A century of surprising ceramics

NGK INSULATORS, LTD.

www.ngk-insulators.com/en/

Over the past century, NGK Insulators, Ltd. has successfully diversified from a supplier of insulators enabling the transmission of electricity to a vital supplier of automotive parts used to reduce exhaust pollutants and components used in semiconductor manufacturing equipment. The Japanese ceramics expert, NGK, continues its mission to bring world market-transforming ceramic innovations to sustain growth and contribute to society.

A history of successful diversification

Ceramics, one of the oldest industrial materials, is full of surprises.

When Taku Oshima, president of NGK, the Japanese industrial ceramics manufacturer, joined the company four decades ago, most of its revenues and profits came from selling high-spec insulators for the transmission of electricity. At the time, the company had just begun the mass-production of ceramic substrates for catalytic convertors used to reduce exhaust pollutants from cars. Today, half of all cars produced globally contain NGK's substrates, and its automotive-related ceramic products generate over 50 per cent of its revenues.

"As our company was a newcomer to the automotive market back then, we had no idea how big this would become. Now we are supplying an essential product to this industry which few others can," says Oshima.

Unexpected diversification has taken place in other directions as well.

Within the last decade, the company has emerged as a top supplier of critical ceramic components necessary for equipment used to manufacture semiconductors. Demand has surged along with the digital transformation of the global economy, with sales now contributing to about 16 per cent of the company's overall revenues. Oshima believes that despite temporary setbacks, such as international trade disputes, semiconductor market demand will only climb higher. 5G, AI, and IoT will fuel further demand for delivering computational power.

Recycling profits from core businesses to develop new products

Ceramic material is also versatile. The material has such desirable features as being highly resistant to heat and chemicals, non-conductive to electricity, while being durable and light. Combining it with other elements, mixing, firing, and aligning its crystals slightly differently generates new and surprising properties.

Not many, however, have mastered this material as well as NGK, which was founded in 1919 and just celebrated its 100th birthday in May.

Taku Oshima
President, NGK Insulators, Ltd.

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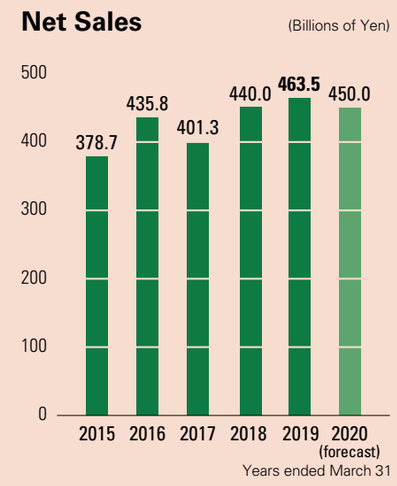
"Our company has always actively sought to develop new ceramic products and applications from our accumulated know-how," says Oshima. "What makes us different from others is not just expertise, but our ability to deliver uniform products of very precise quality at a global scale."

Indeed, NGK's products are critical for foundation industries. Grids in more than 100 countries rely on its ceramic insulators to safely deliver electricity. Automotive factories around the world depend on NGK to meet increasingly stringent exhaust regulations across the globe. Top semiconductor makers will grind to a halt without NGK's components.

For the automotive and semiconductor domains, the demand, in fact, has been so strong that NGK is on target to spend an unprecedented JPY 300bn on capital investment in the last three years, including for this one, to expand and open new factories in Japan, Poland, Thailand, and China. Profits from these core domains are being poured into R&D to maintain a "crucial cycle to keep the company on a growth track," Oshima explains.

The company has institutionalised innovation by setting the goal of increasing the share of new products to 30 per cent of total sales, which it achieved in 2017. It is now maintaining this ambitious target, even if that is becoming an even higher hurdle as overall revenue grows. For FY 2018, overall revenue hit a record JPY 463.5bn, 1.7 times larger than in FY 2008.



Tenacity to innovate

It is not only a relentless pursuit for new products, but also a tenacity in technological development that defines NGK. The company's NOx sensors, which are used to measure levels of nitrogen oxide exhaust from diesel vehicles in real-time, had been in development for more than 15 years before market demand took off. Strong demand for diesel trucks, buses, and construction equipment will continue to generate orders for such sensors in the coming years.

The same long-term determination towards development is evident in its unique NAS® batteries suited for renewable energy. The sodium-sulfur (NaS) batteries, developed by NGK from the mid-80s, became the first large-scale storage batteries to be commercialised in the world in 2002. Scalable, compact, and capable of charging/discharging huge amounts of energy, NAS batteries have already been set up worldwide at some 200 locations. Combined, they provide over 570 megawatts (MW) of output power and 4,000 megawatt-hours (MWh) of storage capacity.

These include the 108MW of storage in Abu Dhabi in the United Arab Emirates for the load levelling of thermal generation. Earlier this year, the country turned on this NAS battery storage plant, making it the world's largest virtual battery plant. The battery plant consists of 15 distributed battery systems controlled by the Centralized Integrated System Controller (CISC) which can work individually, in groups, or all together as a single 108MW/648MWh battery plant. NGK also signed a sales partnership agreement with German BASF New Business GmbH (BNB) that gives the company non-exclusive rights to sell NGK's NAS batteries through BASF's global channels.

