which is one of the items evaluated by MSCI, an ESG evaluation organization. (See the table below.)

We will continue to make the most of its advanced R&D capabilities to contribute to the solution of global issues through collaboration with others.

* Within GICS (Global Industry Classification Standard), the Idemitsu Group belongs to the Oil & Gas Refining and Marketing industry subgroup.

Ranking of companies in the sector of MSCI's "Opportunities in Clean Tech"

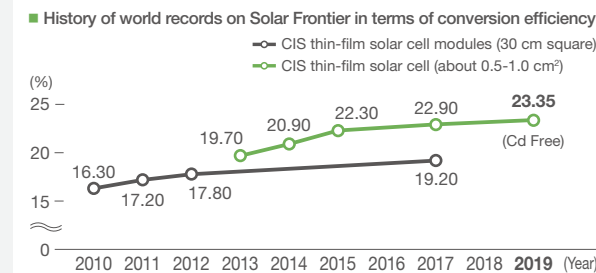
Ranking	2019	2018	2017
1	Idemitsu Kosan	Idemitsu Kosan	Idemitsu Kosan
2	Company A	Company A	Company A
3	Showa Shell	Showa Shell	Showa Shell
4	Company B	Company B	Company D
5	Company C	Company C	Company B

Examples of the Initiatives

Development of CIS solar cell technology

At the Atsugi Research Center of Solar Frontier K.K., we are engaged in leading-edge research and development related to CIS solar cells, aiming to improve energy conversion efficiency at both the research and commercial production levels, while striving to develop new applications and create advanced next-generation products with the potential to cultivate new markets.

In January 2019, a joint-research project with the New Energy and Industrial Technology Development Organization (NEDO) led to the achievement of a world record energy conversion efficiency of 23.35% for a single cell (about 1 cm²) of the cadmium-free CIS solar cell (Cd-Free CIS solar cell). This record is approximately 0.4 percentage points higher than the previous record of 22.9% (achieved by our company in November 2017) for cadmium-containing CIS solar cells, and represents the highest conversion efficiency in the world for all CIS solar cells. By applying basic technologies, we are working to lower costs by increasing the output of panels and to deliver environmentally friendly and economical products to customers.



Developing innovative technologies solar power a major energy source

In August 2020, two of our project proposals were taken up by the NEDO as joint-research projects under its programs titled "Technological Development for Promoting Solar Power Generation and Making It a Major Power Source" and "Technological Development for Creating New Markets for Solar Power Generation." The themes of these projects, respectively, are the "Development of ultra-light-weight film modules (for installation on rooftops with limitations on loading weight)" and the "Research and development of solar cells for vehicles." The terms of both span the five-year period from FY2020 to FY2024. Through the two projects, we will further promote the development of new technologies to broaden the range of terrains in which solar panels can be installed.

In addition, these projects will pursue their respective themes via the application of CIS solar cells (solar cells made using a compound of copper, indium and selenium) manufactured and marketed by Solar Frontier K.K., a wholly owned subsidiary of our company.

Creation of next-generation materials via industry-academia collaboration

On April 1, 2020, our company and the Tokyo Institute of Technology (Tokyo Tech) co-founded Idemitsu Kosan Collaborative Research Cluster for Advanced Materials on the premises of Tokyo Tech's Suzukakedai campus. Since the beginning of the 2000s, our company and Tokyo Tech have been engaged in joint research in polymer materials and other fields encompassing a range of technologies and have achieved outstanding results, including the development of new fiber and film materials. The newly established research base is expected to promote large-scale and comprehensive R&D that involves ongoing inter-organizational collaboration and transcends the traditional framework of joint research for individual projects. In this way, we will help develop next-generation materials while nurturing human resources.

While our company boasts strengths in functional materials (lubricants, advanced materials & performance chemicals, electronic materials, agri-bio, and others) and a track record in marketing them in wide-ranging fields, Tokyo Tech possesses a breadth of sophisticated academic expertise with regard to substances and materials and is equipped with leading-edge scientific and engineering technologies. Bringing together these resources, our company and Tokyo Tech will take on the ongoing challenge of creating new value.

Utilization of collagen and mucin derived from jellyfish

Although the jellyfish displayed at aquariums are popular among onlookers due to their beautiful and mysterious outward appearance, their swarms sometimes negatively impact commercial fishing and other business activities undertaken in coastal areas. Moreover, disposing of jellyfish caught in nets results in significant costs. Because of this, there is a growing call to find ways to use jellyfish as a resource. Jellyfish Research Laboratories, Inc. (Kanagawa Prefecture), an our group company, has invented a technology to utilize useful ingredients extracted from jellyfish. Collagen derived from jellyfish has been confirmed to be effective in promoting the regeneration of epidermis which is considered to be difficult to regenerate, and is expected to be used in the fields of regenerative medicine and beauty treatment. Mucin derived from jellyfish is also expected to have potential as a treatment for knee osteoarthritis.

Taking advantage of the features of jellyfish, we will blaze a new trail in the life science field and help people around the world enhance their quality of life. In addition, the initiatives discussed above were covered by Circular Yokohama, an online media outlet focused on drawing public attention to local businesses engaged in innovative endeavors aimed at realizing a circular economy.