Feature article: Executive Officer's interview

Supporting society through chemistry

Helping to build a sustainable future with exhaust catalyst technologies

Masatoshi Yoshimura
Executive Officer, General Manager of R&D Center

Our social mission

Reducing harmful substances contained in automotive emissions is one of the important issues facing our society. To fulfill our social mission of protecting health and the environment by cleaning the air, we have been developing and manufacturing exhaust catalysts.

Air pollution in the mid-1970s led to the establishment of emissions regulations. Although the required technology has changed in response to repeated tightening of regulations, we have consistently strived to improve the performance of exhaust catalysts.

Since commencing catalyst production at our current Numazu Plant in 1979, we have leveraged our expertise in precious metal salts and precious metal catalysts to improve manufacturing methods in an aim to achieve both enhanced catalyst performance and mass-production feasibility. We have also strengthened our engine evaluation facilities for catalysts and worked to enhance our analytical and characterization technologies. I believe this accumulation of efforts is one reason our customers have placed their trust in us for many years.

Adapting to tighter emission regulations

Recently, driven by the decarbonization trend, the automotive industry has rapidly advanced electrification theme of trying to reduce fossil fuel consumption. However, vehicles equipped with internal combustion engines, such as those run on gasoline and diesel cars, are now being re-evaluated for their advantages in driving range and resilience during winter (reliability in cold climates). Meanwhile, global emissions regulations, such as Euro 7 and the U.S. Tier 5, are becoming increasingly stringent. To meet these needs, we will continue our R&D efforts on the development of catalysts for internal combustion engine vehicles to further enhance their performance.

Achieving even lower emissions requires not only developing common foundational technologies but also precise catalyst designs tailored to vehicle type, engine characteristics, and usage condition. We will further optimize catalyst composition, coating amounts and patterns, and other factors to maximize the environmental performance of powertrains, adapting to variations in exhaust gas temperature and driving conditions.

Technological innovation for diversifying powertrains

Beyond gasoline and diesel vehicles, the trend toward decarbonization is driving powertrain diversification, and this includes electrified vehicles like hybrid electric vehicles (HEVs) and plug-in hybrid electric vehicles (PHEVs), as well as vehicles using ethanol-blended fuels or hydrogen.

For these vehicles, exhaust gas composition, temperature, and even driving modes differ significantly from conventional internal combustion engines, and this necessitates the development of new catalysts capable of delivering purification performance suited to their operating conditions. For example, because ethanol can produce aldehydes and oxygenated organics unlike conventional fuels, and hydrogen engines emit NOx, exhaust catalysts tailored to each characteristic must be developed.

Although the utilization of new fuels in the mobility sector remains in the proof-of-concept stage, and it is unclear which approach will become mainstream, we continue to pursue challenges, aiming to create technologies that contribute to realizing a carbon-neutral society by advancing research and development with diverse options in mind.

Electrocatalyst development aimed at realizing a hydrogen society

We have also focused on fuel cell technology that emits no harmful gases and have been working for more than 20 years on developing the electrocatalysts used in fuel cell vehicles (FCVs). Achieving higher-performance electrocatalysts is a critical issue for the wider adoption of FCVs.

Therefore, leveraging our extensive expertise in platinum-based catalysts accumulated over many years, we are advancing the development of electrocatalysts that achieve high activity and durability while reducing precious metal usage. Moreover, the physical properties of the support material carrying the platinum are also crucial for enhancing catalytic performance, and we are researching cutting-edge materials worldwide, such as porous carbon.

As the advent of a hydrogen society becomes more realistic, we aim to fulfill our role as a catalyst manufacturer by supporting the core technologies of FCVs, which are attracting attention as next generation mobility. Furthermore, by reducing platinum usage, we seek to achieve both resource conservation and cost reduction, and we believe this will contribute to the widespread adoption of FCVs by lowering vehicle prices.

From mobility to industrial applications — expanding application areas

We are also focusing on ammonia utilization technologies from a carbon neutrality perspective. Ammonia serves as a hydrogen carrier and has the advantage of emitting no CO_2 when burned. For this reason, it is being introduced in industrial applications such as thermal power generation and fuel for ships, and we see it as one of the first carbon-neutral fuels most likely to be implemented in society.

On the other hand, ammonia combustion tends to generate by-products such as unburned ammonia, NOx, and N_2O (a greenhouse gas). Leveraging the catalyst technology we have cultivated for automotive exhaust emissions, we are developing catalysts that effectively treat these by-products.

In this way, the technology refined in automotive exhaust purification is now expanding beyond mobility into the industrial and energy sectors. We aim to contribute to addressing global challenges facing our society across an increasingly diverse range of applications through the power of catalysts.

