3^{rd} International Congress on Ceramics
Keynote Lecture
"My Life Developing Fine Ceramic Technology"
-Message to Researchers and Engineers for Future-

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Founder and Chairman Emeritus
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Thank you for your kind introduction. My name is Kazuo Inamori. I am honored to have this opportunity to speak at the 3^{rd} International Congress on Ceramics today.

I was kindly asked to speak at the opening of this congress by Dr. Koichi Niihara, President of the 3rd International Congress on Ceramics, as well as President of the Ceramic Society of Japan.

Let me introduce myself briefly. After graduating college in 1955, I started working as an engineer at an insulator manufacturing company in Kyoto. I was given the responsibility of researching light electrical ceramic insulator components and developed an insulator for cathode ray tubes.

However, I had a disagreement with my boss over the development policy and resigned from the company in late 1958. Fortunately, in 1959, there were people who were willing to support me and we were able to establish Kyocera, a ceramic components company.

Since then, half a century has passed and, in addition to making semiconductor, electronic, industrial mechanic and fine ceramic components, the company has grown into a comprehensive electronics manufacturer that produces solar cells, telecommunications equipment and multifunctional products. Today, Kyocera's sales have grown to 1.08 trillion yen on a consolidated basis; group employees total approximately 64,000 people.

Twenty-six years ago, I established a telecommunications company called DDI, now KDDI. KDDI has grown into the second largest comprehensive electronics communications company after NTT which had previously dominated the Japanese market. KDDI's consolidated sales for FY2010 were approximately 3.45 trillion yen.

Combining the figures of the company groups I have founded and managed, sales are at 4.5 trillion yen and profit is more than 500 billion yen.

Furthermore, this February, I was appointed chairman of Japan Airlines by the request of the Japanese government and the Enterprise Turnaround Initiative Corporation to support the restructuring of the airline.

Today, I would like to speak about Kyocera's Fine Ceramic products using the following slides titled "My Life Developing Fine Ceramic Technology"- Message to Researchers and Engineers for Future-," I would also like to share my thoughts about technological developments.

Please start the slides.

Electron Tube Components

I first developed a ceramic component with high frequency and insulation properties that was used in the electron guns of cathode ray tubes.

The 1950s were a time when television was rapidly growing, and the electron gun used in the cathode ray tube was important for controlling image quality. It was so important that every manufacturer was trying to make improvements.

Kyocera's first product was a component called the U-shaped Kelcima that was developed in 1959. It was an insulator for the electron gun and was made of glass pressed into a trench. Support pins, called a metal grid, were used to hold the electrode in place.

I successfully developed forsterite — the first ceramic material of its kind in Japan — which had superior high-frequency insulation properties. Kyocera was able to mass produce this item by developing techniques for the low-temperature sintering of porcelain, precision extrusion, and precise pressure and firing of the electrical tunnel kiln.

Dawn of Silicon Valley

Next, I would like to talk about the development of the semiconductor package, to which I devoted myself a short while after establishing Kyocera.

Many of you may already know that germanium transistors were invented by Bell Laboratories, the R&D division of AT&T, which was established shortly after World War II in the Eastern United States. These were still the glory days of the vacuum tube, but Dr. William Shockley, one of the transistor's inventors, desperately wanted to commercialize this technology.

Shortly thereafter, in 1956, Dr. Shockley established the Shockley Semiconductor Research Center at Stanford University's Industrial Park. Later, Dr. Robert Noyce, Dr. Gordon Moore and other outstanding researchers joined this group, seeking to commercialize transistors, but they could not succeed. At that time, Mr. Sherman Fairchild, who was managing aerospace camera manufacturers, gave them a helping hand: he decided to finance their venture to make the dream come true for Dr. Noyce and seven other researchers.

In 1957, two years before Kyocera was established, Fairchild Semiconductor was founded in the area now called Silicon Valley. Fairchild Semiconductor successfully developed the planar transistor and became a pioneer of the semiconductor industry.

Ceramic Transistor Beads

The first contact between Kyocera and Fairchild was when Kyocera received an order for ceramic components to insulate silicon transistors.

A huge volume of transistor headers, as shown in the upper left corner of the slide, were used to insulate transistors. Ceramic beads, which served as a base component of the headers, are shown in the center of the slide.

In 1961, Kyocera received its first inquiry about these components from a Fairchild subsidiary, through a trading company in Hong Kong.

We had many trials and errors, but finally succeeded in developing a highly reliable hermetic-seal technology by making small rings with borosilicate glass powder. We settled on using alumina beads and metal wire together, and heat-sealing them under a reducing atmosphere to obtain a high level of hermeticity. Eventually Fairchild found out about our technology and, in 1965, placed substantial orders with us for 10 million ceramic beads based on the TO-5 standard and 20 million ceramic beads based on the TO-18 standard.

Afterward, we started receiving orders for millions of units, one after another, from semiconductor manufacturers in the United States and Asia. This was Kyocera's first step in becoming deeply involved in the semiconductor industry.

High Density Package

Mr. Jack Kilby of Texas Instruments evolved his idea of transistors, and came up with the concept of the integrated circuit by forming transistors and diodes on a semiconductor substrate. Coincidentally, Dr. Robert Noyce of Fairchild also proposed a similar IC concept and succeeded in mass-producing it.

This slide shows a new concept for ceramic multilayer packages — the High Density Package requested from Fairchild. This package had two layers of a highly precise circuit pattern of 125 micrometer width and 250 micrometer pitch pattern printed on 25mm square, 0.6mm-thick alumina sheets. Those upper and lower layer patterns were connected together through 92 vias. Eight ICs were mounted on the surface and connected to 36 external pins. It was a highly sophisticated design that shattered the common conception of ceramic technology.

All project members worked day and night without rest and utilized every technology available: tape-casting technology, co-firing technology, metallizing technology and pattern-printing technology. They finally succeeded in making samples within the three-month lead time they had originally promised. Thanks to their efforts, we successfully developed this historic ceramic multilayer package.

I immediately delivered this High Density Package to Fairchild and they truly appreciated our product; however, due to changes in their plan, we could not go to mass production with this product. But this development proved our high level of ceramic-multilayer technology to the semiconductor industry and to the world.

Intel's Start

Now I would like to talk about Kyocera's relationship with Intel, which was established when Dr. Robert Noyce and Dr. Gordon Moore left Fairchild. I had long been acquainted with Dr. Noyce, a founding member of Intel Corporation, and I worked with him while he was at Fairchild to develop the early stages of the semiconductor package.

In 1968, when Intel was about to start, Dr. Noyce made a special point of visiting me in Kyoto while he was traveling in Japan. I invited him to a traditional Japanese restaurant for dinner, in Kyoto close to the Nanzenji

Temple. He mentioned to me during dinner that he wanted to establish a new company called Intel in order to manufacture a new, large-scale memory device called DRAM. He said, “I need to have a ceramic package for this purpose.” I felt his passion and told him that I was happy to support him.

Since he was a music lover as well, he was very pleased to hear the *koto* — a Japanese thirteen-stringed instrument resembling a zither — that evening. He enjoyed it so much that he wanted to buy one as a souvenir. I took him to downtown Kyoto the next day and he actually bought one and took it back to the States. Some years later, I was invited to his home in Silicon Valley and he showed me the *koto* and told me that he sometimes played it.

As you may know, Intel has developed new products one after another since its inception, and has grown to become a giant in the semiconductor industry. Along with this development, Kyocera supplied new packages in a timely manner.

Side-Braze Package

This slide shows our most memorable product in ceramic-multilayer-package history. This was the 1k MOS package for memory ordered by the newly founded Intel.

This package consists of three layers: the bottom layer, with a metallized die attach pad to mount the LSI device; the top layer with a metallized seal ring pattern for solder sealing to a Kovar lid; and the middle layer formed with signal paths that connect the exterior contacts to 16 metallized pads that have been wire-bonded from the LSI. The three layers are bonded into a single structure with a sealing glass, thus becoming a side-braze dual in-line-package. This type of package for the 1k DRAM application reached a volume of 1 million pieces, but in the earlier stages, the glass seal did not have adequate heat resistance and caused numerous defects in hermeticity.

