

NGK INSULATORS: Delivering ceramic magic behind the scenes

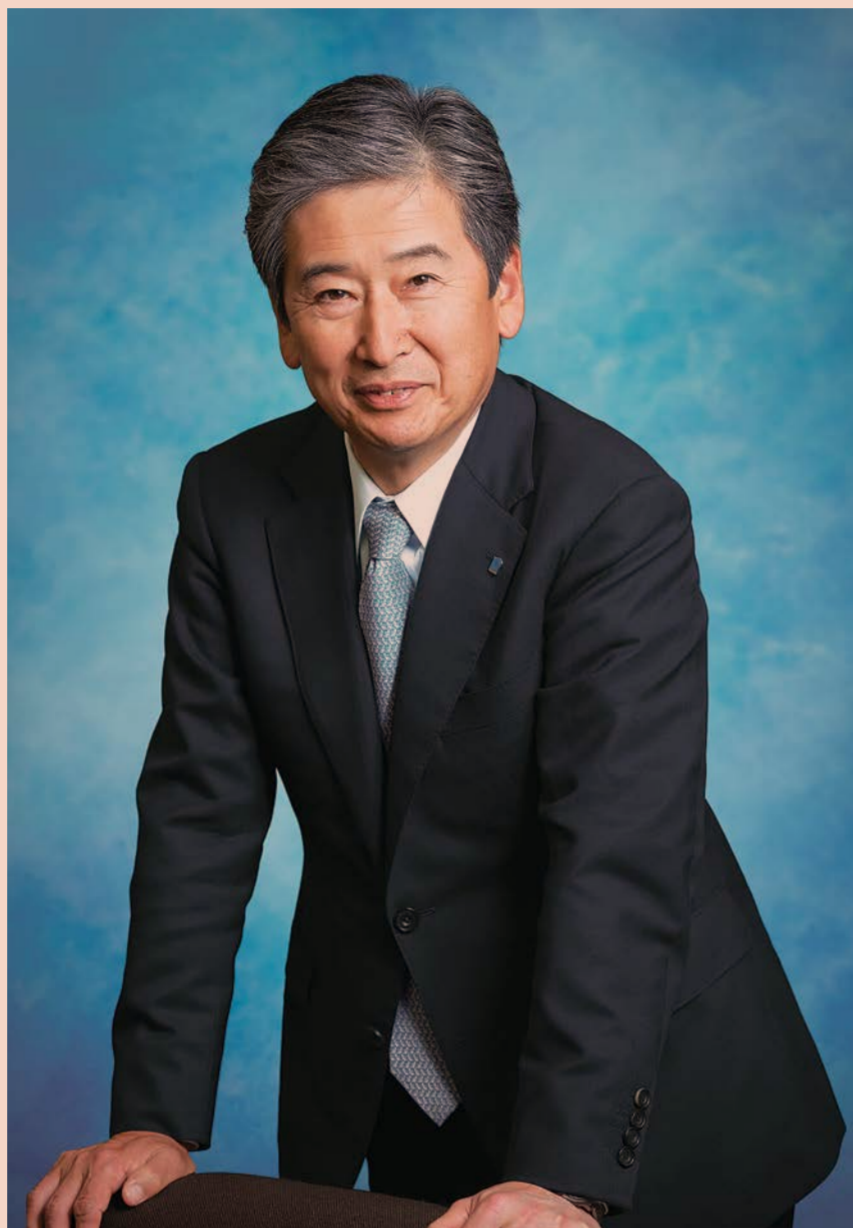
NGK INSULATORS, LTD.

www.ngk-insulators.com/en/

Since being founded in 1919, NGK Insulators has been serving the infrastructures of modern economies from energy to information with its ceramic innovations. Nearly a century later, NGK is still galloping ahead.

If you use a computer, ride a car, or even turn on a light today, you will benefit from ceramic technologies. And chances are high that the ceramics were supplied by NGK Insulators. Though not always visible to end users, the Japanese company's products are everywhere. Its semiconductor manufacturing equipment enables the global production of computer chips. Its substrates and filters reduce exhaust pollutants in over half of all vehicles sold annually across the world. And power grids in more than 100 countries safely transmit electricity thanks to the maker's high-voltage insulators.

Since being founded in 1919, NGK Insulators has been serving the infrastructure of modern economies from energy to information with its ceramic expertise. Nearly a century later, NGK is still galloping ahead. Net sales and operating profit in the fiscal year ended March this year hit a record 451bn yen and 70bn yen, respectively. This represents a jump of 78 per cent in sales and 233 per cent in operating profit compared to five years ago. Maintaining momentum, its earnings are being reinvested into expanding operations at an unprecedented pitch. These efforts, NGK estimates, will lift sales by 11 per cent and operating profit by another 10 per cent for the year ending next March.



Taku Oshima
President, NGK Insulators, Ltd.

cars globally has pushed up NGK's automotive-related sales to new highs.

