

# Understanding the Needs of Our Age and Continuing to Produce New Value

NGK began in 1919 as a porcelain insulator manufacturer to help Japanese society modernize by meeting the growing demand for electricity accompanying the technological development of industry and the lives of the people.

Since then, NGK has used the technological capacity we've cultivated through the manufacture of high-quality and reliable insulators to actively work towards the diversification and globalization of our business, and to realize sustainable growth through the production of numerous products that support industry and the lives of the people in our community, as well as assist in solving complex social problems.

NGK will continue to provide the world with new value through advanced manufacturing that meets the needs of our age.

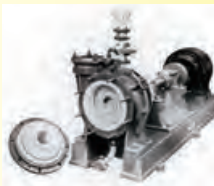
1919

Spin off of the insulator department of Nippon Toki (currently NORITAKE CO., LIMITED) to establish NGK



1931

Acid-resistant equipment for the chemical industry



1958

Beryllium-copper products



1976

HONEYCERAM®, a ceramic catalyst converter substrate for automobile exhaust purification



1978

Low-level radioactive waste treatment equipment



1989

Diesel particulate filter



1919

1930

1940

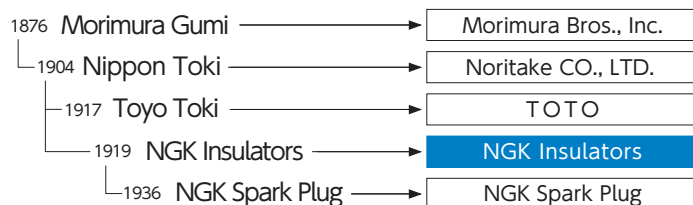
1950

1960

NGK was created to help Japanese society modernize by meeting the growing demand for electricity

## Morimura Group

The ceramics group has its roots in the Morimura Group, a pioneer in the Japan trading industry.



1919



Supporting the development of industry and the lives of people



We solidified our place as the world's number one insulator manufacturer with the completion of our head office and the Atsuta plant in 1957

In 1919, the year after the end of WWI, NGK was founded amidst a time of unprecedented economic growth, and to match the growing demand for electricity, we developed ultra-high-voltage and ultra-high-strength insulators to support the development of industry and the lives of the people. We continue to support the supply of the world's electric power even today as the world's top class insulator manufacturer.

