

Contributing to the Advancement and Development of Humankind through Fine Ceramic Technology

Fine ceramics have unlimited potential as materials for a new age. Kyocera is contributing to global environmental protection and the advancement of society by expanding use of fine ceramic materials in diverse industries.

Continuously creating the new value which is demanded around the world in every field, from daily-use to advanced industrial applications

Raw natural materials refined to a high level of purity and artificial materials synthesized through chemical processes are sintered at high temperatures. These "fine ceramics" which are created by such processes are materials with outstanding heat resistance and abrasion resistance.

At Kyocera, fine ceramics have been the core of our business since our foundation in 1959 — during the early days of the industry. We have developed new technologies and new applications for fine ceramics, and by deploying these in a diverse range of applied products, we have achieved growth and made many advances.

Kazuo Inamori, founder of Kyocera, was the first person in Japan to successfully synthesize forsterite (a type of fine ceramics). That was the start of the history of Kyocera and fine ceramics.

At the time of our foundation in 1959, demand for televisions was undergoing tremendous growth. Kyocera began supplying fine ceramic components which were essential for television cathode ray tubes. Thereafter, in an era of growing use of electrical appliances, Kyocera successfully developed multilayer ceramic packages and many other related products.

During the recession triggered by the 1st oil crisis in the 1970s, Kyocera began developing diversified operations. The aim was to build a corporate structure capable of continuous growing, which would be unaffected by the ups and downs of any one particular industry. We therefore focused on expansion of operations into new products centered on fine ceramic technology. Starting with the development of cutting tools that

contribute to industrial advancement, we then succeeded in developing recrystallized jewels with chemical compositions and structures identical to those of naturally occurring gem stones. Additionally, by realizing that ceramics have higher biocompatibility than metallic materials, Kyocera was able to advance into the field of medical products with the development of ceramic dental implants, artificial bones and artificial joints. In this way, Kyocera has contributed greatly to improving the quality of life for people suffering from injury and illness. With these and other successes, fine ceramics attracted great expectation as an important technology for the 21st century. By steadily providing the world with innovative and essential products, Kyocera will continue to create new value.



Television tube containing the U-shaped Kelcima — the first product made by Kyocera — which was the beginning of the history of Kyocera and fine ceramics.



Outstanding in strength, heat resistance and corrosion resistance, these products are ideal as high-precision and stable structural components — making them ideal for use in semiconductor manufacturing equipment.



High precision and increased size are required for LCD manufacturing equipment. Our alumina ceramic components are among the largest in the world, and support the growing LCD industry.



Kyocera receives an award for its contribution to the asteroid exploration spacecraft, Hayabusa

Kyocera fine ceramics are active in fields not limited to this planet. Applications have expanded to include aerospace industries. For example, they have been used as components of batteries installed in an asteroid exploration spacecraft.

The Hayabusa spacecraft was a major topic of interest last year. Although there were doubts for a while about the Hayabusa's ability to return to Earth, the spacecraft returned safely with a particulate sample of an asteroid named Itokawa. This extraordinary achievement marked the first time matter had been brought to Earth from a body other than the Moon. Kyocera's highly reliable components and

bonding technology were used in the Hayabusa.

Lithium-ion batteries were installed in the Hayabusa, and Kyocera's high-purity fine ceramic components (alumina ceramic) were used for the battery terminal components. Their high strength, outstanding hermeticity, and corrosion resistance were acknowledged. Kyocera's metallizing technology (brazing technology) for creating strong bonds between dissimilar materials also received high acclaim. In December 2010, a Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan awards ceremony was held for corporations and institutions contributing

to the Hayabusa project. Kyocera and all other parties involved received official letters of appreciation. During the awards ceremony, MEXT Minister Yoshiaki Takaki had high praise for the contributing parties. The Hayabusa had given dreams and hopes to the people of Japan, and demonstrated Japan's high technological capability to the world. With its unlimited potential, the importance of space development is expected to rise even higher in Japan. Kyocera is working to further improve the performance of fine ceramic components. In meeting diverse user needs, we aim to contribute further to space development.

