

Ceramic batteries to power maintenance-free IoT



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Until now, the lack of suitable rechargeable batteries for wireless devices has been thwarting the digital transformation to a fully smart society. This technical bottleneck is finally overcome with the advent of the EnerCera® battery. The award-winning next-generation battery produced by NGK Insulators Ltd. (NGK), the Japanese industrial ceramics giant, promises maintenance-free energy for IoT. The EnerCera battery is only one of the many ceramics-based innovations from NGK which build and support the sustainable development of industries in energy, electronics, ecology and beyond.

Missing batteries

With the advent of 5G, the world is becoming ever more connected. Millions of new wireless devices are being deployed to Hoover up oceans of data, crunched by exponentially advancing AI. We appear to be well on our way to a smart nirvana of an IoT society. Yet one little-known problem has been thwarting progress: the lack of proper batteries.

Currently, most wireless IoT modules 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.

The technical bottleneck, however, is finally overcome with the EnerCera battery, a next-generation battery produced by NGK, the Japanese industrial ceramics giant. The high-capacity, ultra-small, ultra-thin, and long-living rechargeable battery with heat resistance has wowed researchers and industries. Since its launch two years ago it has garnered praise and prizes at leading tech trade fairs, including the prestigious Consumer Electronics Show (CES) in Las Vegas.



Taku Oshima
President, NGK Insulators, Ltd.

room of an automobile or factory floors. NGK is currently working to further increase the operating temperature to 125°C. The heat-resistant battery can withstand manufacturing processes like reflow soldering and hot lamination which enable mass production. And with high energy density, EnerCera can be made ultra-compact and ultra-thin. This makes it bendable and an easy fit into things like position tracking tags, sensor tags, price tags such as electronic shelf labels (ESL), wearable devices such as vital sensing patches and card devices such as credit cards with fingerprint authentication scanners, and ID cards with health monitoring sensors.

Moreover, the ability to store exceedingly small electrical currents and release them as large currents when needed makes EnerCera ideal for harvesting energy such as solar, wind and kinetic from its surroundings to continue powering IoT devices. An expected lifespan of 10 years means EnerCera can be left maintenance-free in hard-to-reach locations: outdoor 5G base stations, in devices monitoring the structural integrity of buildings and bridges, and automation sensors in unmanned factories and industrial plants.

"Apart from EnerCera, no battery currently on the market possesses all of these features to make the promised IoT society realisable," says President Taku Oshima of

NGK. "We have sent samples of our batteries to some 200 companies inside and outside of Japan—such as Ricoh Company, Ltd. and Renesas Electronics Corporation. They are currently developing various devices and applications using the EnerCera battery's unique features."

NGK: Behind-the-scenes ceramics
"People may be wondering what kind of company we are: 'maybe NGK is a battery company since we put so much effort into developing new kinds of batteries?'," says President Oshima. "But at the core we are a ceramics company; we develop new technologies to serve social needs from our continually expanding expertise in ceramic materials and processing."

Indeed, as President Oshima points out, NGK has been making headlines in recent years for its innovative batteries, from the very large to the very small.

The company is the world-leading producer of large-capacity energy storage systems (NAS® batteries), which are mainly for renewable energies, installed in over 200 locations worldwide. As the only grid-scale energy storage systems with a proven track record of safety and effectiveness, NAS is one of the most promising candidates for storing and stabilising renewable energy, a capacity critical for countries to reach net-zero emissions.

NGK is also developing the world's first zinc rechargeable battery using a ceramic separator. The battery system, which last year acquired the world's first UL verification mark of safety in the battery storage category, will be optimal for safe and large energy storage indoors. Potential use cases include schools, hospitals, stores, base stations and communication buildings where maintaining power during black-outs is vital.

All of these new battery technologies are derived from properties of ceramics—ionic conductivity, resistance to heat and corrosion, mechanical strength—drawn out by a century of NGK's research. In recent years, Oshima explains, the company has been making leaps and bounds in understanding and manipulating the atomic-level structure of ceramics. This know-how has generated a whole range of new technologies, including the EnerCera battery, which utilises crystal-oriented ceramic plate as electrodes to achieve its unparalleled features.

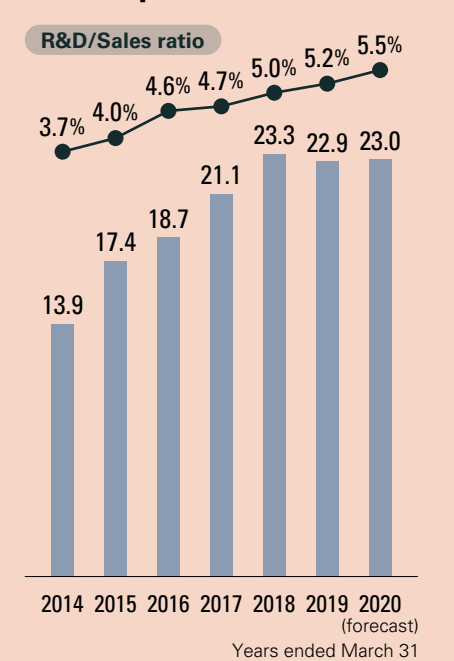
"It is not only our expertise in ceramic materials but also our know-how in processing techniques which makes it difficult for other companies to replicate our products," says Oshima.