"To reach net-zero emissions by 2050, as many countries and regions have promised, large-scale batteries for renewable energy will become absolutely necessary," says Oshima. "Only NAS batteries have the proven track record to meet such needs effectively and safely."

Sustaining the next century through ceramics

Looking forward, NGK is developing new, market-transforming ceramic materials and products—GaN wafers, chip-type ceramic secondary batteries, and subnano-ceramic membranes (see column)—with potential to transform the world in the coming century.

"It seems to be a pattern for NGK where we develop a technology and a competitive product, but market demand catches up later," says Oshima.

"Although it's impossible to know what the next century will bring, we plan to continue to nurture our expertise in ceramics to deliver innovations for the world."

The future of CERAMICS

Gallium nitride (GaN) wafers

The Gallium nitride (GaN) wafer is produced using NGK's original crystal growth technologies (liquid phase crystal growth method) and is considered to have the potential to unseat the ubiquitous silicon wafer due to its higher performance for high-frequency applications, resistance to temperature, and ability to sustain higher voltages. NGK is striving to realise next-generation power devices through joint research with Nobel Prize-winning professor Hiroshi Amano of Nagoya University. Earlier this year, the company won the Grand Prix Award in the Electronic Materials category at the Semiconductor of the Year Award 2019 held by Electronic Device Industry News.

In the initial phase, NGK is planning to produce GaN wafers as a substitute light source as an alternative to high-pressure mercury lamps used in projectors, stadium lighting, and car headlamps, among others. Demand is set to grow as the Minamata Convention, an international treaty signed by 128 countries, phases out mercury-added products.

The next phase is to mass produce GaN wafers for high-frequency devices and power devices.

NGK's GaN wafers could generate huge energy savings by replacing silicon ones in a wide range of applications including amplifiers for wireless communication signals, inverters for electric vehicles, as well as power conversion equipment for photovoltaic power.

"EnerCera®" batteries

Another product taking off is NGK's "EnerCera" battery series. The chip-type Li-ion secondary battery with ceramic plates as electrodes has high capacity and high-temperature resistance, making it ideal for mounting on thin and compact applications. Within this year, "EnerCera" has won both the 2019 CES Innovation Awards in Smart Energy and the grand prix in the device and technologies division of the CEATEC Award 2019. "EnerCera" has potential applications in IoT devices, smart cards, electronic shelf labels, and RFID tags. Mass production commenced in April 2019 and sales are expected to be driven by the expanding market for smart cards and wearable IoT devices.

"We have been contacted by dozens of companies interested in EnerCera," says Oshima. "In a world where security is always a concern, these chip-type batteries could be used to run fingerprint authentication for credit cards or car keys, among other applications, without any external power source."

Subnano-ceramic membranes

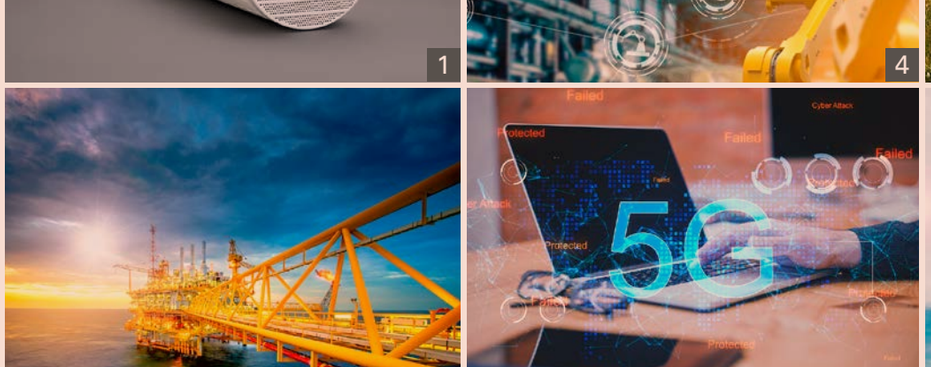
Acting as a molecular sieve, NGK's DDR-type zeolite membrane is capable of separating out carbon dioxide from associated gas during oil production with carbon dioxide enhanced oil recovery. Once the carbon dioxide is removed, it can then be reinjected and partially stored underground, thereby contributing to CCUS (Carbon, Capture, Usage, and Storage). The technology has the advantages over existing polymer-based membranes of being highly durable and able to function effectively even at higher pressures and carbon dioxide concentrations.

Currently, Japan Oil, Gas and Metals National Corporation and JGC Corporation are jointly conducting a demonstration test using NGK's subnano-ceramic membrane technology in an oil field in the US. If successfully commercialised, the innovation will help secure fossil fuel supplies efficiently and ecologically, vital during the transitional phase to non-carbon sources of energy.

1–2. Subnano-ceramic membranes *act as molecular sieves (1) and can be used for the recovery of carbon dioxide from associated gas during the production of oil (2).*

3–5. "EnerCera" *is a series of chip-type Li-ion secondary batteries (3). Potential applications include sensor modules in factories for Industry 4.0 (4) and in electronic devices for the 5G era (5).*

6–9. Gallium nitride (GaN) wafers *(6) provide higher performance for high-frequency applications, resistance to temperature, and ability to sustain higher voltages. Potential applications include electric vehicles (7); power conditioners for solar power generation (8); and amplifiers for satellite communications (9).*



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