Oshima expects global sales of internal-combustion engine vehicles to keep rising for the next ten years. Markets forecast that such cars which require exhaust substrates and filters will comprise around 90 per cent of all new vehicle sales in 2030. An additional boost will come from various countries, foremost among them India and China, which are phasing in new car pollution regulations. Developing and emerging markets also have a greater need for trucks and construction transport vehicles that run on gasoline or diesel. In anticipation of overall demand trends, NGK announced further expansion of its factories in Poland, China, and Thailand in the past year.

In the meantime, NGK is preparing strategically for the electrification of the automotive industry. NGK's proprietary ceramic-based solid state batteries, GaN wafers (see column), and silicon nitride insulated circuit boards are some new technologies aimed at fully electric and hybrid vehicles. NGK's range of automotive products, both for internal-combustion cars and electric vehicles, will continue to be vital in keeping skies blue and transport running smoothly across the world.

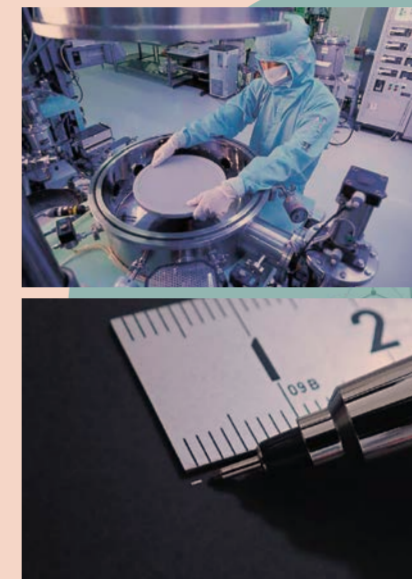
Supporting the energy infrastructure

In its energy division, NGK has emerging projects involving ceramic-based batteries and fuel cells to generate new business while contributing to global environmental challenges.

One of the key projects is the NAS battery system. NGK's unique ceramic-based batteries store and stabilize intermittent power generated from renewables such as wind and solar. As the only large-scale storage battery system that is fully commercialized, NAS battery systems have been deployed worldwide in some 200 locations. A new demonstration project in Dubai, where investment for renewable energy is being dramatically accelerated, will commence this year. The project will serve as a stepping stone for Middle Eastern markets, where solar power usage has been on the uptick. A partnership signed last year with Schneider Electric, a leader in energy management and automation, will also generate global opportunities to market NGK's NAS battery together with Schneider Electric's inverters.

"We believe there is tremendous latent demand for our NAS system," says Oshima. "Like many of our successful businesses today, we have always focused on innovating and commercializing sustainable businesses. With a proven track record of more than two decades, our NAS business is entering a new stage of growth."

Supporting global data



Left: NGK is a leading global supplier of ceramic-based heaters and electrostatic chucks used to manufacture semiconductors.

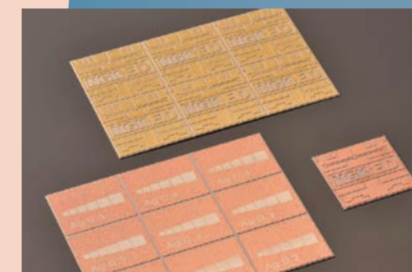
Below: NGK's microactuators with nanometer precision enables the tracking of data in hard disk drives that are increasing in storage capacity to meet surging global data demands.

Keeping skies blue



Left: NGK's NOx sensors for internal-combustion engine cars help the automotive industry reduce pollutants to meet tightening exhaust regulations across the world.

Below: Silicon nitride insulated circuit boards produced by NGK have both high durability and heat dissipation qualities vital for power semiconductor devices in electric vehicles.



OVERSEAS PLANTS
Mexico, U.S.A., Poland, Belgium, South Africa, Indonesia, China, Thailand, Japan

Transforming the energy industry

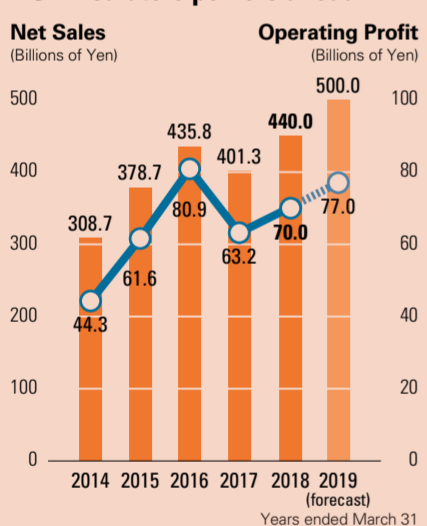


Left: NGK's unique ceramic-based NAS battery system stabilizes intermittent power generated from renewables such as wind and solar

Below: The nickel-zinc battery developed by NGK uses proprietary ceramic separators of solid electrolyte, providing high-capacity and greater safety, making it suitable for indoor use.



NGK Insulators powers ahead



"It has been a very busy year for us," says NGK President Taku Oshima. "We had to move forward our capital expenditure plans in order to meet soaring demand, particularly for semiconductors."

