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Pursue Essential Research to unleash breakthrough innovations that help realize more sustainable lifestyles by solving social issues and easing people's pains.

Kao's creating value to address social issues

Social issues we are aware of

The economic and production activities that have supported our way of life also produce carbon dioxide and other greenhouse gas emissions that cause temperatures to rise, and therefore, mitigation measures as a strategy to reduce these emissions need to be accelerated as an issue of the highest priority. So far we have taken steps to reduce carbon dioxide emissions, such as making efficient use of natural resources and developing energy-saving and water-saving products, but to realize the future decarbonized society, resource circularity initiatives for plastic packaging are another important cross-industry issue.

In addition to taking steps to cope with the heat as part of adaption measures to reduce risks associated with heat waves and water disasters caused by these rising temperatures, we also need to build a more resilient society.

COVID-19 emerged in 2019 and has changed how we think and act in our daily lives. R&D activities on hygiene, diagnosis and treatments as part of adaption measures for new and re-emerging infectious diseases—whose occurrence is said to be only be a matter of time—are increasingly important.

The COVID-19 pandemic has become an opportunity to take another look at the connections between people and the wider society. It has also reminded us of the importance of social acceptance for diverse values and enabling people's physical, mental and social needs to be met (well-being).

Risks related to realization of What Kao Aims to Be by 2030

It is our responsibility to create a society that offers safety and security. Our goal is to realize enriched lives and a sustainable society in which no one is left behind, where everyone can confidently lead Kirei lives every day with vitality and peace of mind.

In this, the frequent occurrence of natural disasters caused by climate change, environmental pollution caused by increasing amounts of waste, and water insecurity not only lower consumers' quality of life (QOL)—they are also serious risks in terms of the continuity of our business activities. Changes in society due to the global pandemic in particular have also transformed the role of companies in society.

Opportunities related to realization of What Kao Aims to Be by 2030

Since our founding, we have embraced the ethos of responding to social issues with safe and reliable quality. Swiftly identifying changes in consumers' lifestyles and social issues, we use science to reveal the mechanism of phenomena and, using technology, connect this to product creation that meets diverse needs. Going forward as well, we will be able to give consumers and customers new experiences and satisfaction through products and services that leverage our strengths in research findings and technology assets built up in wide-ranging business domains, as we have done with precise interfacial control technology, where we have built up expertise and deployed it for a diverse range of products from clothing to precision electronic components.

Various risks including social issues and uncertainty that cannot be solved by one company alone, for example environmental and infectious disease countermeasures, are projected to increase. Along with strengthening internal collaboration, while cooperating broadly with consumers, customers, industry, government, academia and others, we will increase the velocity of our technology and product development and make daily life more fulfilling for consumers around the world with our unique and novel approaches.

Kao's creating value

Through the fusion of science and technology, we will continue striving to solve issues from the perspective of people, society and the environment, and to create value.

The human perspective

We have strived to enhance consumer QOL. From the human perspective, together with ways to reduce the burden of housework and realize diverse beauty that we have offered so far, we also continue to conduct research on protecting people from bacteria and viruses and preventing lifestyle diseases and geriatric syndromes, with protecting consumers' lives as our highest priority.

In addition, by combining our research findings and scientific data on the skin and health that we have collected so far with biological information including RNA, we aim to offer individually customized, precision life-care proposals and realize well-being so that everyone can lead comfortable, beautiful and healthy lives.

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The social perspective

From the social perspective, we are deploying our expertise in the mechanisms of propagation and inactivation of the causes of infectious diseases, revealed through exhaustive research on microbes and viruses, to create products and services, and making use of this knowledge in infection countermeasures taken in daily life, public health, hospitals and other medical facilities.

Moreover, we are contributing to the creation of a safe society by offering highly functional chemicals for road and bridge construction such as *Visco Top*, which does not pollute water, as well as asphalt additives that enhance pavement durability and useful life.

The environmental perspective

From the environmental perspective, we are working to realize a recycle-based society by adhering to the 4Rs for packaging, reducing the use of plastic, recycling used refill packs for further use, and developing technology to recycle reprocessed materials back into containers and film. In addition, we are also attempting to create business by taking waste materials and turning them into new value. We are also working to reduce the environmental impact of consumer product contents, and continue to research ways to utilize natural raw materials such as inedible biomass and to reduce the amount of water and energy consumed during product use.

Contributions to the SDGs



Policies

We have adopted the following three basic policies for our R&D activities.

1. Create the seeds for new businesses
2. Bring about innovation that creates new customers' needs in existing business domains
3. Share scientific technologies with society

Based on these basic policies, we seek to enrich people's lives through innovation and advance our research activities while embracing two approaches.