1996 Ceramics for semiconductor manufacturing equipment

1996 NOx sensors for automobile exhaust

1998 Piezoelectric micro-actuators for inkjet printers

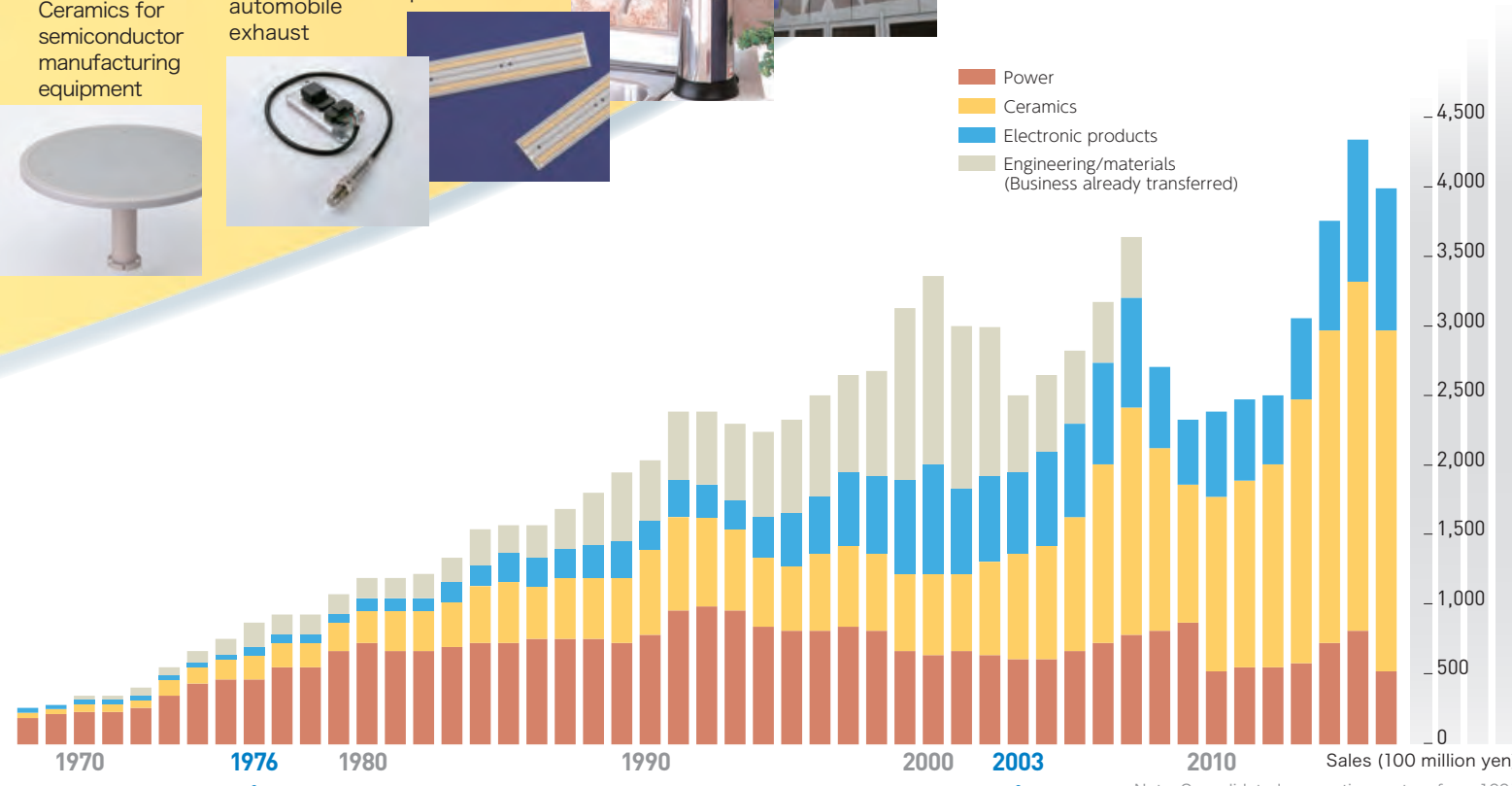
2002 C1® home-use water purifier

2003 NAS® batteries

2007 Subnano-ceramic membranes

2014 Composite wafers

2016 Copper-nickel-tin alloy products



# 1976

## Protecting clean air



HONEYCERAM mass-produced product #1. In 2009, it was registered in the important science and technology history collections (Essential Historical Materials for Science and Technology) of the National Museum of Nature and Science

As restrictions on car emissions tighten as a response to worsening air pollution, NGK has developed a ceramic substrate for catalytic converter, called HONEYCERAM (see page 32), that can be mounted right after an engine. HONEYCERAM, which can withstand the high heat and shock of high-temperature emissions, is loaded on cars around the world and contributes greatly to solving environment problem.

# 2003

## Contributing to making a sustainable society possible



There are already approximately 200 working examples of the NAS battery in Japan and overseas.

It was in the 1960s when the basic principle was described for the NAS battery, which uses ceramics in electrolytes. However, there were many technical issues and, while the many companies gave up trying to turn it into a product, NGK overcame numerous issues, like how to make it have a larger capacity and reduce costs, to finally begin mass production of the world's first NAS battery in 2003. This product is gaining attention as the key to spread and expanding renewable energy.

# Our strengths lie in the growth of our business with the skills we have developed since our founding and the people that support that growth.

Since our founding, we have leveraged our diverse set of skills to develop and offer products that support the infrastructure of society and assist in the solving of environmental problems. It's our people that are the bedrock of our strength, and their mentality to relentlessly pursue quality, to continue to push the envelope, and to give back to society has continued unabated from our founding up to today.

## Pushing the envelope globally and in new fields

NGK goes right back to 1876, when Ichitaro Morimura (Ichizaemon VI) and his younger brother, Toyo, founded Morimura Gumi (currently Morimura Bros., Inc.). In an age when Japan was beginning to modernize, the Morimura brothers were pioneers in globalizing Japan and blazing a trail for Japan-US trade. NGK, having started as an insulator manufacturer, began to develop acid-resistant machinery for use in the chemical industry soon after our founding; we then actively engaged in diversifying and globalizing our business by making our first export of power transmission insulators to India in 1935 and establishing our first overseas production facility in 1973. Even now, we continue to constantly push the envelope in new fields and strive for sustained growth.



