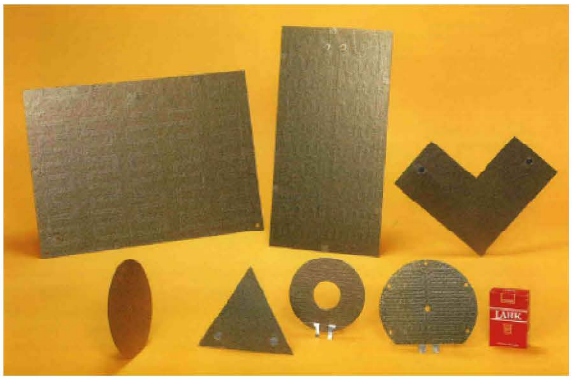
Ultra-thin Model
Micathermal Heater

Our micathermal heaters use our original-design stainless steel foil element, are extremely thin and feature high density performance.

This heat source supports a wide variety of heating and drying needs including liquid crystal, semiconductor and metal applications, and is used an many fields of industry. We will listen to your needs and provide you with proposals for an



Benefits

■Fast response

The thin 1mm sheets have low thermal capacity enabling rapid heating.

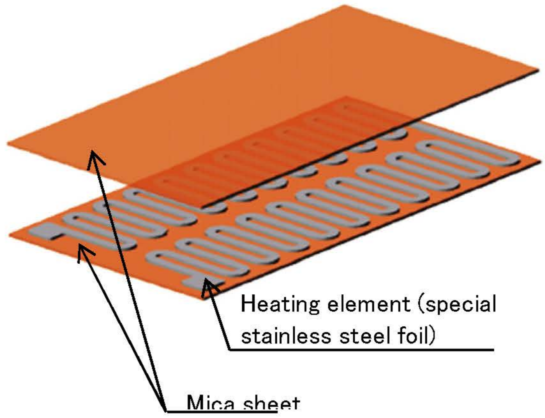
■Even heat distribution

The planar heating element distributes heat more evenly than sheath heaters.

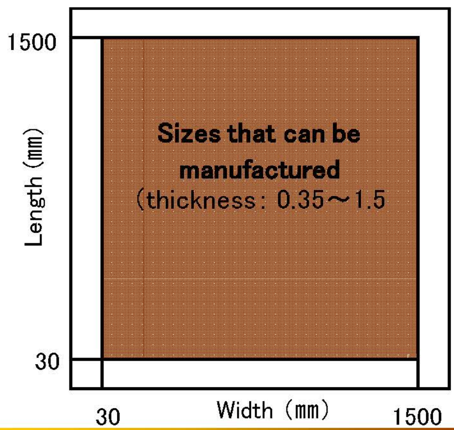
■High heating efficiency

As a planar heating element, the surface area in contact with the object to be heated is large making heating more efficient.

■Responding to many kinds of shapes



Product Specifications



General Specifications	
Max. Dimensions	up to 1500×1500
Thermostable Temp.	up to 500℃
Metal Foil Material	Special stainless steel foil
Electrical Specifications	
Withstand Voltage	AC1800V / minute
Insulation Resistance	100MΩ or more (DC500V)
Resistance Deviation	±10% or less (when cold)
Other	
Terminal Treatment	Metal foil exposure, eyelet, spot welding, stud bolt
Other	Can be dust proofed

・We can produce the largest micathermal heaters in the industry

Applications

■ Appliances: electric ranges, irons, in-floor heaters, space heaters, medical devices, etc.

■ Industrial: press mold heaters, medical devices, semiconductor production, LCD production, etc.

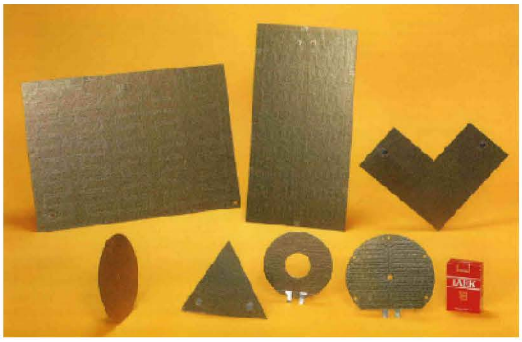
Notices

● Specifications given above are subject to change without notice in order to improve the product.

Ultra-thin high watt density supporting high temperatures

Micathermal Heater

Conventional micathermal heaters can be used up to about 250 to 300℃. At Krosaki Harima, we have developed a high temperature micathermal heater able to support 800℃. The high watt densiry enables rapid heating with improved response by increasing output per unit area. We know that customers using conventional sheath heaters can use this product to solve issues related to heat distribution and heater thickness.