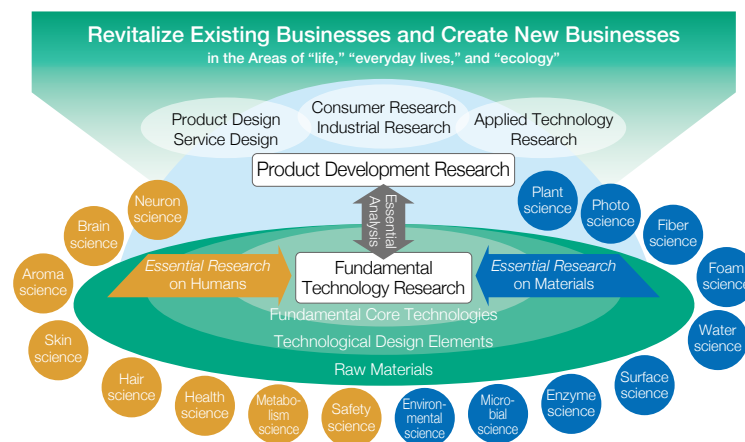
One is pursuing Essential Research, which is driven by our passion for discovery. Essential refers to the universal nature and root causes that are revealed through exhaustive investigation of objects and phenomena using the lens of science, which offer clues to solutions to issues and spark ideas for new

technologies and consumer and customer value creation.

The other approach is promoting technology innovation to create the seeds for new businesses and products. We have many technology assets built up through Essential Research on humans and materials. In addition to deploying our core technologies such as interfacial control, reframing our technology assets in terms of solving social issues will enable us to design products that will strengthen our existing businesses and realize the Kirei Lifestyle. And we will bring new businesses to fruition by creating technology solutions and value using backcasting.

By continuing to build on these activities, we will create innovations that will have major positive impact on people's lifestyles and contribute to people and society through *Yoki-Monozukuri*.

Essential Research



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Education and promotion

To advance our R&D activities, we must develop individual researchers' advanced specialization, creativity and originality as well as foster a culture in which many researchers work together to take on challenges in new fields.

For this purpose, we have established a research report database that all researchers can access to independently browse internal research findings, technology assets and the latest research results. We also provide opportunities to engage with leading-edge science and technology through lectures and technical guidance provided by outside experts.

In addition, we hold presentation sessions with participation and discussion open to all researchers to create opportunities for collaboration where new discoveries can be made through the exchange of ideas. Using an online conferencing tool, over 100 researchers participate each session, which is helping generate innovation. Focusing on efficiency gains through the use of digital tools as well as dialogue, we are establishing awareness for tackling challenges related to realizing the ideal sustainable society of the future.

Collaboration and engagement with stakeholders

Multi-faceted linkage and collaboration between industry, government and universities are necessary to solve challenging environmental and social issues. Open innovation is one example of this approach. New value is created when two or more parties mutually supplement and

combine their technology strengths, and this enables products and services to be quickly delivered to consumers. Especially when it comes to realizing a sustainable society, collaborating with companies that are tackling the same social issues is necessary. When it comes to our efforts for packaging as part of resource circularity, we collaborate through field testing, aiming to establish technology and realize swift social implementation.

By presenting important knowledge gained through R&D activities at academic conferences and through publications, we strive to propagate science and technology. This has earned us recognition, including awards for various technologies that reduce environmental impact.

Framework

We are promoting matrix management in our R&D Division to gather knowledge across business and technological boundaries. Each of our research laboratories reports directly to the R&D Division, with flexible cross-team coordination between the Fundamental Technology Research and Product Development Research laboratories as the situation demands. This helps us also respond swiftly to climate change trends with product suggestions.

To generate innovation, we need to transform technology into new consumer and customer value and realize swift social implementation in the form of products and services.

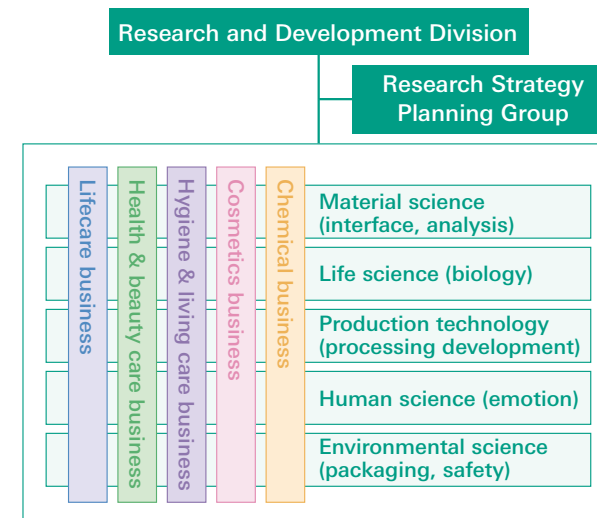
In our existing business domains of beauty, health, cleanliness and the environment, our Product Development Research laboratories link their activities with our business strategy to quickly establish policy for the proposed value and continue offering innovative products.