A map showing our 30-year history with overseas trading partners. The orders we receive from overseas continue, and we are increasing our factories.



## Contributing to society



Kazuchika Okura, our first president Okura was the first-born son of Magobei Okura, the brother-in-law of Ichizaemon Morimura, founder of the Morimura Group. At the age of 28, Okura was appointed as the first president of Nippon Toki (currently the Noritake CO., LTD.). He would later serve as president of Toyo Toki (currently TOTO) and NGK Insulators, as well as chairman of INAX (currently LIXIL).

During the Meiji Period when electricity first began spreading throughout Japan, insulators that could withstand high voltage had to be imported. The first president Kazuchika Okura stated, "It is our duty to our country to produce insulators in Japan." Research and development into special high-voltage insulators and the first Japanese insulators began from this keen sense of duty and clues from shards of US-made insulators.

Our founding spirit—the urge to contribute to the development of industry and the lives of the people by meeting the growing demand for electricity with a stable supply of high-quality insulators—continues today still in NGK's corporate philosophy.

Shards of US-made insulators that would serve as the starting point of the founding of NGK. Development began under the belief that with the fine techniques of Japanese craftsmen, they were certain to be able to manufacture special high-voltage insulators.



Ceramics, which are largely determined by natural phenomena like soil, water, and fire, were originally extremely difficult to make with any uniformity. However, with insulators, which have served as the supporting framework for society's lifeline for decades, even a single defective product could have an enormous impact on all of society. For NGK, which broke away from the ceramic ware-making industry and began down the path of industrial manufacturing with insulators, product uniformity was the sought after quality. By refining our core techniques with materials and processes to achieve this, we have continued to provide high quality and reliable products. NGK's manufacturing is made possible by our commitment to quality and our technical capacity.



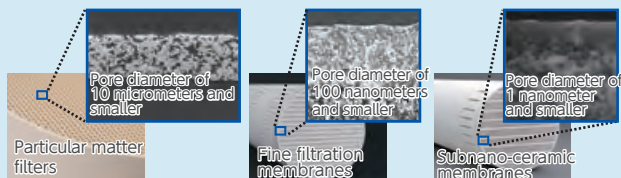
The written pledges (the Founding Pledge) of our first president, Kazuchika Okura, and his five other managers. The pledge includes the expansion of the insulator business and continuous quality improvement.

## The pursuit of quality

### Our Core Techniques

#### Materials techniques

Our materials techniques draw out synergistic effects through the combination of differing materials, rapidly produces ceramics with outstanding qualities, and controls properties like ceramic pore diameter (pore size), crystal orientation, thermal conductivity, ion conductivity, and electrical resistance. With our thorough familiarity with the mechanical, thermal, electrical, and physical properties of ceramics, and our adept manipulation of materials into a plethora of configurations, we are able to manufacture just the right products to meet the needs of society.



By controlling the pore size, ceramic filters can screen out fluids and gases at the molecular level

#### Process techniques

NGK is adroit at using various molding techniques, such as mold casting, extrusion molding, and tape molding, as well as firing and processing techniques, to achieve a variety of ceramic structures, and we also bind differing materials, such as metals, to ceramics. We develop and manufacture our products of various configurations—everything from fine and complex three-dimensional shapes to the one of the largest porcelain products in the world at 11.5 meters.



Mold casting differs from the conventional casting method where clay was formed and fired in that it is an entirely new molding method where a liquid material is introduced to a mold, and simply cooled and hardened. This method allows for complex and highly-precise shapes.

#### Production techniques

The many innovative and competitive products NGK produces come from the production equipment that we have developed using our own mass production techniques and manufacturing know-how. In order to meet the needs of our customers around the world, we quickly deploy to our overseas locations the cutting-edge production lines we have developed and we promptly build highly efficient global production systems. Additionally, rapidly introducing an analysis of big data into production management leads to improvements in quality and reductions in cost.



Improvements to productivity through innovative mass production processes

#### Evaluative/analytical techniques

We are constantly working to innovate in manufacturing by rapidly incorporating, fusing with our own core techniques, and advancing the latest technology, including advanced computer simulation technology that enables significant reductions in development periods and image inspection technology that never fails to overlook even the slightest defects.