I solved this problem by utilizing the aforementioned High Density Package technology to develop a side-braze multilayer package, which had superior hermetic quality and mechanical strength.
In 1971, Intel developed the first microprocessor, called the 4004, followed by the 4K DRAM in 1972. They commercialized many new products one after another. This multilayer ceramic package was used in the most advanced MOS LSIs and it was mass-produced as the most reliable semiconductor sealing package.

Ceramic Pin Grid Array Packages

This slide shows ceramic Pin Grid Array packages for the 16-bit microprocessor developed in the United States in 1981.

The trend of high integration and higher-speed ICs never stopped, so we needed to develop semiconductor packages of a smaller size but with a higher number of pins to comply with these requirements. Therefore, we developed PGA packages, which allow for more points of contact when pins are placed perpendicular to the surface.

Demand for these packages drastically increased during the 1980s, along with the popularization of personal computers, and we significantly contributed to making higher-performance, lower-priced computers.

Inside of MCM Packages

The package shown here is for demonstration purposes. This cross-section reveals the internal structure of the multi-chip module package.
At the time of developing multilayer technology, the pattern pitch and diameter of the vias were both 300 microns, but at the time of this product, it became possible to reduce the diameter to 75 microns. Finally it was possible to make ultra-high-density electronic circuits with the number of layers skyrocketing from the original three layers up to 50, and vias, up from about 10 to six hundred thousand per layer.

This slide shows one of sample packages. Some products have a physical size of just 106mm square — containing 43 layers, about 1.3 million vias, a diameter of 100 microns, and a total circuit length of 396 meters. We have developed highly advanced manufacturing technology in order to produce ceramic packages with this much circuit length, a 100-micron line width, and no disconnection fault.

Even now, it is still recognized among all other materials and production processes that the three-dimensional circuit pattern structure and the ceramic-multilayer technology of the multi-chip module is the highest-density multilayered circuit pattern structure available.

CMOS Packages

So far, I have shown some examples of early ceramic semiconductor packages on previous slides. Now, let me introduce some more recently developed packages to you.

As cell phones become smaller and thinner, packages for CMOS imaging devices in imbedded phone cameras must also become smaller and thinner.

Because Ceramics possess high rigidity and easier cavity creation during production, smaller and thinner ceramic packages are used for many types of cell phones.

Surface Mount Ceramic Packages

Crystal oscillators, crystal-controlled oscillators and Surface Acoustic Wave filters are used in telecommunications equipment, such as cellular phones. These elements need a package that can protect them from outside air contamination and moisture, since they are processed for high precision.
Kyocera has been developing surface-mount ceramic packages since the mid-1980s.

To meet the specifications for increasingly smaller devices, it has recently become mainstream to make the lid cap, which is a part of sealing cap, thinner. Since conventional alumina was not strong enough, we developed a new alumina ceramic material having 1.5 times higher strength than conventional materials. The picture you see is a sixteen twelve-size micro SMD package with a 0.15mm lid width. Its size is much smaller than a sesame seed.

Alumina Multilayer Substrates for CT Scanning Sensors

We developed multilayer substrates for the light-receiving element of x-ray CT scanners by using ceramic lamination technology.

Currently, CT scanners rotate at very high speeds to take internal pictures of the human body. The centrifugal force reaches 20G to 30G. Therefore, ceramic multilayer substrates, which have high rigidity and can withstand this pressure, are used in the mounting substrate that supports the receiving optical device.

Applications of Fine Ceramics Technologies

I have been thinking of contributing to the safety and comfort of humanity by applying the wonderful possibilities of ceramics in various fields.

Starting with components for cathode ray tubes, I devoted myself to developing fine ceramics applications, such as semiconductor packages and other new products in various fields.

Today, since our time is limited, I would like to discuss new products applied to three fields: Energy and Environment, Space Research, and Consumer Goods.

PV Module Development

The oil shock of 1973 brought about our first global energy crisis. Because I wanted Kyocera to contribute to solving the global energy problem, we decided to enter the photovoltaic solar cell business. Our first R&D effort was in 1975, with ribbon crystal silicon photovoltaic cells created using the edge-defined film-fed growth method.

After many setbacks, we finally succeeded in mass-producing crystal silicon solar cells. We continued our R&D efforts, and in 1982, succeeded in using a multi-crystal casting method to mass-produce silicon solar cells for the first time anywhere in the world. This reduced the cost of solar cells and expanded the business.

In 1984, we developed a more efficient process using silicon nitride bulk passivation with the plasma CVD technique. Through this process, most multicrystalline silicon solar cells can reach practicable levels. Our R&D department succeeded in developing the more efficient back-contact structure — a world leader at 17.3% in aperture area efficiency with consumer-sized solar modules.

SOFC

The solid oxide fuel cell (SOFC) is attracting considerable attention as a promising power generation system due to its high power generation efficiency. Kyocera has been developing SOFC systems for residential use.
To decrease the size of the SOFC, ceramics technology is utilized in co-firing the SOFC's anode and solid electrolyte, resulting in superior durability and highly efficient power generation. Presently, an A/C power generation efficiency of 45% and a total efficiency — combining heat and power efficiency — of 85% has been attained.

A joint development — with Osaka Gas, Toyota Motor, and Aisin Seiki — of the SOFC system is aiming for production in few years.

Laminated Piezoelectric Actuators

In Europe, many automobiles are equipped with diesel engines using high-pressure direct fuel injection systems that make it possible to create high-performance engines with less CO_2 exhaust. Kyocera mass produces the laminated piezoelectric actuators used in the fuel injectors of diesel engine automobiles. The piezoelectric ceramic actuator has a laminated structure of few hundred layers. It has a superior response time compared to conventional solenoid actuators and enables a more precise fuel injection control.

Our piezoelectric actuators are produced using co-firing technology, in which low-temperature piezoelectric ceramics with high piezoelectric constants are co-fired with internal electrode materials. Based on our original low-temperature sintering technology, we utilize a special internal electrode material with only one-sixth the amount of palladium as conventional compounds, thus greatly reducing the cost. High reliability was also achieved due to our original stress-relaxation design: lasting 50 times longer than conventional actuators in acceleration durability tests.

Ceramic Insulation Ring for Thermal Fusion

The International Thermonuclear Experimental Reactor Project is a collaborative project between Japan, EU, Russia, the U.S., Korea, China and India to develop nuclear fusion for peaceful purposes. Kyocera has contributed with our ceramic technology.

A large ceramic ring — 1560mm in diameter — is required at the incident of the neutral beam in the thermonuclear reactor. Kyocera was in charge of developing this ring. We succeeded in developing an Alumina structure that could withstand 1-million-volt electrical charges.

Ceramic Components for SUBARU Telescope

Next I will discuss astronomy-related applications.

The “Subaru Telescope” is set up at the observatory atop Mauna Kea in Hawaii. Kyocera participated in a joint project to improve the resolution performance of the telescope ninefold. A reflector and an optical lens 8.5m in diameter were built into this telescope.

High density cordierite, with its high rigidity and small thermal expansion coefficient, was chosen as the structural material for these optical systems in order to maintain their high accuracy in a stable environment.

Conventional cordierite ceramics were porous and lacked strength, which limited their use as structural materials.
Kyocera, however, succeeded in creating a large mirror cylinder out of sintered ceramic — 700 – 950mm in diameter, 3m in length, and consisting of 18 components — by developing a new type of cordierite with higher density and strength as well as a near-zero thermal expansion coefficient. The performance of the Subaru Telescope was drastically improved with this large ceramic cylinder.

Kitchen Utensils

Last is the consumer-related field.

Taking advantage of ceramic materials — notably zirconia, which has excellent fracture toughness — we developed kitchen products, such as knives, slicers, peelers and other utensils.

In addition to its long-lasting sharpness and light weight, ceramic knives are rust-proof and germ-resistant due to their smooth surfaces. Ceramic knives are sold in over 35 countries in North America, Europe and Asia. We have shipped more than 7 million ceramic knives since they were first introduced in 1994.

Jewelry Pottery

This slide shows porcelain made of translucent glazed alumina with a traditional Japanese painting technique. In 1959, I saw a translucent alumina developed by Dr. Coble of GE and was very impressed by the state-of-the-art material technology of fine ceramics. Since then, I have been thinking of using ceramics in jewelry applications.

