A ceramics company for a smarter, carbon neutral future

NGK INSULATORS

For most people, 'ceramics' conjures up images of kilns and pottery, tableware and tiles, or perhaps super-sharp kitchen knives.

But fewer realise that the ceramic industry keeps the modern economy ticking. For example, ceramics are the most commonly used insulators in electric systems, vital for power transmission and distribution. Vehicles would choke the skies with toxic gases without the ceramic substrates used in modern catalytic converters. And ceramic components are also essential for producing semiconductors, which are the building blocks of modern computing.

This abundant and versatile material, invented more than 25,000 years ago, now has another vital role to play. As the global economy commits to carbon neutrality by mid-century, it's becoming clear that ceramics could help us decarbonise our future.

And pioneering many of these solutions for a smarter and more sustainable world is NGK Insulators, a global industrial ceramics and technology leader.

"The world is currently moving towards a carbon-neutral, digital society. We already possess many products and technologies for these areas," says Shigeru Kobayashi, NGK's president. "We will continue to apply our advanced technologies in responding to issues such as energy and the environment to meet the expectations of our global society."

The road to carbon neutrality

The global transition to low-carbon energy sources is ongoing and various carbon capture, use and storage (CCUS) technologies are urgently needed to meet climate goals. The challenge is to develop viable solutions that can separate carbon dioxide at scale. Ceramic-based filters are one promising option.

"Compared to rival polymer membranes, ceramic membranes can achieve high accuracy in separating out molecules under conditions of high temperature and pressure while being resistant to solvents and corrosion," says Ryohei Iwasaki, executive vice president and head of the Corporate NV (New Value) Creation for NGK.

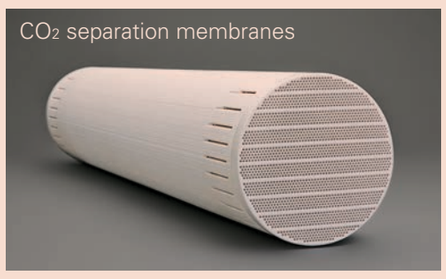
NGK had successfully developed the world's largest ceramic CO_2 separation membrane, known as a DDR-type zeolite membrane. Last year, the company took the technology further—with the announcement of the successful development of a carbon dioxide separation membrane for industrial exhaust gas.

In a test simulating industrial exhaust gases, the membrane achieved a CO_2 separation factor for simulated industrial exhausts approximately five times that of conventionally developed membranes. The company hopes to commercialise the technology to capture emissions at factories and power plants by 2030.

Equally pressing is the need to capture emissions already released into the air. All signs point to growing momentum for the technology of DAC, or direct air capture of greenhouse gases.

In 2020, governments around the world committed over $4bn to back the development and deployment of DAC technology. The first large-scale plant capable of capturing up to one million tonnes of CO_2 ($MtCO_2$) per year will begin operating in the US by the mid-2020s. The International Energy Agency forecasts that DAC will need to be scaled up from the current 0.01 to 980$MtCO_2$ by 2050.

NGK hopes to meet this challenge by developing an atmospheric CO_2 adsorptive module based on its HONEYCERAM* technology for automotive ceramics. Iwasaki sees very high market potential for such a product once demand takes off for DAC. When orders do come in, Iwasaki explains, NGK's automotive ceramics factories across the globe can be rapidly repurposed to produce these products for DAC.



Another vital technology needed to shift away from fossil fuels are batteries. Production of safe, sustainable large-scale energy batteries must be stepped up to meet demand for the storage of intermittent renewable energies such as wind and solar. NGK's advanced ceramic batteries include the grid-scale NAS* battery; the world's first zinc rechargeable battery suitable for use indoors; and the ultra-thin EnerCera* battery, which will help companies and governments in their race to a fossil-fuel-free future.

Smart ceramics from the start

Ceramics is also enabling a smarter world.