In new business domains, we are examining solutions we can offer in healthcare and skin care as well as new businesses such as hygiene services that target social issues such as infectious diseases, population aging and treatments, based on deploying technologies and data we have built up in fundamental technology research and product development research as well as collaborations involving leading-edge external technologies.

By sharing these R&D policies with management and business divisions at strategy meetings, etc., and by confirming strategy implementation and progress in annual plans, we are increasing the speed of our decision-making and velocity of our global growth.

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Research and Development structure



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Mid- to long-term targets and performance

We will advance innovation, aiming to strengthen existing businesses and create new businesses. In our existing businesses, we will meet the expectations of consumers and customers and realize a sustainable society by providing safe and reliable quality as well as environmentally friendly products and services. In new businesses, we aim to make new proposals for social issues such as infectious diseases, hygiene and population aging.

2030 long-term targets

We have prepared concrete activity plans for two research objectives to ensure that all researchers conduct R&D activities with a high level of awareness.

1. Propose products with major positive impact on lifestyles

Propose ten or more product releases by 2030 incorporating innovations capable of causing major positive change with respect to lifestyles, society or the environment (cumulative beginning in 2019)

2. Propose businesses and schemes with major positive impact on lifestyles

Propose ten or more businesses or schemes by 2030 incorporating innovations capable of causing major positive change with respect to lifestyles, society or

the environment (cumulative beginning in 2019)

Anticipated benefits from achieving mid- to long-term targets

Business impacts

We will achieve higher sales from new or improved products and create new business areas through R&D activities.

Social impacts

We will solve environmental and social problems, and realize a resource-circulating society and safer, more reliable, healthy lifestyles by offering distinctive technologies and innovative businesses and products.

We aim to become a needed presence for people around the world by continuing to create and offer technology solutions and value.

Transformative innovation

Performance in 2021

In terms of infection countermeasures, we launched body wash products that wash away viruses and bacteria as well as products that have lasting antiviral properties. We are developing recycling technology to take used plastic containers and turn them into products for the same application, toward realization of a resource-circulating society.

At the Kao Group Technology innovation session in November 2018, we announced our new technologies in five domains: skin, health, hair, surface chemistry and environment.

One of these is Bio IOS, an environmentally friendly surfactant obtained from natural raw materials that do not readily compete with food resources. Including the surfactant in product formulations makes it possible to reduce carbon dioxide emissions, and it received the Minister of Economy, Trade and Industry Award in the Green and Sustainable Chemistry Awards organized by the Japan Association for Chemical Innovation.

In 2019, we deployed our Fine Fiber Technology, which forms an extremely thin, natural membrane on the skin through deposition of ultra-fine fibers, in a skin care serum. We are advancing research to deploy the technology in more products, and in 2021 we found that its

unique structural properties attach to and remove PM2.5 and other polluting airborne molecules, and that it offers functional protection from friction and other physical irritants.

Skin surface lipids-RNA monitoring makes visible precise, day-by-day changes in skin and body condition, and in 2020 we began testing its use in beauty counseling. The expertise to estimate the progression of skin aging, which differs from person to person, and the potential for early diagnosis of Parkinson's disease, are the results of open innovation, and we plan to connect these results to business and solving social issues.

We believe that we will have achieved innovation not just when we propose products and services that mobilize the features of the respective technologies, but when this changes how people live their lives and enriches society. We are advancing proposals as planned for our long-term goals. In this, it is not only the number of proposals that is important but also the speed with which the technology is deployed in products and services. We are looking at ways to measure the actual impact of innovation sparked through these efforts while quickly meeting market and customer requests and deploying unique technologies in wide-ranging products.

Transformative innovation

Our initiatives

Brands launched in 2021 that epitomize the Kirei Lifestyle

Essential Research on Humans: Product development for consumer-focused infection countermeasures

As infection countermeasures, we are proposing products with our Essential Research and technologies that alleviate people's worries.