Later on, I used this material and worked on developing porcelain with Meissen painting. I wanted to introduce wonderful porcelain that integrated the art and technology of east and west — especially using traditional Japanese painting. The GYOKUJI "gemware" you see here with eight scenes of Satsuma was made into a piece of artistic beauty.

We are displaying this porcelain in our booth. Please feel free to visit.

I have introduced you to just a few examples from the vast array of products that Kyocera has developed since its inception. Please turn on the lights.

Next, I would like to explain my thoughts on the attitudes and ideas needed by researchers in order to conduct successful R&D.

[Motivation for R&D]

First, when you start R&D, your motivation — in other words, why you yourself have to carry out this R&D — becomes very important.

When I look back on the time when Kyocera started, we were a very small company with 28 employees. We had only a single product — an insulator for TV cathode ray tubes. As the company could not remain stable with only a single product, we visited many electronics manufacturers to increase our orders. However, very few companies would buy products from a very small, unknown company like Kyocera.

Although we were turned down so many times, we never gave up and kept on visiting customers. However, the only orders we received were those that other companies declined because they were too difficult to fulfill. We had no choice but to accept such orders, saying "We can do it" and then developing the products that seemed impossible for us to make.

In those days, our R&D activities were driven by a sense of responsibility to protect the company and the lives of our employees. This sense of responsibility was the motivation for our R&D in the early days of Kyocera.

Among researchers, some might work to get a Ph.D. Some might work to get rich quickly by starting a venture business using their research results. Researches that work for such personal gain, will soon lose interest in R&D after achieving their goals. For example, those who work for a Ph.D. study very hard until they receive their doctorates, but after that, they will not be able to concentrate on R&D anymore. For those who start venture businesses, once they achieve some success, their pace of R&D slows down.

Therefore, I believe the motivation for R&D should not be for personal gain but something at a higher level. In other words, it is very important for researchers' motivations to be such that R&D activities become their reason for living.

[Love your work]

I started R&D in fine ceramics by chance, at a company I joined after graduating Kagoshima University. Now, I feel I was very lucky that I had such a wonderful job.

I feel so, because I believe, among the various materials used in our daily lives, fine ceramics are a very promising material that will be further developed in the future. I am a very lucky man to have been involved in R&D activities of fine ceramic materials which have great potential.

In the beginning, we dedicated our R&D efforts to protecting employees. But now Kyocera has grown and we feel very happy that we can continue our research of ceramic materials which have wonderful potential.

It is often said that we should have a dream for our lives. I believe if a researcher does not have a big dream for his/her own project, it will be very difficult for him/her to continue the research. If you love your research, you can devote yourself entirely to your research work. You might even forget to eat and sleep. On the other hand, if you don't like your research, you will not produce any research results even if you are in a very wonderful research environment.

There is a saying in Japan: "A thousand miles may seem like one mile when you are traveling to see your love." Indeed, a thousand miles seems like only one mile if you are traveling on a road to see the person with whom you have fallen in love. Love for your research and work will be the best motivation of all.

[Always be creative in your work]

As I just explained, it is very important to have big dreams and deep desires in your research work. However, even if you set a big goal, your daily work still requires many mundane, tedious tasks. So, you might sometimes feel a big gap between your dream and reality, which can be frustrating.

However, in any research field, creative efforts and tedious works, such as conducting experiments or collecting data, are critical to achieving great results.

It sounds very difficult — "Be creative" — but it simply means to continuously think about how to improve your work on a daily basis (better today than yesterday, and better tomorrow than today). If you make creative efforts in your daily research, it will lead to better results little by little, even in humble experiments, and your interest in research will increase as well.

Even a huge structure like a pyramid cannot be built without carrying up stones, one by one, for an extraordinary length of time.

You must be dedicated to your research, to conducting experiments and processing data. Great results will be produced only with the accumulation of such efforts. Having a strong will to complete a task and accumulate tedious efforts will bring you wonderful research results.

[Character required for a researcher]

Another important factor in successful R&D is being hard on yourself.

When we are conducting R&D, we are apt to have a go-it-alone mentality without realizing it. The experimental results we produce ourselves often look very good. When we get a result that we do not want, we often distort the facts and interpret it as we like.

If you can be hard on yourself, you can also be hard on your experimental results. You cannot achieve good research results unless you examine your experimental results carefully and interpret the facts as they are.

Unfortunately, research results respected by others cannot be achieved with only the knowledge we acquired in college. Wonderful results cannot be achieved unless we conduct research based on levelheaded judgments derived from a well-rounded human nature and a sincere attitude.

You should have the courage to accept challenges and difficulties at the same time. As human beings are weak, we often want to avoid them when we face problems. When you cannot get the results that you want, you look for the reason and find an excuse to console yourself.

You cannot promote true research activities unless you listen to the voice of truth and have the courage to overcome any difficulties.

[Project our abilities into the future]

Next, when you decide on an R&D project, how you set your goal or completion date becomes important. Whether it is a company or a research institute, the choice and timing of an R&D project is a matter of life and death. Even if two firms choose the same R&D project, it is likely that a delay in completing the project will bring no value to the second firm.

Therefore, we set a completion date when we choose an R&D project. Many of the R&D targets we set under severe market competition are aggressive and beyond the level of our present abilities. The more technically-difficult the R&D project is, the more likely the success or failure of the project will be determined by how fast we raise our present abilities and complete the project on time.

When making plans for R&D projects, a research leader must have the ability to predict whether or not it is possible to raise the abilities of team members to meet higher targets by a certain point in the future.

Anyone can say whether or not a target is attainable at a present level of ability. Instead, we must choose projects of which we are not now capable of achieving at our present level of ability and make up our minds to focus on that point in the future. For this purpose, the research leader must have a plan to raise the team's abilities to meet these higher goals by a certain point in the future.

I express this as "Project our abilities into the future" and I have taught research leaders to project their R&D abilities into the future.

If you set a high target and try to achieve it within a set time, you should project your abilities into the future.

[Never give up until we succeed]

When I was president of Kyocera, I gave a lecture to researchers of a leading electronics manufacturer. I discussed the R&D activities at Kyocera. During the Q&A session, I received a question about the success rate of R&D at Kyocera.

When I answered, "We have a 100% success rate of R&D at Kyocera," everybody gave me a dubious look. So I continued, "We never give up until we succeed. It is our basic attitude in R&D at Kyocera. Therefore, basically our R&D will never end in failure."

If we really wish to achieve difficult goals, we can learn from the way a hunting tribe tracks prey. Once they find the tracks of their prey, they will track them for days with nothing more than a spear in hand. Even if they become very hungry, they will never give up until they have killed their prey.

When I conducted R&D, I pursued it with the passion of a hunting tribe. Hunters endlessly track prey until they succeed in catching it. To achieve wonderful results, we must tenaciously persevere in our efforts — and never give up until we succeed.

[Divine revelation after much suffering and struggles]

I encountered many hardships in my research and development, and often could not solve problems with only the knowledge and experience that I had. I believe all of you have had the same experiences and have looked for good ideas to solve such difficult problems. However, I believe such good ideas will not appear to us if we are just thinking in a desultory way.

Some people think up wonderful ideas. I believe they are people who have suffered much and tried to solve these problems with their utmost efforts.

When I faced difficult problems and suffered much, these problems penetrated into my subconscious mind. In such a state, I could remain focused on these problems, even when I was thinking about other things.

In R&D activities, if you use your subconscious mind, you can achieve excellent results. If your passion to solve these R&D problems penetrates into your subconscious, you will have an unexpected moment when a good idea will flash into your mind.

For example, when I worked all through the night and daydreamed in the garden, there was a moment when a solution to a problem suddenly flash into my mind. I believe the reason why it happened was that God couldn't stand by any longer and watch as I suffered, so God gave me inspiration.

I would like to ask all of you who are engaged in R&D activities not to run away from problems, but try to solve them with a perseverance that penetrates into your subconscious mind. When you face difficult problems and suffer so much, your passion to solve these problems penetrates into your subconscious mind. In such a state, a truly creative idea will come up to you.

[Confidence in your unlimited potential]

Another important thing in conducting R&D is to believe in your unlimited potential.

For example, during research project discussions, we sometimes hear negative comments such as "It is very difficult to achieve this project because of such and such." As for me, although I myself don't have special talent, I strongly believe a human being has unlimited potential, so I drop negative thinking altogether and try to promote R&D activities with a positive mindset.

