

Functional Materials Segment

Review of Operations

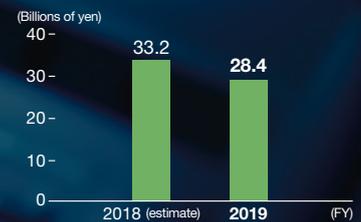
This segment encompasses the development, manufacture, and sale of lubricants, advanced materials & performance chemicals, electronic materials, bitumen, agri-bio products, and lithium-ion battery materials based on core technologies cultivated in petroleum refining and petrochemistry.

The lubricants business leverages its R&D capabilities to globally manufacture and sell a wide range of products that meet customer needs, including automotive engines and transmissions, actuators for construction equipment, wind turbine brakes, and cutting oil for metalworking. The advanced materials & performance chemicals business develops, manufactures, and sells engineering plastics, adhesive materials, electronic materials, derivatives, solvents, and other products. The electronic materials business manufactures and sells OLED materials and develops next-generation materials. The bitumen business develops, manufactures, and sells high-performance asphalt with excellent environmental effects as well as other products that meet customer needs. The agri-bio business develops and sells such materials as biological pesticides that contribute to the production of agricultural products. The lithium-ion battery materials business develops next-generation lithium-ion battery materials for electric vehicles (EVs) and other applications.

■ Net sales



■ Operating income + Equity earnings



Social Issues

- Responding to demand for addressing climate change via greenhouse gas emission reduction
- Need for technological innovation facilitating the widespread adoption of EVs in order to realize a low-carbon society
- Development of materials for EVs, high-speed telecommunications, AI, and IoT
- Increase in food demand in line with population growth, especially overseas in other Asian regions and emerging countries

Lubricants

Strengths

- A lubricant business with a global manufacturing, selling, and R&D network spanning 26 countries
- A product development and technical assistance framework for lubricants that address customers' frontline issues and needs

Risks

- Economic slowdown and lower demand due mainly to prolonged U.S.-China trade tensions and COVID-19 pandemic effects
- Slowing demand for motor oil and other internal combustion engine oil due to the wider spread of EVs
- Stagnant prices due to intensifying competition in the general-purpose product market

Opportunities

- Growing demand for functional materials amid economic development and population growth in Asian regions
- Growing need for energy-efficient products and EV-related products amid the climate change crisis
- Increased logistics demand due to changing consumer trends caused mainly by the COVID-19 pandemic

Business Environment

The COVID-19 pandemic has had an impact on supply and demand. For example, despite stagnant demand for lubricants in the first half of 2020 due mainly to reduced plant operations, we expect growing demand for automotive lubricants and other products in step with an upturn in logistics and transport demand caused by changing consumer trends. As vehicle sales in Japan have leveled off, both car and automotive parts manufacturers are moving overseas, and the market for automotive motor oil is shifting to emerging countries

in Asia and elsewhere. As for our medium- to long-term forecast, we expect an increase in new demand for the lubricants used in EVs and other automobiles amid the global trend toward realizing a decarbonized society. Regarding industrial lubricants, such as hydraulic and gear oil for industrial machinery, we expect a global increase in demand for environmentally friendly, high-performance products that meet the need for energy and resource conservation.

Medium-term Management Plan

In the field of automotive lubricants, we make full use of advanced tribology to provide OEM products (to be branded by our partners) that meet customer needs and support their business development. Overseas, we are expanding our production and sales bases, especially in China and emerging Asian countries, where demand is expected to grow. In November 2019, Idemitsu Lube Pakistan opened the Group's 40th lubricant sales location overseas. In addition, in the market for EVs, which are being promoted to help realize a decarbonized society, we are working to develop products suited to electric-powered units and grease that meets the need for higher

heat resistance associated with lower noise motors.

As for industrial lubricants, such as hydraulic and gear oil for industrial machinery, we are developing high-performance environmentally friendly products that meet the energy and resource conservation needs in line with heightened interest in environmental issues. In September 2020, our work on developing lubricants for wind power stations was chosen as a subsidized business of the New Energy and Industrial Technology Development Organization (NEDO), a national R&D organization.