We learned that ethanol-based hand sanitizer tends to not get adequately rubbed all over the hands. While it had been a challenge to dispense our existing sanitizer as foam, *Bioré Guard Sanitizer Foam* is designed to dispense as a foam using a pump foamer. This makes it less prone to spilling and easier to apply the active ingredient all over the hands as the foam changes to a liquid after being dispensed. In Indonesia, we released the gel-type *Bioré Guard Gel Hand Soap Eucalyptus Scent Antibacterial*, which matches local lifestyle preferences.

People are also more aware of viruses and bacteria adhering to them while they are away from home. To meet needs related to this and expand hygiene practices to the entire body, we released a medicated body wash product that can also be used for washing the hair and is formulated with sanitizing ingredients. For clothing as well, we are offering *Resesh Disinfecting EX Protect Guard*, which has lasting ability to reduce the amount of virus adhering to clothing just by spraying it on clothes before going out.

We announced our findings about the homeostatic natural bacterial and viral barrier function

of human hands and individual differences in the effect and how lactic acid contained in sweat secreted from the hands, the pH level and temperature of the hands play an influential role in this function. Based on new findings from our Essential Research on Humans, as well as our wide range of product offerings, we will develop products that safeguard people from infections in various daily situations and that are easy to use for everyone from children to the elderly.

Essential Research on Humans: Protecting human lives by opening up new domains

We are opening up new domains for protecting human lives by making maximum use of our technology assets. One of these is our obtaining of VHH antibodies, which have the ability to inhibit (neutralize) infection from novel coronavirus (SARS-CoV-2), in 2020. Kitasato University, Epsilon Molecular Engineering Inc. (EME) and Kao collaborated on this research. EME provided a screening system (cDNA display) able to select VHH antibody candidates in a short period of time. Using this, we prepared the candidate VHH antibodies, and together with Kitasato University confirmed the binding of the VHH antibodies to novel coronavirus particles and their neutralizing capacity. We also reported that nasal delivery of these antibodies inhibits replication of the novel coronavirus in animal models.

We aim to contribute to preparing candidate VHH antibodies and to build basic production technology

for VHH antibodies using our technology to cultivate and genetically modify *Bacillus subtilis* bacterium built up through work in enzymes for laundry detergents. Currently, the National Institutes of Natural Sciences and Shionogi & Co., Ltd. have also joined this project. Under the Japan Agency for Medical Research and Development, we are developing antibody-based therapeutics for COVID-19, including variants, as well as developing antibody-based therapeutics for respiratory infections.

Transformative innovation

Essential Research on Materials: Social implementation of environmentally friendly functional materials

Cellulose nanofiber

We are also working to develop technology that not only removes dirt and stains from the target objects, but also modifies their surface so that dirt and stains do not adhere to them. Taking hints from the functions and structures of living organisms, such as the surface of snail shells and the pitcher fluid of tropical pitcher plants, we combined these hints with cellulose nanofiber (CNF), a high performance, sustainable material derived from wood that is attracting attention globally. We then successfully applied the result to products and created surfaces where dirt and stains did not stick but simply slid off. Hydrophobic modified CNF blends well with lubricating oil and keeps lubricating oil firmly adhered to the surface of objects. Examples of applying this technology are having bird droppings slide off solar panels and having snow accumulation slide off roofs. In water, hydrophobic modified CNF emulsifies in the shape of beads coated with lubricating oil, and these beads form a structure on the surface of target objects to create a laminating film able to maintain a slippery surface over a long period of time. This aqueous coating agent is safe and reliable for workers and the environment.

We will create new businesses and strive to realize sustainability in society by reusing waste materials and creating natural materials with higher performance.

NEWTLAC 5000 asphalt additive

With the recent widespread uptake of hybrid and electric vehicles and future self-driving vehicles, vehicles driving on the same roads and heavier vehicles will become placing greater burden on road pavement. The importance of creating more durable pavement is expected to rise. Using upcycling technology for low-quality waste PET, we have created *NEWTLAC 5000*, an asphalt pavement modifier that can be easily used in road construction. Adding this product to pavement strengthens the adhesion of rocks and sand to asphalt, and increases pavement durability more than five-fold compared with standard pavement. This product is the aggregate of our core technologies in interfacial properties control and functional molecular design. Going forward, we aim to have a large number of customers use this product and contribute to sustainability in society.

Employees' voice

Yusuke Akino

R&D - Performance Chemicals Research 1,
Kao Corporation



When Kao was pivoting to ESG-driven management, we created this product through a series of discussions with sales and research divisions by focusing on the serious social issue of waste plastic, with the goal of creating a product able to make greater environmental contributions.

Quickly creating a product that met the needs of the times was the result of innovation born from an "all Kao" approach.

We will continue offering pavement that is gentle to both people and the global environment and contribute to safe and reliable community development.