When we discussed research projects at Kyocera, one or two researchers always had a negative attitude. They would say, "Dr. Inamori, I have a few problems with what you are saying. I don't think it is possible to complete this project because of these problems."

On such occasions, I used to say, "Don't give up before you start. Let us believe in our potential and think of how we can achieve our goal." Then I pushed forward our R&D projects with a positive mindset.

At Kyocera, we believe that possibilities are infinite if we work very hard, even for the very difficult R&D projects that seem impossible to complete. With such an attitude, Kyocera has succeeded in many R&D activities and we were able to diversify our business into many different fields.

[Challenge the impossible]

This is a story from about 20 years ago. David Halberstam, a well-known, Pulitzer-Prize-winning American journalist asked me for an interview and came to Japan. This interview appears in his book, *Next Century*. There he introduced me as follows.

*"He brought his company to the cutting edge of technology. He said, '**What we like to do next is what people tell us we can never do.**'"*
As Mr. Halberstam said, Kyocera has been challenging what people tell us we can never do — in other words, what is generally considered impossible.

We, at Kyocera, consciously believe that we can achieve what others tell us is impossible by exerting our utmost efforts. This is the history of Kyocera. It is neither a miracle nor a fortune. Spanning over our 50-plus-years history, Kyocera has been accumulating daily improvements, believing in the unlimited potential of human beings. This has lead Kyocera to what it is today.

For all of you in audience, if you believe in your unlimited potential and devote yourself to R&D work, I am sure that you will be able to achieve wonderful results.

Please don't settle for status quo, but work hard on fine ceramics R&D with the courage to face difficult challenges for the benefit of society and humankind.

Today I discussed some of Kyocera's developments as well as my thoughts on the ideal attitude that a researcher should have. I hope that you find them useful for your research and development activities.

I would like to conclude my speech by wishing all of you gathered here today success in your R&D works and that you have a wonderful and happy life as researchers and engineers.

Thank you very much.

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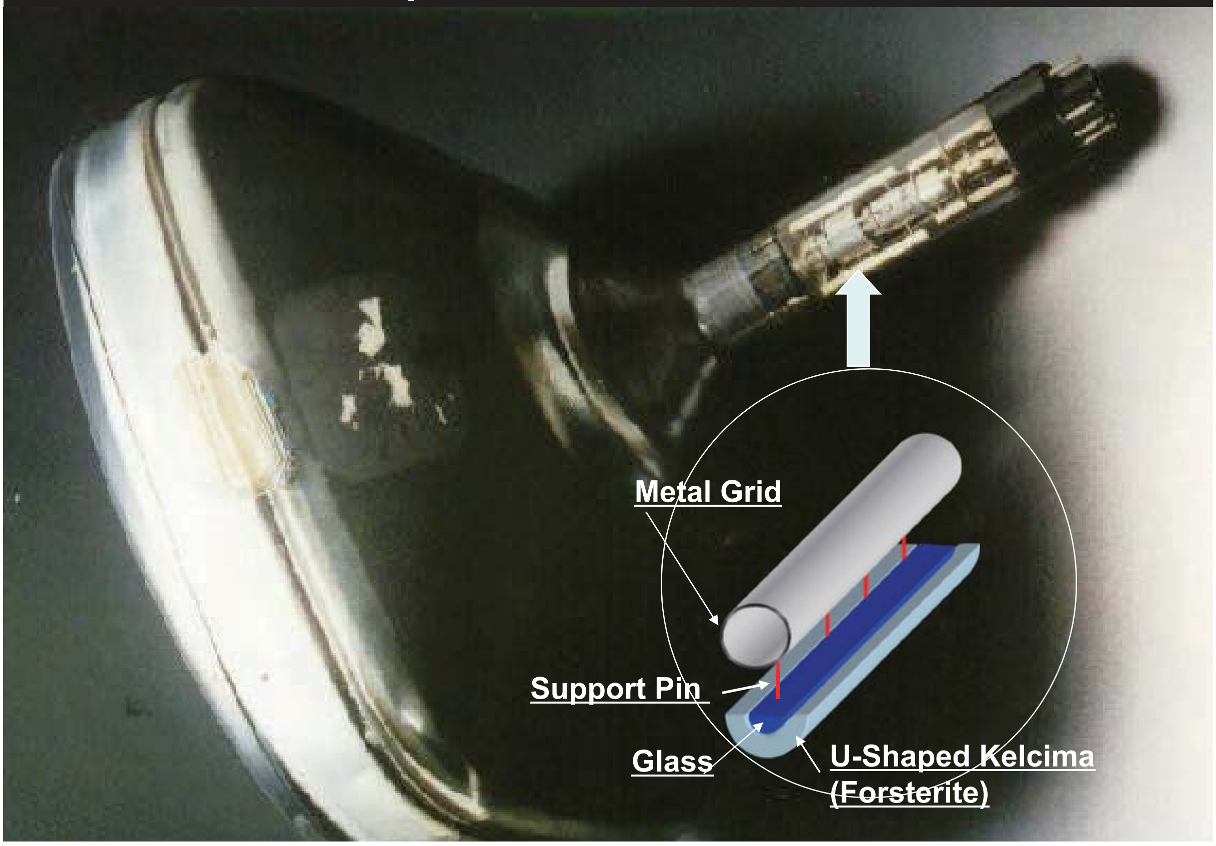
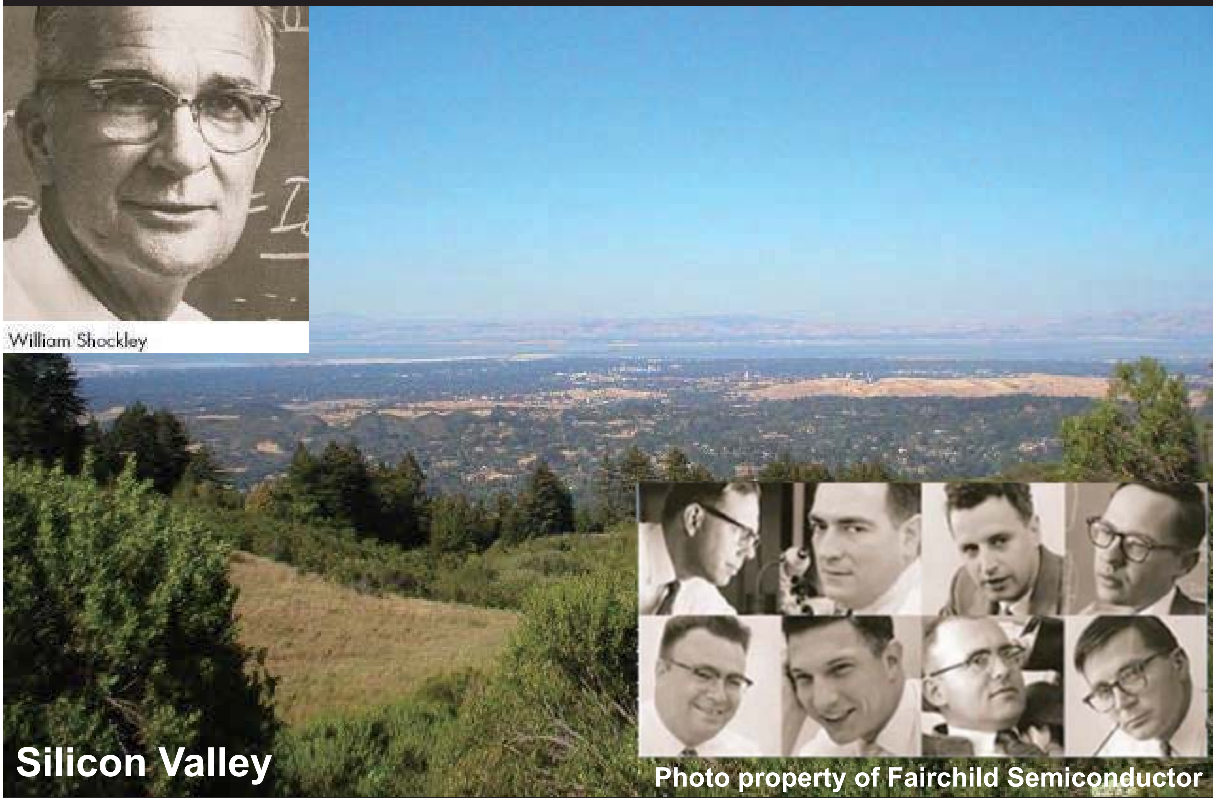
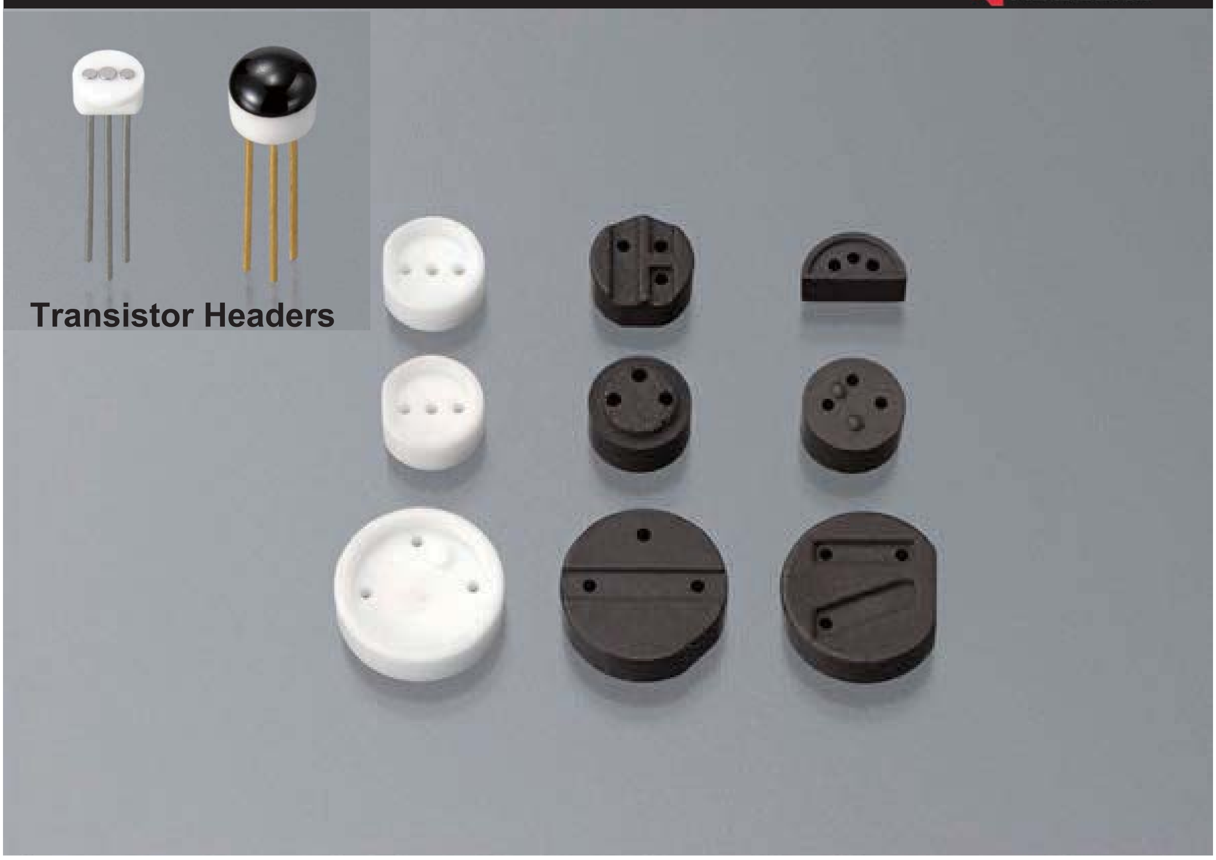