In a digital society, ceramic technologies and materials will be vital for the sensors, radar, high-speed telecommunication devices and power semiconductors needed for autonomous and electrified transport. Highly compact, durable and wirelessly rechargeable ceramic-based batteries will power IoT devices everywhere, from supply chains to factory floors. And high-performance wafers and actuators using ceramic materials will play a critical role in processing the vast streams of data circulating through a digital world.

> **We will continue to apply our advanced technologies in responding to issues such as energy and the environment to meet expectations of our global society.**

NGK is a key global supplier of ceramic components for semiconductor manufacturing equipment, piezoceramic actuators for HDD used in data centres, and bonded wafers for SAW filters that filter out unwanted smartphone frequencies. If you have a high-end smartphone, there's a good chance it contains NGK wafers or semiconductors made using the company's components. It may also regularly receive data processed by NGK's actuators.

Reflecting this crucial role, NGK's electronics and SPE (Semiconductor Production Equipment) related business has grown rapidly over the past two decades. Its digital society business segment hit record sales of ¥150bn (roughly a quarter of total sales of ¥510bn) for the year ending in March 2022. It aims to generate some ¥300bn by 2030 for this segment by continuing to roll out and market unique ceramic technologies with significant impact for areas like mobility, logistics, automation, healthcare, and telecommunications.

"There is no question that the current explosive growth of digital technology in our lives will continue onto 2050: more semiconductors, more data, faster telecommunications from 5G to 6G and beyond," says Kobayashi. "For these trends, we will utilise our high precision ceramics technologies to develop products for a carbon neutral and digital society."

Shigeru Kobayashi
President, NGK Insulators, Ltd.

Realising the infeasible

On the face of it, an energy-intensive manufacturer which generates a substantial chunk of its sales from products to filter out exhaust from internal combustion engines would seem an unlikely champion for transitioning to a decarbonised and digitalised future. But it surprisingly is.

To start with, NGK is slashing its own emissions at a dramatic pace.

This year, the company switched to using renewable energy in all its European factories and is aiming to achieve the same for all factories outside Japan by 2025. It aims to achieve carbon neutrality across all operations by 2050.

The plan is for half of all NGK's sales by 2030—and 80 per cent by 2050—to come from products related to carbon neutrality and digital society.

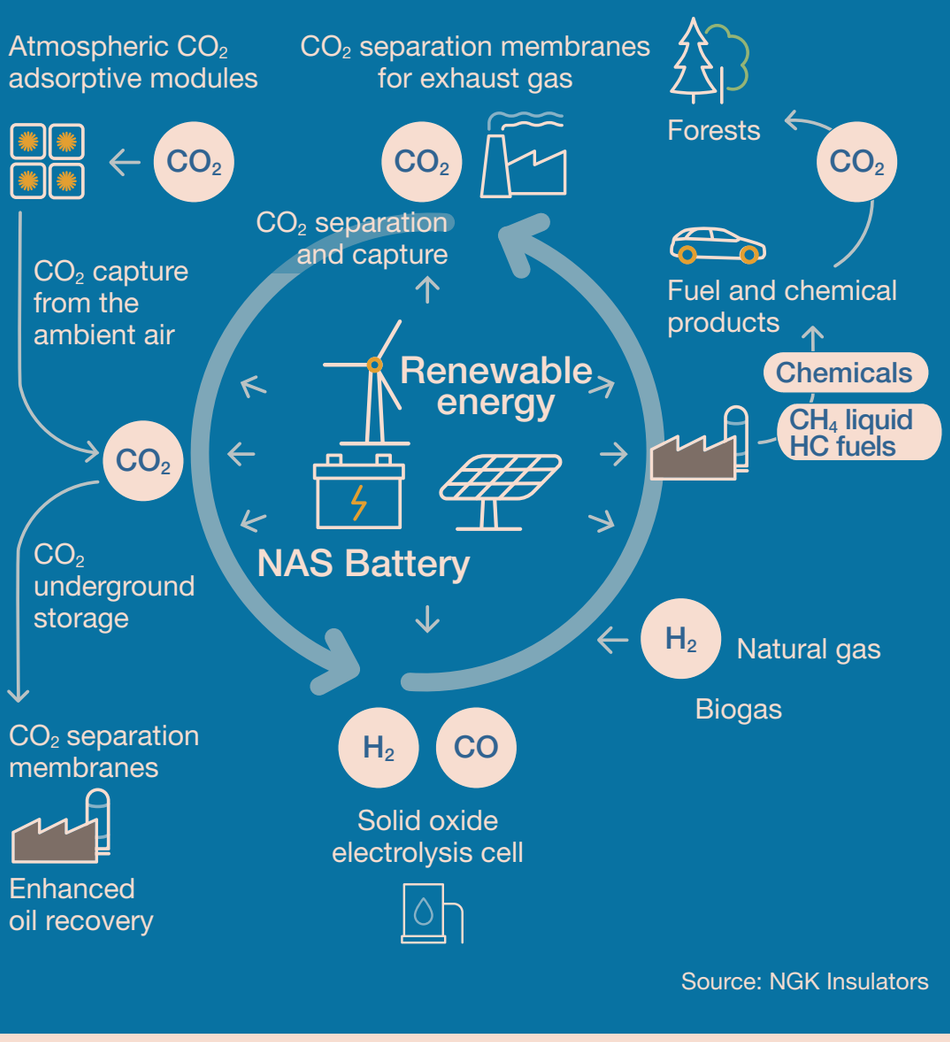
To that end, the company established a new division called Corporate NV (New Value) Creation earlier this year. Some ¥300bn will be poured into R&D over the coming decade, with a mission to generate over ¥100bn in new products (which represent a fifth of current total sales) by 2030.