New Development of Axle Fluid for EV Motor Units

In December 2019, we developed IDEMITSU E AXLE FLUID, a fluid specially designed for the E AXLE driving unit used in EVs and hybrid cars (HEVs) that features excellent brake lubrication, clutch performance, and motor cooling properties. The E AXLE is essentially a driving unit that integrates a motor, an inverter, and brakes. It can turn a gas-powered car into a hybrid with minimal design changes and can also be used in EVs. For these reasons, it is being widely used, especially by automotive manufacturers in Europe and China. As an OEM product, IDEMITSU E AXLE FLUID has been rolled out to over 28 countries worldwide from our lubricant sales bases, and we are considering selling it as an Idemitsu brand product.



IDEMITSU E AXLE FLUID

HIGHLIGHTS

Starting Production at Our Lubricant Manufacturing Plant in Huizhou, China

In July 2020, we began operations and production at the Huizhou Plant through Huizhou Idemitsu Lube Co., Ltd., our second directly operated lubricant plant in China. With an eye to increasing supply capacity, the plant was constructed to meet growing demand for high-performance lubricants in China, and has brought the Group's current total lubricant supply capacity in China to 290,000 kL per year. We will continue striving to enhance our stable supply and sales system across Mainland China, which has the world's highest demand for lubricants, with the aim of strengthening and expanding our business as a global supplier of lubricants.



Huizhou Idemitsu Lube Co., Ltd., Huizhou Plant

HIGHLIGHTS

Advanced Materials & Performance Chemicals

Strengths

- Accumulation of technological development capabilities and expertise related to functional materials needed for cutting-edge products
- Positioning of global business bases for various functional chemicals

Risks

- Economic slowdown and lower demand due mainly to prolonged U.S.-China trade tensions and COVID-19 pandemic effects
- Price stagnation and deterioration in supply and demand due to market entry of other companies and intensifying competition to develop new technologies
- Structural changes in demand due mainly to technological innovation and emergence of new products

Opportunities

- Growing demand for functional materials amid economic development and population growth in Asian regions
- Increase in new demand accompanying technological innovations, including for automotive and electronic parts and telecommunication devices

Business Environment

Due to economic sluggishness in the wake of the pandemic, functional materials have seen demand decline for some products, such as engineering plastic, which has suffered amid stagnation in the automotive industry; however, demand grew for other products, including PLALOC™ zipper tape for food packaging and low molecular low modulus polypropylene (LMPP), a nonwoven fabric product used for facemasks and other items.

Technological innovation is rapidly advancing in such fields as

EVs and high-speed telecommunications, where advanced materials are used, and the standard of living is continuing to rise in emerging countries due to increasing incomes. For these reasons, our medium- to long-term forecast is that demand for automobiles, home appliances, and daily commodities will grow, especially in Asia. However, factors that could negatively impact supply and demand conditions include an expansion in new functional materials manufacturing facilities established by Chinese or other interests.

Medium-term Management Plan

In the advanced materials and performance chemicals business, we handle high-performance products with unique technologies. These include engineering plastic (for use in automotive and electronic parts and telecommunications devices) as well as hydrogenated petroleum resin (for use as an adhesive for disposable diapers and other hygiene products). To make this business a pillar of the functional materials segment, in line with the policy of expanding our business scale and scope, we are working to expand production facilities in Japan and overseas, especially in Asian regions where demand is expected to grow.

More specifically, Malaysia is the site where we are constructing our second manufacturing facility for syndiotactic polystyrene (SPS), which is used in high-speed telecommunication devices and other sophisticated devices. To this end, we have established Idemitsu Advanced Materials (Malaysia) Sdn. Bhd.. Commercial operations are slated to begin in the second half of 2022, which will double our current production capacity, and we will continue working to strengthen our sales and research framework.

Demand is growing in China and Southeast Asia for our proprietary hydrogenated petroleum resin (product name: I-MARV™),

which has excellent performance as an adhesive for hygiene products. Against this backdrop, we established Idemitsu Formosa Specialty Chemicals Corporation jointly with Formosa Petrochemical Corporation in Taiwan, which is situated near areas of high demand. The two companies are moving ahead with the construction of manufacturing facilities, with commercial operations set to begin in FY2020.

Going forward, we will continue accelerating business growth, partly via efforts to acquire resources through external collaboration and M&A.