Research & development, and manufacturing that utilizes superior evaluative/analytical technology

### The people who underpin manufacturing

We build comprehensive educational programs so that each and every one of our employees can gain the ambition to try new things, work to build an environment of growth, and demonstrate their best performance. We are concentrated on the full training of the people who form the bedrock of our production infrastructure.

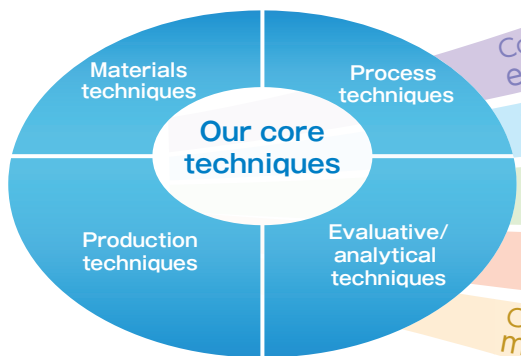
Two months after our founding, a policy to allow employees to use the skills they have in a welcoming environment was promptly created that held the development of business as the same as the advancement of happiness of the workers.



# We provide products/services that contribute to solving various social issues by freely manipulating materials and properties.

Our major strength is our ability to produce a variety of products by combining our techniques with materials, such as porous ceramics and functional ceramics, with our own process techniques involving molding, firing and processing.

NGK products, adept at freely controlling unseen factors, such as electricity and heat, make solid contributions to society in the places we don't often see to help create a better environment, a future for energy, and the advancement of electronics.



- Control of electricity
- Control of gases/fluids
- Control of light
- Control of heat
- Control of motion



## Supporting our electricity supply

Insulators

Compatible with the highest voltage electricity transmission systems (1 million volts, UHV). Supports transmission wires while providing insulation, to contribute to the stable supply of electric power.



## Removing particulate matter

Diesel particulate filters

Removes 99% of particular matter in car emissions to make the air of our world cleaner.



## Purifies car emissions

HONEYCERAM®

An ultra-thin wall of only 0.05 mm purifies emissions to support the development and evolution of more eco-friendly cars.



Ceramics for semiconductor manufacturing equipment

## Warms uniformly

Adapted to the increasing detail and lamination of semiconductors, this technology supports the evolution of IoT and AI.



Piezoelectric actuator

## Moves at high speeds

This is a micro-sized motor that controls electronic devices with high precision at high speeds.

## Stores electricity



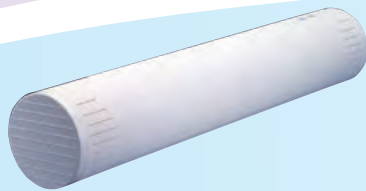
NAS® batteries

Electricity storage systems in the megawatt category. This contributes to the spread of renewable energy.

Product development and manufacturing that supports the stable supply of **energy** and the creation of a **sustainable society**.



## Separates gases



Subnano-ceramic membrane filter

This molecular sieve can separate fluids and gases at the molecular level.

## Measures concentrations



NOx sensor

This is the world's first in-vehicle sensor that can measure NOx concentrations in real time with high precision.

Product development and manufacturing that resolves **environmental** issues in a wide variety of fields, like automobiles, chemicals, medicine, food, and nuclear power, and contributes to a richer, safer and more secure society



## Allows light to pass



HICERAM®

This transparent (99.9%) ceramic material is used in LED circuits.



Wavelength control drying system

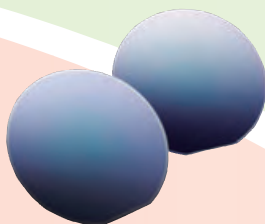
## Dries with light

This system reduces drying time by half and allows for significant energy conservation.

Product development and manufacturing that contributes to the evolution of **IoT** and **AI**, and the advancement, miniaturization and weight reduction of electronic products.



## Controls heat expansion



Bonded wafers for SAW filters

Adapted to next-generation LTE. Suppresses heat expansion to 1/3 or less than conventional products, and reduces noise. Also improves sound quality.

## Quickly cools



High-cycle metal dies

Cools and hardens resin in a short period of time, and contributes to improve production efficiency and quality.