Ceramics' versatile properties—electrical resistance, ionic conductivity, resistance to heat and corrosion, mechanical strength—allow it to be used in both batteries and insulators. And the ability, which NGK excels at, to manipulate its atomic-level structure and align its crystals as well as techniques like ultra-high precision-polishing and bonding means new features and applications can be unleashed.

As we race towards a smarter and more sustainable world, NGK will continue to "refine and utilise ceramic technologies to realise things which were previously considered technically infeasible".

HONEYCERAM, NAS, and EnerCera are trademarks of NGK Insulators, Ltd., registered in the U.S. and other countries

How NGK's technology powers the carbon capture, utilisation and storage cycle (CCUS)



Source: NGK Insulators

Currently, most wireless IoT devices are powered by single-use batteries with the hassle and cost of replacements, or rechargeable ones with long charging times and short lifespans. Existing batteries are also not sufficiently heat resistant. This prevents them from being installed through manufacturing processes using heat and limits their use in high-temperature environments.

NGK's EnerCera battery can overcome these bottlenecks.

At only 0.45mm thick and as large as a stamp with high capacity and affinity for wireless recharging technologies and energy harvesting, the new EnerCera battery is an ideal option to power maintenance-free IoT devices. Since its launch in 2019, NGK has conducted numerous demonstration tests for the battery's IoT capabilities in sectors including logistics, wearables, air quality monitoring, factory automation and smart agriculture have been conducted.

Along with wireless power transfer systems and logistics tracking sensors, other potential applications include renewable energy systems, wearable tech, and back-up electricity sources.

Image, right: EnerCera batteries can be used in sensor tags to track shipments, including wine.

Large-scale energy battery capacity will be vital to stabilise grids, by storing excess energy and releasing it in times of high demand or when renewable generation falls, such as when the wind stops blowing or the sun stops shining.

NGK's ceramic-based NAS* battery appears a strong candidate for such use. The battery beats rival technologies in terms of scalability, constancy to six hours or more of high electric power output, and durability. As the world's first commercialised large-scale energy storage battery system, it is now used in about 250 locations worldwide.

Recent deployments of NAS systems include Taiwan's Kinmen Island, German energy company BASF's factories worldwide, and various locations within Japan. The battery is also gaining traction as a backup power source, independent of the grid, to deal with blackouts which have increased in frequency due to natural disasters in recent years.

Images: NAS batteries effectively meet the requirements of long-duration energy storage systems for renewables.