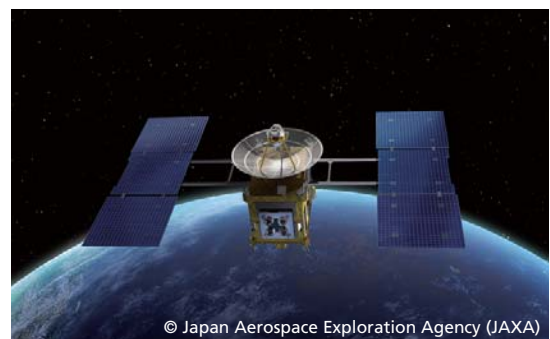
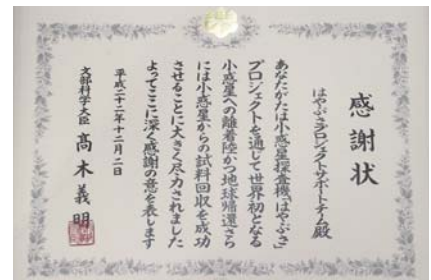


Photo by The Furukawa Battery Co., Ltd.

Kyocera fine ceramic components and metallizing technology were used for the terminals on the lithium-ion batteries in the Hayabusa. Kyocera components and technology were chosen for their high strength, outstanding hermeticity, and corrosion resistance.



Kyocera received letters of appreciation from MEXT Minister Takaki and from Banri Kaieda, then Minister of State for Space Development.



© Japan Aerospace Exploration Agency (JAXA)
In May 2003, the Hayabusa was launched on a mission to the asteroid Itokawa. The spacecraft landed in November 2005 and collected a sample. For a time, equipment problems stirred doubts about Hayabusa's ability to return to Earth. However, Hayabusa reentered Earth's atmosphere in June 2010 and was safely recovered.

Pressure-resistant vessel supports ocean-bottom seismographs at a depth of 11,000 meters

Fine ceramics are also used in pressure-resistant vessels for ocean-bottom seismographs. The vessel utilizes the outstanding features of fine ceramics, such as high compressive strength, corrosion resistance and low specific gravity.

Kyocera, the Japan Agency for Marine-Earth Science and Technology, and Nippon Marine Enterprises, Ltd. jointly developed the fine ceramic Ocean-Bottom Seismograph. The vessel can withstand deep-ocean water pressure at 11,000 meters. As conventional glass vessels can only tolerate water pressure up to about 6,000 meters, the use of the fine ceramic material silicon nitride has made it possible to place seismographs at the bottom of what is said to be the deepest part of the world's oceans — the Mariana Trench.

This will allow for the formation of a detailed observation network and improved observational accuracy; as well as there are expectations for benefits to other research areas such as studying the mechanism of

earthquake generation and structural analysis of the ocean floor. Kyocera will continue to improve the performance of the fine ceramic vessels, to enable more advanced measurement at deep ocean.



Photo by Nippon Marine Enterprises, Ltd.



The Self-Surfacing Ocean-Bottom Seismograph is an instrument designed to measure and record earthquakes on the ocean floor. After measurement, the main body floats to the surface and is recovered by a ship. Earthquake data is then analyzed.

Photo by Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

Kyocera's technological strength and ability to meet difficulties contributed to problem solving in this application

Kenichi Asakawa, Dr. of Engineering Assistant Director
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

"We were faced with the difficult problem of achieving high pressure resistance while at the same time maintaining light weight. Kyocera's prompt response has allowed us to proceed with development as planned. Kyocera's technological strength in ceramics combined well with JAMSTEC's oceanic equipment technological capability in pressure-resistant vessels, and efficiency in advanced technological development led to success. The resulting pressure-resistant vessel has enabled earthquake observation at ocean floor depths greater than 6,000 meters. We have high expectations for its usefulness in measurement of future earthquakes."

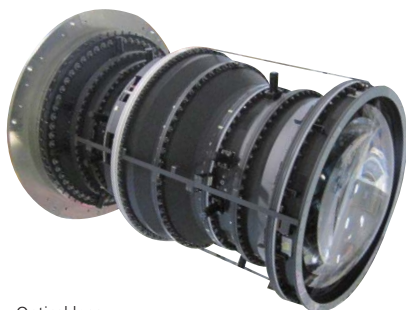


Large-scale ceramic structure to achieve 10-fold performance increase in Subaru Telescope

Located at the summit of Mauna Kea in Hawaii, the Subaru Telescope is a large-scale optical-infrared telescope run by the National Astronomical Observatory of Japan. Kyocera participated in a project to achieve a 10-fold increase in performance of the telescope. The Subaru Telescope has a reflector with

a diameter of 8.5 meters and an optical lens. The optical system is calibrated for high accuracy, and to maintain stability of the system, Kyocera developed a cordierite with superior performance. In its original state, cordierite is porous and has low strength — use as a structural material was therefore limited. Kyocera developed a cordierite featuring density and high strength, as well as

a coefficient of thermal expansion approaching zero. We completed a sintered unit with a diameter of 970mm. The lens barrel containing this large-scale ceramic structural unit has a maximum diameter of about one meter and total length of 1.7 meters. It is to be installed in the Subaru Telescope later this year as part of an ultra-wide-angle camera.