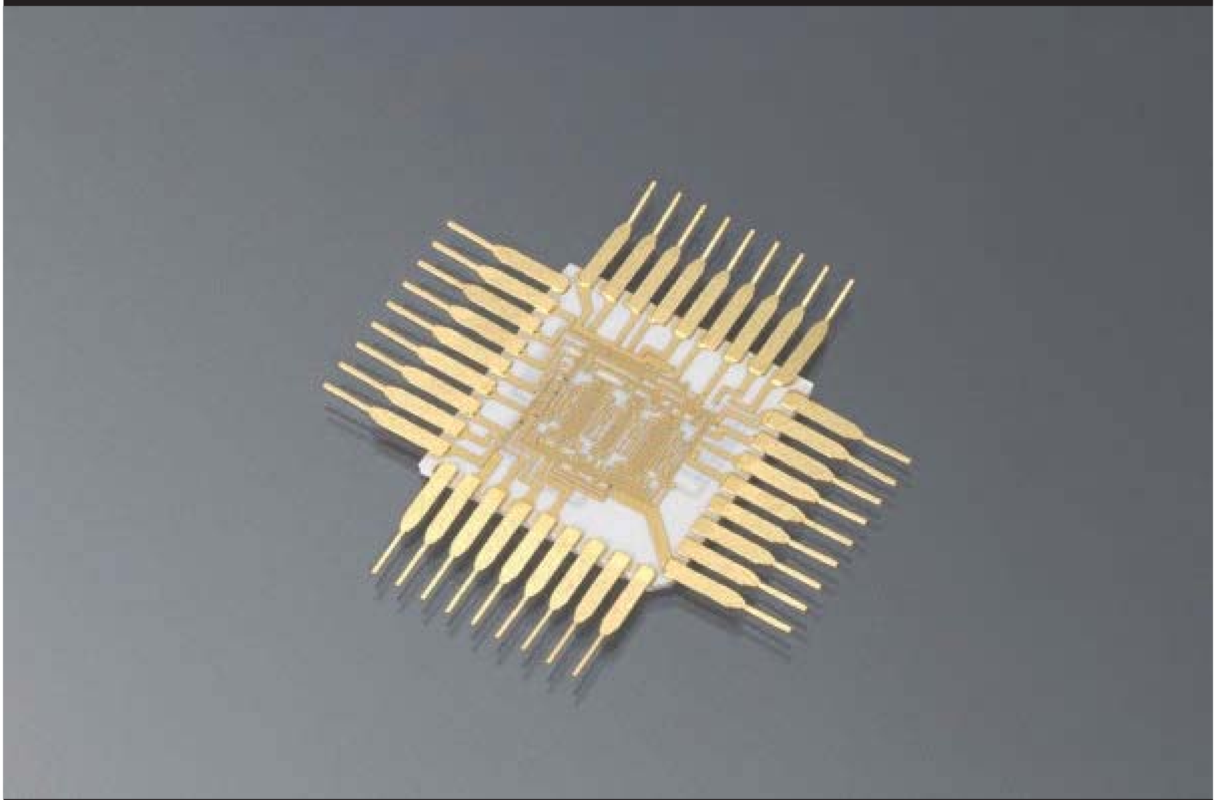
Dawn of Silicon Valley



Ceramic Transistor Beads



High Density Package



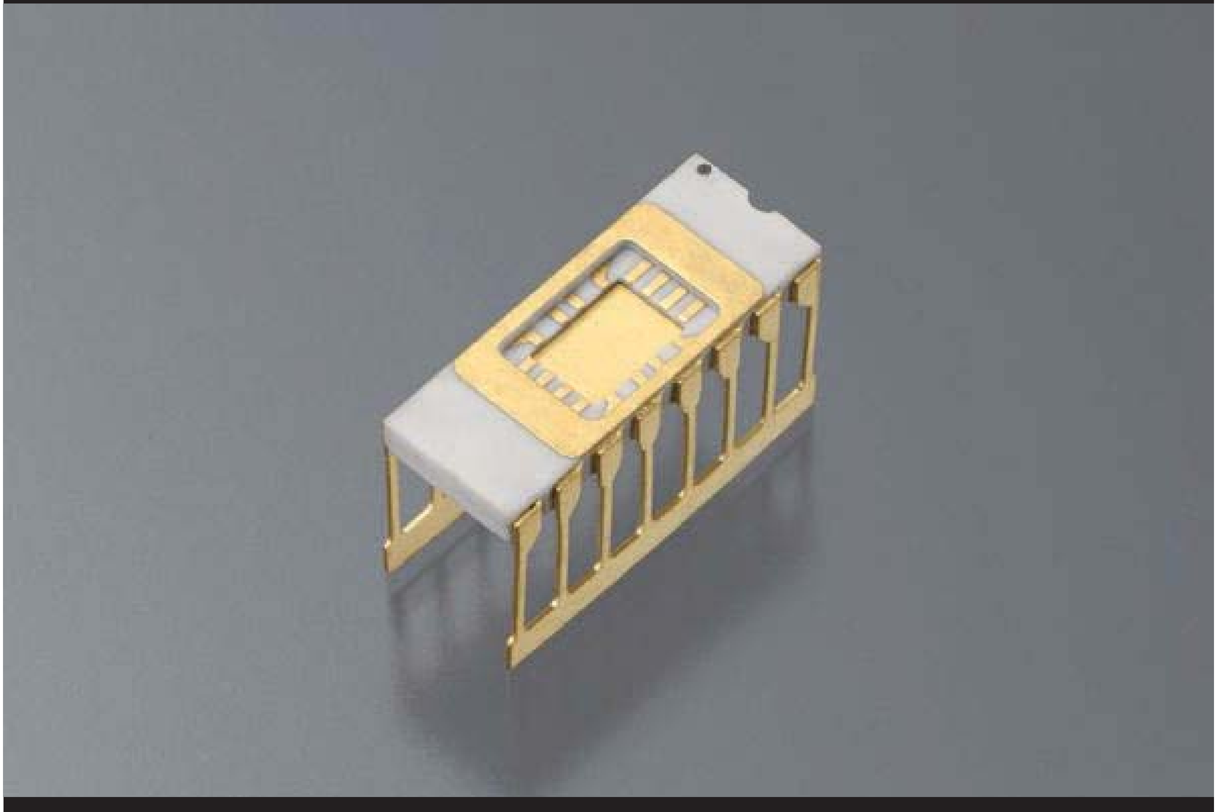
Intel’s Start

Dr. Robert Noyce

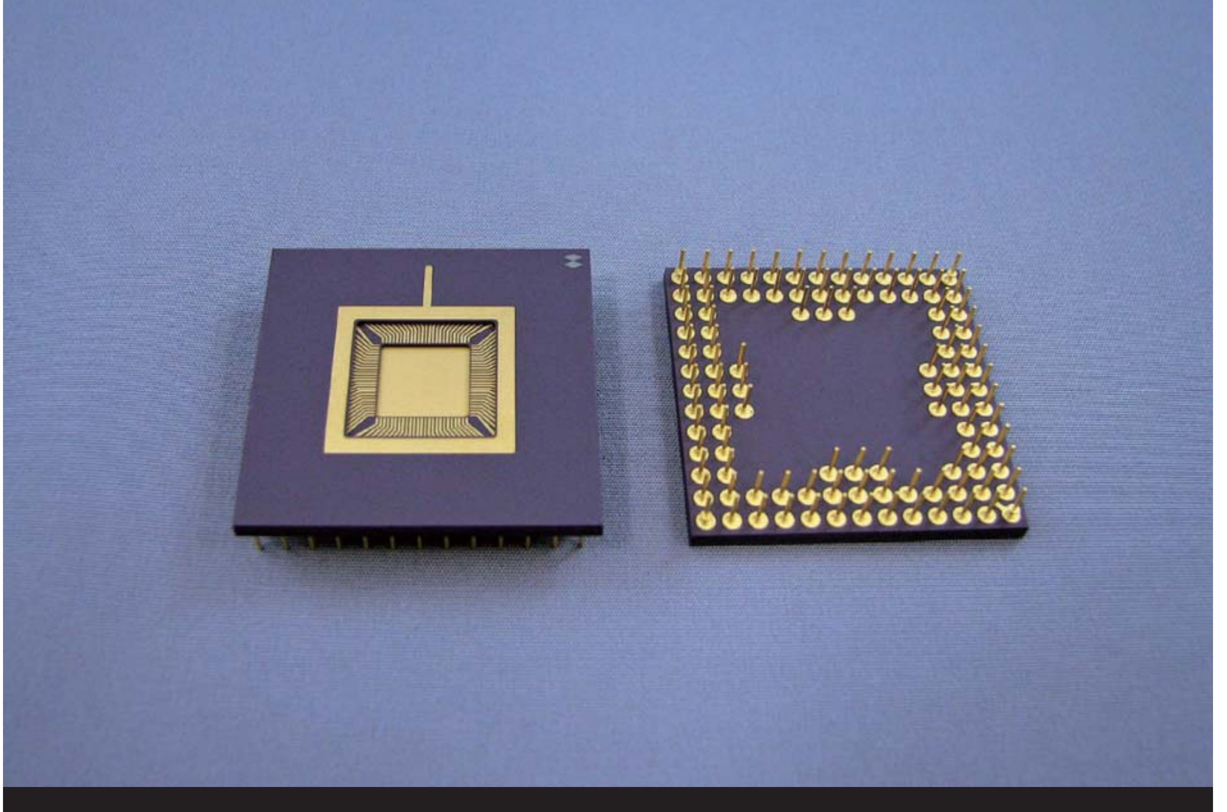
Photo property of the Society of Motion Picture and Television Engineers