Car parts made from SPS resin (product name: XAREC™)

Electronic Materials

Strengths

- Accumulation of technological development capabilities and expertise related to OLED materials
- Possession of patents for materials that have an advantage in the area of blue-light emission, an area of special technical difficulty, for OLED panels
- Global supply framework for OLED materials

Risks

- Lower display-related demand due to economic stagnation caused by prolonged U.S.-China trade tensions and COVID-19 pandemic effects
- Price stagnation and decline in market share due to market entry of other companies and intensifying competition to develop new technologies
- Structural changes in demand, such as sluggish adoption of OLED TVs due to technological innovation and the emergence of new products

Opportunities

- Growing demand for products using displays amid economic development and population growth in Asian regions
- Progressing shift from liquid crystal to OLEDs for such varied displays as those for smartphones, PCs, tablets, and vehicles

Business Environment

Due to economic sluggishness in the wake of the pandemic, we expect a decline in demand for electronic products and parts, including smartphones and TVs. That will, in turn, impact sales of electronic materials in the short term.

On the other hand, over the medium term, with South Korean and Chinese display manufacturers aggressively investing in OLED

display manufacturing facilities, we expect the shift from conventional LCDs to OLED displays to continue for smartphones, large-screen TVs and many other products. In addition, demand is expected to grow in line with the expanding market, such as the launch of foldable smartphones that make use of the flexibility of OLEDs.

Medium-term Management Plan

As our business centered on OLED materials and oxide semiconductors expands, we will promote the development of new businesses and applications. Regarding OLED materials, we completed construction of a new OLED materials plant in Chengdu, Sichuan Province, China. The Company's third such plant, complementing those operating in Japan and South Korea, began commercial operations from July 2020. In tandem with this overseas business expansion, we will continue to deepen our relationships with display manufacturers and other development partners as we work to develop high-performance next-generation materials that

help displays save energy and last longer, including our superior blue light-emitting materials.



OLED materials

Achieved World Record Technological Development in Next-Generation OLEDs



In our joint efforts with Toray Industries, Inc., we achieved the world's highest luminous efficacy, with a near practical range and a long life span, in an OLED device that uses thermally activated delayed fluorescence (TADF). We expect this will become a next-generation technology. In November 2019, Idemitsu and Toray released joint press releases about the technology and gave a joint presentation at an international workshop. By

adopting technology that uses TADF materials instead of the currently dominant phosphorescent materials, we expect to help create OLED displays that are lower cost, save more energy, and offer a wider range of colors. We will continue to pursue development aimed at quickly achieving the practical application of this technology for smartphones, TVs, and more.

HIGHLIGHTS

Bitumen (High Performance Asphalt)

Strengths

- Accumulation of technologies and know-how as Japan's only comprehensive asphalt manufacturer
- A resilient sales network with dealers
- Technological alliances with the national government and road construction companies (including joint research)

Risks

- Declining domestic population and depopulation in rural areas
- Labor shortages, especially in construction and transport industries

Opportunities

- Growing demand for reductions in environmental impact and CO₂ emissions
- Growing need for longer lasting pavement and asphalt recycling
- Expanding demand for asphalt products in Asia and the Middle East

Business Environment

In line with the government's policy to strengthen its national resilience for infrastructure and the economic and social system, the domestic road-related budget remains at a high level, and demand for functional asphalt is expected to remain firm. As environmental awareness increases and the population structure changes due to

the declining birthrate and aging population, there is growing interest in asphalt paving technology that contributes to CO₂ reduction, asphalt recycling technology, and extended-life pavement technology. In Asia and the Middle East, demand for functional asphalt for both paving and waterproofing is expected to increase as local economies grow.

Medium-term Management Plan

As a "comprehensive asphalt manufacturer" that supplies asphalt for a wide range of applications, for roads, waterproofing materials for housing and industrial materials, we will fulfill our social mission of supporting infrastructure in Japan. Specifically, we are contributing to the reduction of CO₂ emissions from road construction and the reduction of road life-cycle costs through the development of

various asphalt products, including technology for improving workability by greatly reducing the allowable paving temperature, technology for recycling high-quality pavement, and technology for longer-life pavement and improved durability.

We will also expand technologies developed in Japan to build infrastructure in Asia and the Middle East.