Supporting the digital infrastructure

In the mid-1990s, NGK was one of the first companies to develop ceramic components, such as heaters and electrostatic chucks, for manufacturing semiconductors. It is now a leading supplier to top semiconductor equipment makers which cannot do without the unparalleled heat- and corrosion-resisting properties of ceramic components. In recent years, the global data explosion linked to emerging AI and

IoT technologies has fueled a surge in the semiconductor market.

"The semiconductor-related business is rapidly becoming the next pillar of growth for our company," says Oshima.

The business has more than doubled in the past five years, generating about 15 per cent of the company's total earnings last fiscal year. Keeping pace with demand, NGK announced in March that it would accelerate the expansion of its Japanese and US factories. Output will increase by 1.5 times the previously planned level by 2020. Orders for spares are accumulating along with new orders, as these ceramic components are consumables that must be replaced every few years.

"Our competitive advantage is that we produce, in partnership with our clients from the development stage, ceramic-based semiconductor manufacturing equipment that cannot be imitated by rivals in terms of precision and durability," says Oshima.

Besides semiconductor manufacturing equipment, NGK delivers other ceramic products to support the world's digital infrastructure. Its microactuators control magnetic heads used in hard disk drives in data centres, which are being built at record rates globally to keep up with surging data storage needs. More recently, NGK has been developing chip-type ceramic

Like many of our successful businesses today, we have always focused on innovating and commercializing sustainable businesses.

batteries with high capacity, fast-charging capability, and high-temperature durability. These features, which are usually difficult to be achieved simultaneously, were attained by NGK's original crystal-line orientation technology. These tiny stamp-sized batteries may be used in wearable IT devices, smart cards, and IoT modules serving to process and transmit data.

Earnings engine for bluer skies

As its electronics-related business bounds ahead, NGK's largest business division—producing ceramic-based exhaust substrates and filters as well as NOx sensors for gasoline and diesel vehicles—remains robust. Tightening exhaust regulations as well as steady demand for

the GaN wafer, which can withstand high voltage and heat, include various power devices for electronic cars and wireless communication base-stations. Another marvel is the quartz-based micro-lens. The complex lens-shape, boasting high durability and transparency, was achieved through NGK's proprietary manufacturing techniques. Applications include ultraviolet light-emitting diodes (LEDs) used for effective sterilization and hardening of resins.

Both the GaN wafer and micro-lens technologies are set to replace mercury-based lamps, as mercury is phased out around the world with the implementation of the Minamata Convention from

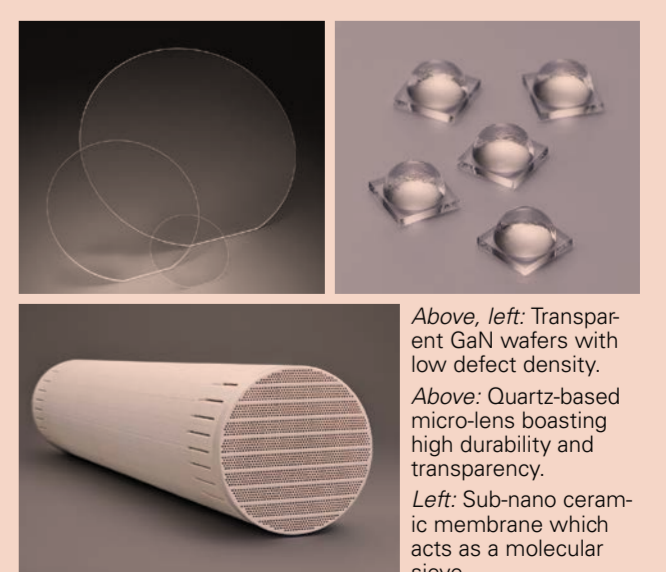
2017. The company expects to begin mass-production of these products within the year and forecasts sales of over 10bn yen annually in five years' time.

A third example of NGK's ceramic magic is the sub-nano ceramic membrane. Acting as a molecular sieve, the membrane is capable of separating out carbon dioxide from the gas mixture of methane and carbon dioxide. This technology drastically reduces costs to extract methane from natural gas fields with high carbon dioxide levels. The innovation is atomic in precision, but once realized, its impact on the world's energy infrastructure could be vast.



Mixing, moulding, and firing ceramics in new ways, NGK is constantly in search of new applications. The company drives this innovation by annually spending 4 to 6 per cent of earnings in R&D and maintaining around 30 per cent of all sales from new products.

A technology ready for commercialization is the GaN (gallium nitride) wafer, developed using NGK's ceramic expertise in growing crystals. The transparent wafer with low defect density through the entire wafer achieves ultra-high brightness of laser diodes (LDs). These qualities make it ideal for projectors and automotive headlights. Other applications for



Above, left: Transparent GaN wafers with low defect density. Above: Quartz-based micro-lens boasting high durability and transparency.

Left: Sub-nano ceramic membrane which acts as a molecular sieve.