Dr. Kazuo Inamori

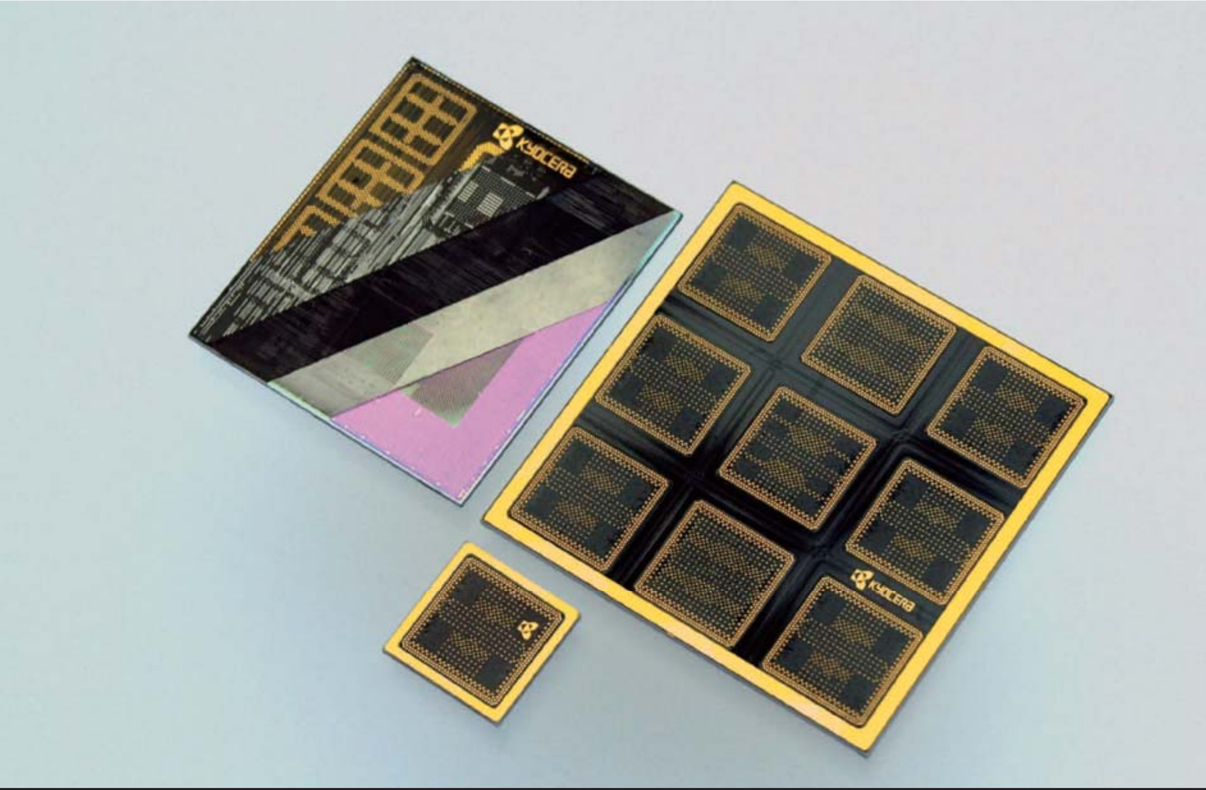
Side-Braze Package



Ceramic Pin Grid Array Packages



Inside of the MCM Packages



CMOS Packages

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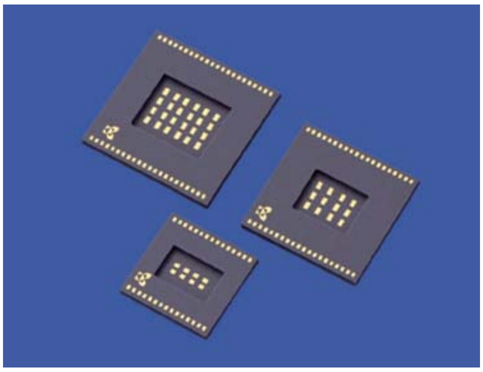
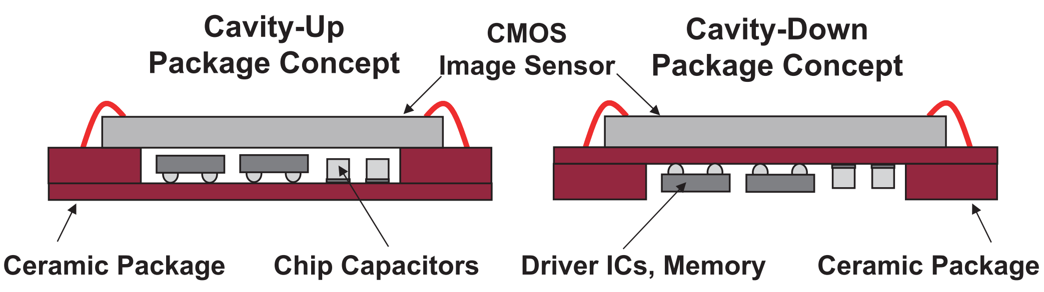


Application:
- CMOS Camera Modules

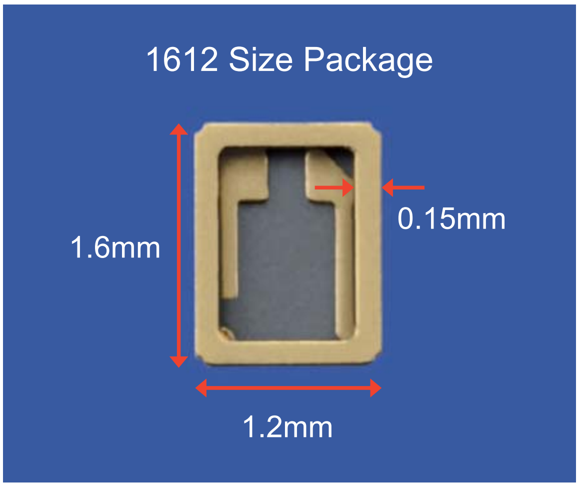
Features:
- Thin and Small Outline
- Cavity for Chip Capacitors and ICs
- High Rigidity

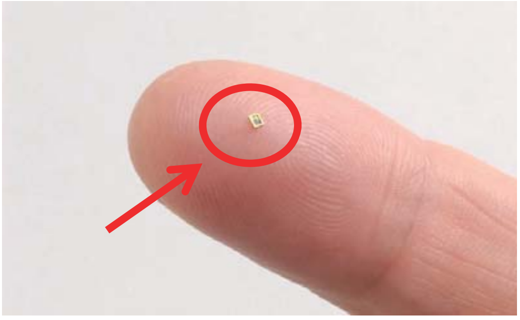
CMOS Camera Packaging Concepts for Miniaturization



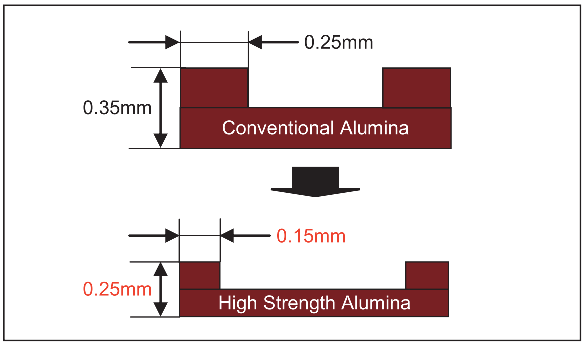
Surface Mount Ceramic Packages

KYOCERA



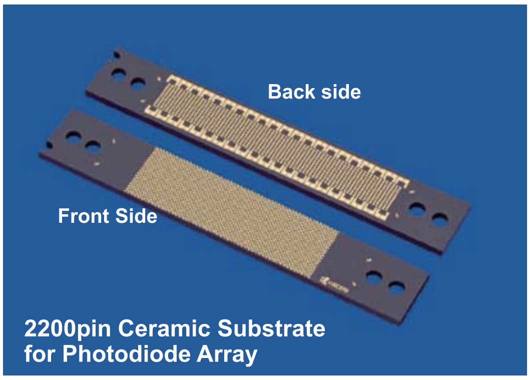


Features:
- Increased Cavity Area
- Decreased Thickness
- High Strength Alumina

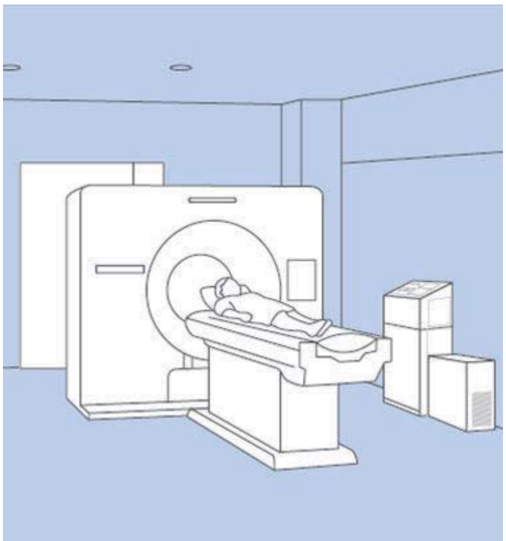


Alumina Multilayer Substrates for CT Scan Sensor

KYOCERA



Features:
- High Rigidity
- High Density Chip Assembly and Fine Pitch
- Endurance Centrifugal Force 20-30G



X-ray CT Scanner

Applications of Fine Ceramic Technologies

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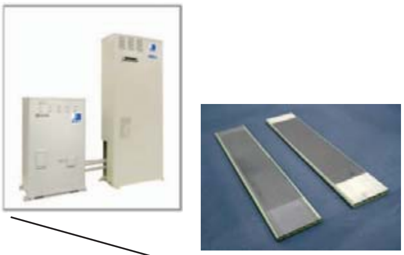
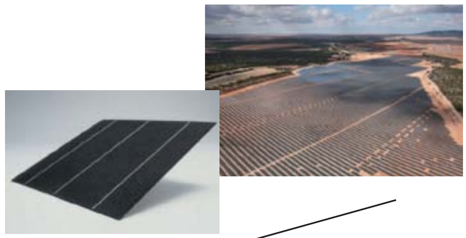
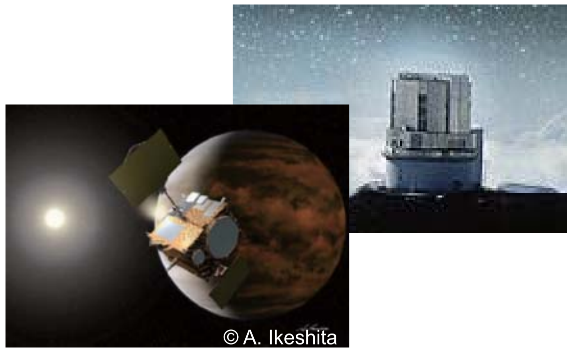
Energy and Environment related field





Consumer related field

Space Research related field



Development of Photovoltaic Modules

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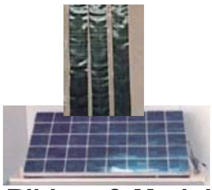
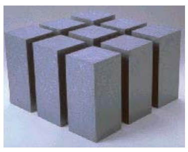
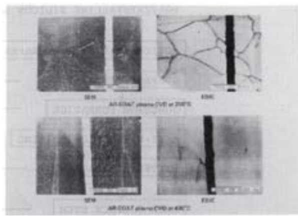