Agri-bio Products

Strengths

- Expertise in developing, manufacturing, and selling biological pesticides and feed additives, for which demand is expected to grow, especially in Europe and the United States

Risks

- Stagnation of the pesticide market in Japan due to declining population and farming area
- Widening gap in business size due to the integration and reorganization of competing overseas companies

Opportunities

- Expanding pesticide market in line with growing global population and food demand
- Shift in demand from chemical to biological pesticides due to tightening environmental regulations, especially in Europe
- Growing need for natural materials that can enhance agricultural productivity

Business Environment

Although there has not been a significant change in existing demand in the short term amid the pandemic, going forward it is possible that the gain in new demand may be sluggish.

Over the medium term, as global population increases and food demand increases, there are concerns that regions with agricultural production will experience a decrease in available arable land, an increase in feed grain consumption due to rising meat demand, and

an increase in serious damage to agricultural products caused by drought and other abnormal weather conditions. As a result, demand is increasing for agricultural materials that support efficient food production. At the same time, the need for such naturally-derived materials as biological pesticides continues to increase due to the tightening of regulations on the use of certain chemical pesticides and antibiotics, mainly in Europe.

Medium-term Management Plan

Through our microbe- and plant-derived biological pesticides and feed additives, we are promoting the development and sale of agricultural materials in line with needs on the production frontlines and contributing to enhanced food safety and agricultural productivity. To expand the scale of our business in the biological pesticide field, we have concluded agreements with multiple companies, academic organizations, and other groups and are now considering new collaborations. In the field of feed additives, we entered into collaborations with partners with the aim of overseas expansion. In these and other ways, we will continue promoting initiatives aimed at expanding into new markets.

In addition, we will continue to develop products that meet the increasingly stringent regulations for chemical pesticides, antibiotics, and other products, especially in Europe. A specific new development is that in May 2020 we began sales of *Swirmite*, a biological control agent safe for both the environment and people that uses phytoseiids, which are a natural predator of vegetable pests.



Biological control agent *Swirmite*

Lithium-ion Battery Materials

Strengths

- High-performance sulfide-based solid electrolyte materials and mass-production process technology
- Competitive proprietary manufacturing technology for solid electrolytes raw material (lithium sulfide)
- Ability to procure some solid electrolytes raw material from our own refineries

Risks

- Potential market entry of other companies and intensifying competition to develop new technologies
- Progress in development of next-generation batteries through technological innovation to lower the cost and improve the performance of existing liquid lithium batteries

Opportunities

- Growing demand for all-solid-state lithium-ion batteries that meet the increasing need for long driving range, safety (flame resistance), and convenience (short charging times).
- Growing demand for batteries and battery materials due to the promotion of EVs amid global warming and other issues

Business Environment

Lithium-ion batteries boast higher capacity than primary batteries and their market has expanded alongside their growing use in smartphones, laptops, and other products as rechargeable secondary batteries. They are also finding wider use as batteries for EVs and hybrid cars, which have become more commonplace in recent years. Going forward, the market for these batteries is expected to

expand for residential use, industrial use, and such consumer applications as 5G devices. Regarding electrolytes, which are a main component of lithium-ion batteries, technological innovation is accelerating from the currently dominant liquid type to a solid-state type. All-solid-state lithium-ion batteries are expected to be commercialized in the mid 2020s.

Medium-term Management Plan

By creating solid electrolytes for lithium-ion batteries, we have significantly shortened charging times and improved storage capacity and safety performance, and all-solid-state batteries are expected to be used more widely in EVs in particular. We have developed sulfide-based solid electrolytes and can procure the main raw materials from its own refinery facilities. This type of electrolyte is characteristically high-performance (highly conductive) with consistent quality that can be stably produced. We are accelerating development of solid electrolytes and constructing compact demonstration equipment within the Chiba Complex for mass production with the aim of commencing operations at the beginning of FY2021.

Going forward, we are aiming for the commercialization of solid electrolytes. We are striving to further enhance quality and pare costs while building an integrated production and stable supply framework that effectively spans raw materials through finished products.

Over the medium to long term, we are working to realize a smart society in part by developing businesses related to battery life cycles, from raw materials to waste batteries, and developing other materials that seize on the trend in all-solid-state battery development.