NGK's older businesses attest to the difficulty of rivals to mimic and commodify its ground-breaking innovations. The company is still the top supplier of critical ceramic products which it launched decades ago and continues to refine to match changing industry needs. These products include insulators for the transmission of electricity, ceramic substrates for catalytic converters used to reduce exhaust pollutants from cars, and components used in semiconductor manufacturing equipment. These three products form the bulk of NGK's sales, which for the year ended March 2020 were JPY 442.0bn with operating profits of JPY 55.0bn.

Sales from newer business areas—energy storage and electronic components—have been also expanding for the company. Management goals to increase the share of new products to 30 per cent of total sales, an ambitious target it set out five years ago, has propelled innovation. So have R&D outlays, which have steadily risen.

Besides new batteries, notable innovations include NGK's Gallium Nitride (GaN) wafers for power semiconductor devices, which one day may replace the industry standard silicon wafer. Another is the subnano-ceramic membrane, a nano-level sieve which can be used for the highly efficient separation and recovery of

R&D expenses (Billions of Yen)



carbon dioxide in the processes of producing crude oil and natural gas. Its potential to contribute to the capture, utilisation, and storage of carbon is significant.

Another 100 years of SDGs

Since its founding in 1919, the Japanese ceramic specialist has been contributing to social needs and supporting vital industrial infrastructure.

During its earliest decades, NGK enabled Japan to electrify by producing domestic-made transmission and substation insulators and then supplying them overseas to help countries build power grids worldwide. Since the 1970s, the company has become one of the largest manufacturers of substrates and diesel particulate filters for catalytic converters for automobiles, reducing the global environmental impact of cars.

In the past 20 years or so it has become a key producer of components used in semiconductor manufacturing equipment, enabling the explosion in production of semiconductors underlying the ITC revolution. Its NAS battery and nano-level membrane technologies promise to be vital tools for the world's sustainable energy infrastructure. And now with the EnerCera battery, NGK has provided a critical missing piece in the transition to a ubiquitous and maintenance-free IoT society.

"We have been envisioning SDGs from 100 years ago, supporting key social infrastructure throughout our company history," says Oshima. "In the next 100 years we will continue to do the same: meet social needs by cultivating the many seeds we have nurtured in the world of ceramics."

It is not only our expertise in ceramic materials but our know-how in processing techniques which makes it difficult for other companies to replicate our products.

"NGK has delivered the ideal solution to power wireless modules necessary to realise an IoT society: a completely maintenance-free power source," commented one of the judges at CEATEC 2019, Japan's largest tech trade fair which awarded EnerCera its latest prize. "Applying unique ceramics technology, NGK has created a new category of electricity storage device with exciting potential for market development."

EnerCera Everywhere

Such enthusiasm around EnerCera is generated by game-changing features.

As the world's first lithium-ion rechargeable battery with an operating temperature of up to 105°C, the battery can be used in high-temperature spaces like the engine



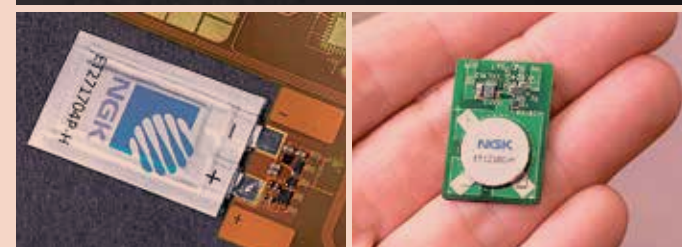
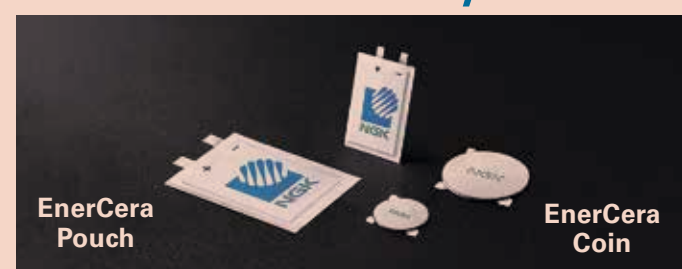
Self-driving

- Improvement in crime prevention function
- Improvement in safety
- Improvement in convenience

Smart logistics

- Quality management
- Dynamic price setting

EnerCera Everywhere



Device monitoring

- Infrastructure deterioration diagnosis
- Operator and environment management
- Data maintenance

Security

- Smart home
- Home surveillance systems
- Health care