Optical lens

Photo by Todai Institute for Advanced Studies, The University of Tokyo
Institute for the Physics and Mathematics of the Universe



Cordierite components of the lens barrel

Large-diameter, high-purity ceramic ring, needed in the development of a next-generation energy source

The world has high hopes for nuclear fusion reactors. Differing entirely from nuclear fission reactors, fusion reactors promise safe and clean power supplies. Kyocera ceramic components are actively used in research of this future energy source.

Working with the Japan Atomic Energy Agency (an independent administrative agency), Kyocera has made a trial version of a large-scale insulator using the world's largest-diameter, high-purity ceramic ring. This component is needed in a neutral beam injector (NBI). The NBI is used to heat plasma and cause a fusion reaction in the International Thermonuclear Experiment Reactor (ITER). In high-voltage testing, insulation performance required by the ITER was demonstrated for the first time.

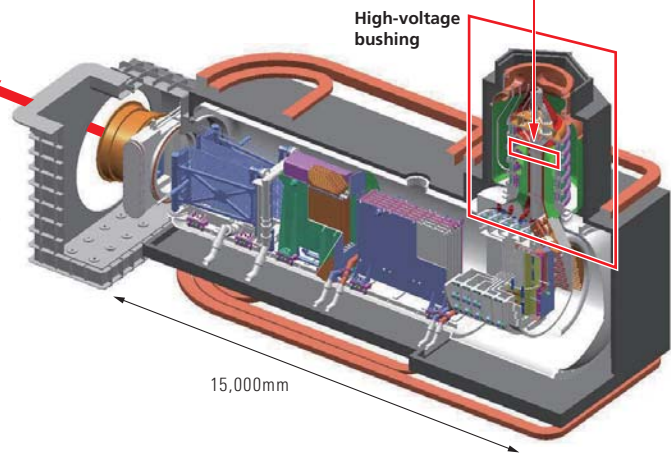
With earlier technology, manufacturing a ceramic ring to the size needed for megavolt insulation was not possible. Establishing manufacturing technology of large-bore ceramic

rings for the ITER was thus a longstanding problem. Kyocera and the Japan Atomic Energy Agency undertook joint development of a large-scale ceramic ring shaping method, and succeeded in its completion. This has contributed greatly to the advancement of ITER/NBI development. There are also high expectations for ripple effects of the technology in the semiconductor industry, and theoretical fields such as particle physics and other areas.



The neutral beam injector in the nuclear fusion reactor required a large ceramic ring with a diameter of 1.56 meters.

Illustration by Japan Atomic Energy Agency



Ceramic mounting wafer is the key to raising LED performance and lowering cost

The use of light-emitting diodes (LEDs) has continued to grow in recent years due to their low power consumption compared to incandescent bulbs and fluorescent lights. Kyocera has succeeded in developing a ceramic mounting wafer for LEDs, which has contributed greatly to increasing LED performance and lowering costs.

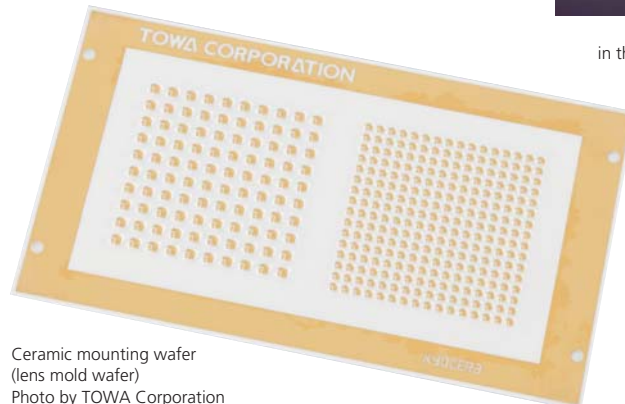
First, fine ceramic material is used for the wafer. Compared with conventional materials, ceramics have good insulation, heat dissipation and reflectance. Second, costs are reduced by producing high-precision large-scale wafers. Many individual wafers can then be cut from the large wafer. Next, compared with previous processes, Kyocera uses new laser-processing and machine-processing technology capable of cutting with fine precision. These processes

also raise LED performance.

At present, Kyocera's ceramic mounting wafers are used mainly for LED lighting. We will continue to explore other applications, pushing fine ceramic technology to broaden the possibilities of LEDs.



Sapphire wafer used in the manufacturing of LED chips



Ceramic mounting wafer (lens mold wafer)
Photo by TOWA Corporation