Feature Article: Officer Interview

Quality that supports invisible reliability

Catalysts are located inside the vehicle and cannot be seen directly by users. Precisely for this reason, we pursue reproducible quality to ensure stable performance in all environments.

Our strength lies first in our deep expertise on the materials and analytical capabilities. Catalysts do not function simply by mixing precious metals and their carriers. Numerous parameters interact complexly, such as the nanoscale structure of the support, the dispersion state of the precious metals, and interactions with additive elements. The test data and reaction-mechanism analyses accumulated over many years to control these parameters appropriately are valuable assets for our company.

In addition, during development, we must not only design catalysts that deliver specified performance but also consider mass-production feasibility. To prevent issues during mass production, we actively address potential manufacturing defects during the transition from development to manufacturing, and departments closely collaborate to optimize manufacturing conditions and select materials. We believe this cooperative framework is crucial for ensuring stable manufacturing.

Verification of catalyst performance is also indispensable for delivering high-quality products. Based on the actual operating conditions provided by customers, we conduct engine tests that simulate those conditions and supply catalysts that meet performance and durability requirements. We invest substantial resources in our engine evaluation system and pay meticulous attention to data accuracy.

Development framework that leverages knowledge and experience

Organizational collaboration and co-creation are essential to make the most of this knowledge.

The R&D center I was established in 2009 by integrating the auto exhaust catalyst development department, the process catalyst development department, and the analysis department. The collaboration within the center has been getting deeper over time leading to more active discussions. As a result, themes that previously seemed difficult to solve can now be addressed and solved in a short time by working across departmental boundaries.

In 2022, the Fundamental Technology R&D Department was established, and it supports the development of exhaust catalysts and process catalysts from a DX perspective by shortening catalyst design cycles and predicting performance using simulation technology.

For example, by reproducing and visualizing on computers the fluid behavior, temperature changes, and reaction distribution as exhaust gas passes through the catalyst layer, we can now analyze phenomena, which were previously difficult to fully understand, in advance. This enables more precise and efficient design than ever before, which leads to shorter period for development and optimization of prototyping and testing. Furthermore, we are pursuing DX with an eye toward predicting durability of the catalyst without conduction the actual durability test.

While the Fundamental Technology R&D Department's mission is to develop and utilize fundamental technologies, its activities extend beyond the R&D center. The department actively listens to the voices from the manufacturing field, and plays a key role in solving issues arising during mass production and in the design of production equipment. While solving issues, it also trains manufacturing department members, improves simulation skills in the field, and supports organizational self-sufficiency.

We also accumulate knowledge daily on advanced materials and new chemical reactions through collaboration with shareholders and academia. We are confident that this knowledge will become core technology for solving social issues in the future.

However, when it comes to real-world implementation of such technology, there are limits to what a single company can do. Therefore, we promote co-creation with external partners who share our aspirations, including in government-led R&D projects.

How to make the most of scarce precious metals

Precious metals such as platinum and palladium used in exhaust catalysts are scarce and reserves are also limited. Using these scarce resources to the fullest without waste is a key initiative toward a sustainable society.

Because the catalyst performance generally correlates with the amount of precious metal used, reducing precious metal usage while maintaining or even enhancing performance and durability is no easy task. Technologies such as nanoscale structural control and high dispersion have become crucial, and by applying them, we have reduced precious-metal usage in exhaust catalysts to roughly one quarter of what it was 20 years ago.

The technology we have cultivated to reduce use of precious metals contribute to society. One of our strengths is achieving both precious metal reduction and performance enhancement, and we would like to contribute to society by pursuing further technological innovation.

Toward a sustainable future

The environment we operate in is also undergoing significant changes as we move toward decarbonization. In particular, the automotive industry is facing a once-in-a-century transformation, and the catalyst technology supporting this evolution continues to advance. While keeping an eye on new technologies, such as the purification of gases emitted from carbon-neutral fuels, we will continue to pursue further advancements in our core catalyst manufacturing technology and make improvements to our existing exhaust catalysts.

In addition, we want to expand the application areas of our accumulated chemical knowledge and technological capabilities beyond mobility to support the sustainability of people's lives and society as a whole, while giving consideration to the environment.

An example of this is green hydrogen. We believe its implementation in society will come in the near future. We want to establish the various technologies necessary to build the hydrogen value chain that includes producing, storing, transporting, and using hydrogen, as early as possible and be ready to provide them at any time. We are committed to continuing development until such technologies are complete, while balancing them with our current business.

In addition, we aim to apply our catalyst technologies not only to the energy field but also to new areas such as reduction of food waste and healthcare. We will continue to take on challenges to realize a better future while fulfilling our social mission of solving social issues through chemistry.