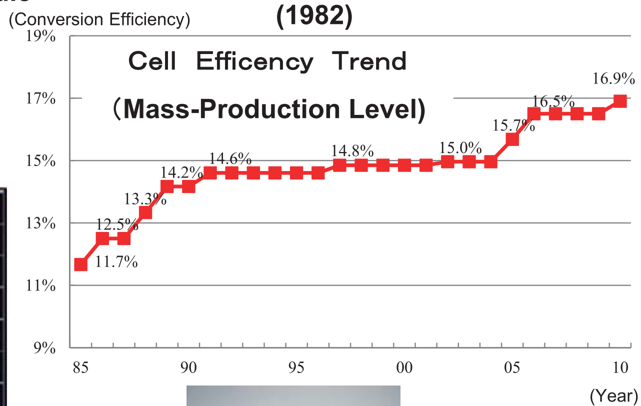
Si Ribbon & Module (1978)

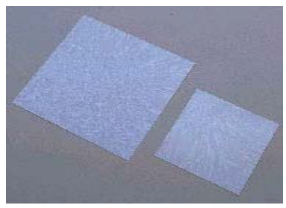


Multi Crystalline Si (1982)

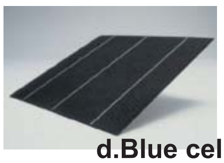


SiN Process (1984)





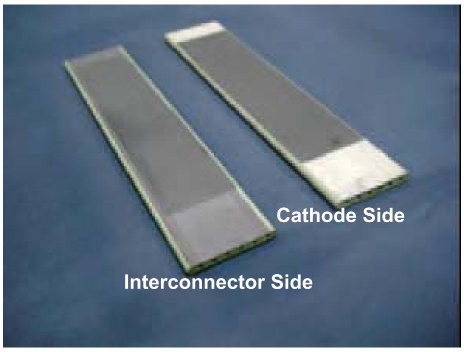
15cm × 15cm Wafer (1995)



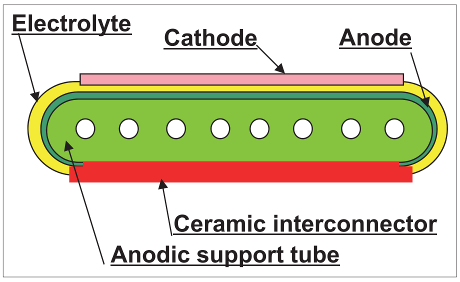
d.Blue cell
High Efficiency PV Module (2004)

Aperture Area Efficiency 17.3%(R&D) (2009)

SOFC Co-Generation System



SOFC Cells

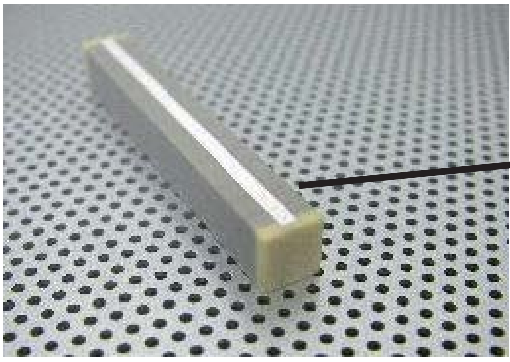


Cross Section

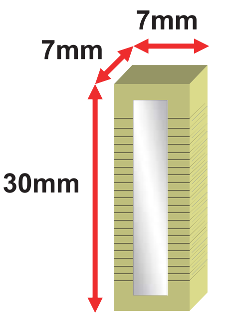
SOFC CHP (Combined Heat and Power) system

Features:
- All Solid Ceramics
- Flat Tube Easy to Seal
- Compact

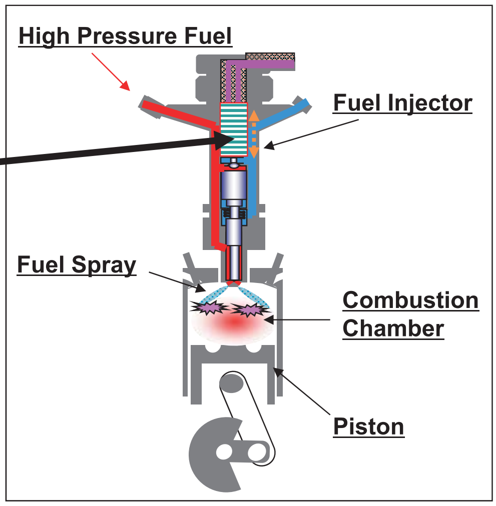
Laminated Piezoelectric Actuator



Laminated Piezoelectric Actuator



400 Layers



Schematic Diagram of Piezoelectric Fuel Injection System

Features:
- High Piezoelectric Constant
- Low Sintering Temperature
- High Durability and High Reliability

Insulation Ceramic Ring for Thermal Fusion

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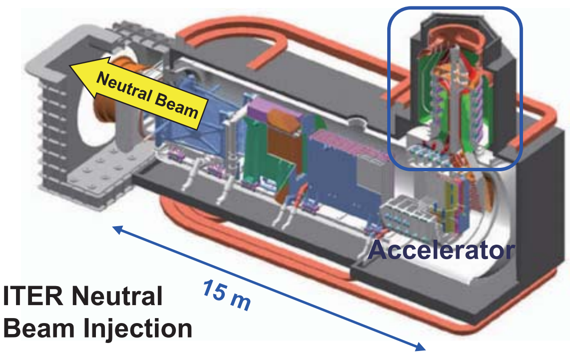
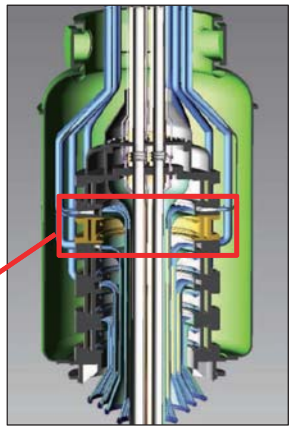


ITER Neutral
Beam Injection



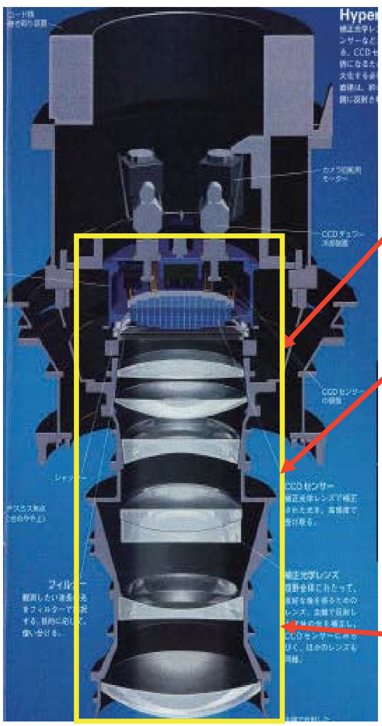
The Largest High-Purity Alumina Insulation Ring

Features:
- High-Break Down Voltage 1MV
- Ultra Vacuum Seal (Brazing)
- Large High-Purity Alumina

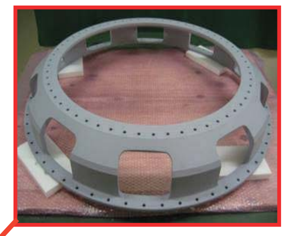
Courtesy of Japan Atomic Energy Agency

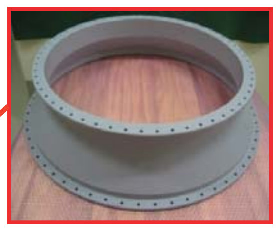
Ceramic Components for SUBARU Telescope

KYOCERA



SUBARU Telescope





SUBARU Observatory

Features:
- Material: Cordierite
- Size: φ700-950mm
- 18 components

Joint Project of NAOJ,
Canon and Kyocera

Kitchen Utensils

KYOCERA


Knives


Peeler

Features:
- Long-Lasting Sharpness
- Rust-proof and Hygienic
- Light-Weight


Slicer

Jewelry Pottery

KYOCERA

玉磁

(Gyokuji)