



Fumiaki Iwasaki

Director, Managing Executive Officer, General Manager, Research & Development Division

Role of the Research & Development Division and R&D Policy

The raison d'être of the Research & Development Division is to contribute to the growth of the Tokuyama Group by supporting existing businesses and creating new businesses in the fields of ICT, healthcare and the environment through open innovation and the development of the Company's unique technologies. The main role of the division is to comprehensively understand the current state of the Tokuyama Group's technologies from a bird's eye view and to set and implement the development themes

necessary for future growth.

The Company strengthens marketing, which links the Company's technologies to the needs of society. The Company and the Research & Development Division are always considering who our customers are, whether we have a market, whether we are correctly managing schedules and whether prices meet the expectations of our customers, and this is beginning to produce results.

Characteristics of the Company's R&D

The Company develops new technologies and products with a main focus on the ICT, healthcare and environment fields, leveraging its unique technologies including those listed at right.

Particularly in the area of ICT, we have many themes related to miniaturization and 3D technology that utilize the Company's unique high purification technology. The Research & Development Division will continue to focus on pursuing these themes in cooperation with business divisions.

	Technologies and Products
Unique Technologies	High purification / Nitride reduction / Sintering / Sol-gel / Powder control / Crystallization, deposition / Electrode and membrane / Photopolymerization / Molecular design / Organic synthesis and direct hydration
Uses of Proprietary Technologies	Pharmaceutical ingredients / intermediates, IPA SE / TMAH high-purity chemicals for electronics manufacturing, semiconductor-grade polycrystalline silicon, fumed silica, materials for dental cavity treatment (composite resins), photochromic dye materials, hard coat materials, thermal management materials (AlN, BN and Si ₃ N ₄), technology for 100% recycling of waste gypsum boards

Achievements in Fiscal 2019

In the fiscal year under review, progress was made in the development themes almost as planned. A major achievement is that a new chemical solution for semiconductors and silica aerogel, "Airlica[®]," came very close to being adopted in customers' products.

In September 2018, the Taiwan Research Laboratory was established to promote open innovation with semi-

conductor manufacturers in Taiwan, a place with advanced semiconductor technology and the location of the Industrial Technology Research Institute (ITRI). In fiscal 2019, we began joint development with ITRI in the fields of healthcare including technology development for semiconductor-related products.

Future Strategy

In our medium- to long-term management strategy, the Company aims to become a global leader in advanced materials. We will put resources primarily into the fields of ICT, healthcare and the environment and will conduct research and development to expand and develop each business.

Reducing CO₂ emissions is an important management issue. We will promote the reduction of CO₂ emissions from technical aspects by developing technology for utilizing CO₂, forming alliances with external companies and helping develop business plans to create new businesses.

New Chemical Solution for Semiconductors

At the Tsukuba Research Laboratory, we are developing a new chemical solution for semiconductors to be used as release agents and washing solutions. We have always developed products from the customer's perspective, using the Taiwan Research Laboratory as a point of contact, to manufacture products that meet the needs of the manufacturers of cutting-edge semiconductors and that are in line with trends in the semiconductor industry where technology evolves rapidly.

While the Company has continued to enhance the quality and features of its products, it has failed to identify market needs accurately. As a result, many development themes have not resulted in commercialization. Considering this failure, in the development of the new chemical solution for semiconductors, we took full advantage of our high purification technology, one of the strengths of the Company, and responded thoroughly to cutting-edge semiconductor manufacturers' challenging requests for quality and speed. This is a major achievement resulting from our actions in line with one of the Company's values: Customer satisfaction is the source of profits. We plan to build a plant with the goal of launching the product in fiscal 2022.



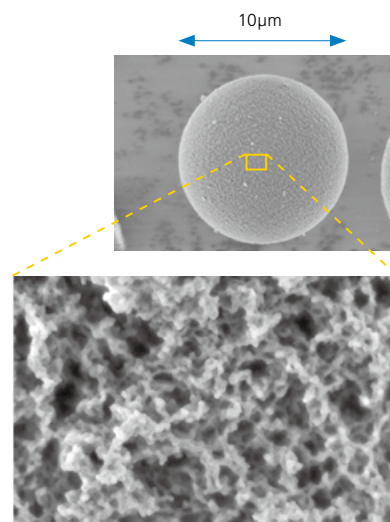
Development at the Tsukuba Research Laboratory

Airlica® Silica Aerogel

Development started when we generated an interesting type of silica using powder control technology, in which the Company has a leading edge.

Airlica® is a type of silica. Each particle has many pores, and it has high oil absorbance capabilities. It has a very smooth texture. With high oil absorbance capabilities and a smooth texture, Airlica® is a unique type of silica. We have decided to take advantage of these features to develop foundation and other cosmetic products using Airlica®.

We had no previous experience in the cosmetics field. We assessed the functions and features of products being developed and undertook comprehensive marketing along with making proposals to cosmetic manufacturers and providing samples. Currently, Airlica® is close to being selected by a major manufacturer for their cosmetic products and is in the process of final adjustments. We are also accelerating development of the second and third phases for cosmetic products following the development of Airlica®, with a view toward establishing a cosmetics business in the future.



A magnified photograph of an Airlica® particle, with many holes on its surface

New Thermal Management Materials (Aluminum Nitride Fillers, Boron Nitride, Silicon Nitride)

In the thermal management materials business, we will expand the business domain, augmenting the product lineup of nitride ceramic materials leveraging the Company's unique technology to achieve effective heat management, which is an indispensable part of improving the performance of EV, HEV and other power devices.

We are focusing on developing high-purity aluminum nitride, a mainstay product, and boron nitride, a product being developed, for fillers. Our goal is to see the products used in metal substrates, resin substrates and TIM.

Meanwhile, research and development and demonstration tests for mass production of silicon nitride will be conducted at the Center for Commercialization of Advanced Technology (Yanai City, Yamaguchi), which is expected to commence operations in 2021. Silicon nitride is a hard ceramic that does not break easily. In addition, it has high thermal conductivity. As increasing numbers of automobiles include computerized equipment, demand for silicon nitride to be used in the circuit boards of the electrical control parts installed in automobiles is expected to increase significantly. We will continue to develop products that are useful in the promotion of ICT.



Silicon nitride powder and ceramics