Benefits

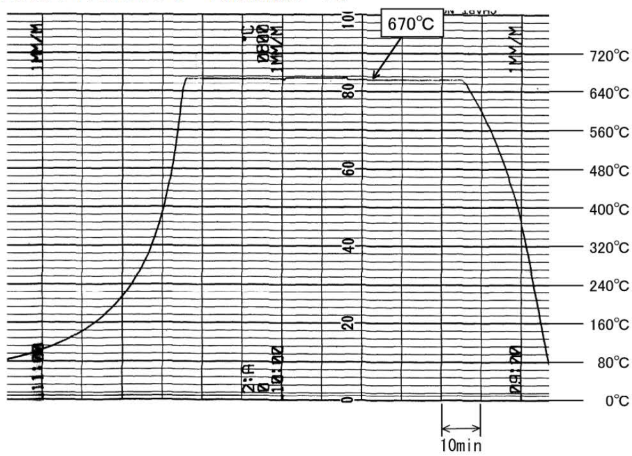
■ Fast response
High watt density with 1mm thinness means low heating capacity for rapid heating support.

■ Even heating distribution
The planar heating element distributes heat more evenly than sheath heaters.

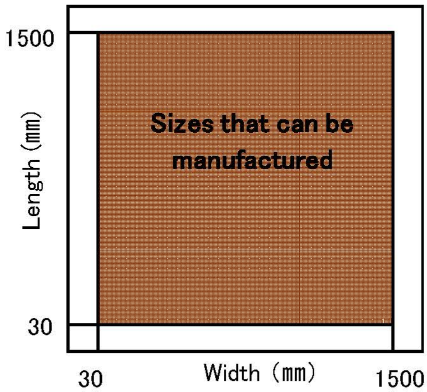
■ High heating efficiency
As a planar heating element, the surface area in contact with the object to be heated is large making heating more efficient.

■Responding to many kinds of shapes
The shape can be modified to match the heated object,

【300×300サイズホットプレート昇温試験データ】



Product Specifications



	High Watt Density Heater	High Temperature Heater
Max Dimensions	up to 1500×1500	
Thermostable Temp.	up to 600℃	up to 800℃
Metal Foil Material	Austenitic stainless steel foil	
Electrical Specifications		
Withstand Voltage	AC1800V / minute	
Insulation Resistance	100MΩ or more (DC500V)	
Resistance Deviation	±10% or less (when cold)	
Other		
Terminal Treatment	Metal foil exposure, eyelet, spot welding, stud bolt	
Other	Can be dust proofed	

・We can produce the largest micathermal heaters in the industry

Applications

■ Appliances: electric ranges, irons, in-floor heaters, space heaters, medical devices, etc.

■ Industrial: mold heating, medical devices, semiconductor production, liquid crystal production, OLED production, solar cell production, etc.

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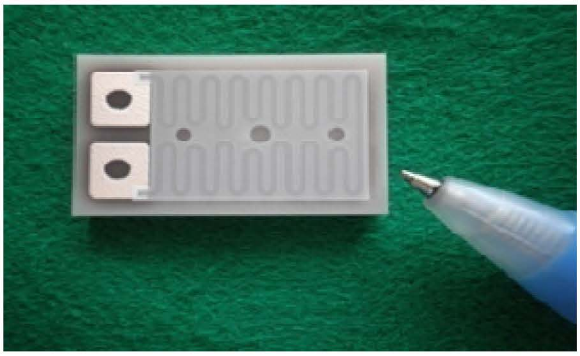
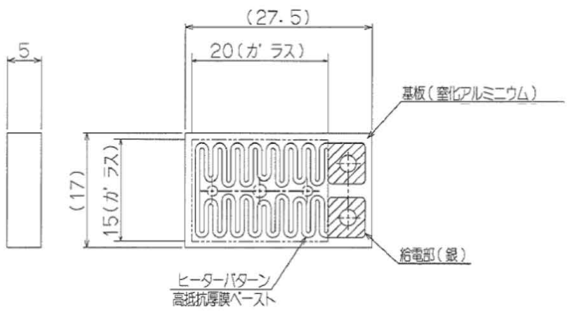
Heating Applications

Compact AlN (Aluminum Nitride) heater

This ceramic heater incorporates an aluminum nitride base for high thermal conductivity and demonstrates uniform heat distribution. Suited for use in extreme environments with rapid heating and cooling. The heating element is produced using a printing technology for compact sizes and excellent



Product Specifications



定格出力：200V 2000W
使用温度：680℃以下

General Specifications	
Maximum Dimensions	Please consult with us
Thermostable Temp.	up to 680℃
Element Material	Special metal paste
Electrical Properties	
Withstand Voltage	≧1000V/25μm
Insulation Resistance	100MΩ or more (DC500V)
Other	
Terminal Treatment	Please consult with us
Installation	Please consult with us

Please consult with us regarding cooling units for this heater.

Benefits

■ Energy Saving

Since the electrical resistance ratio of the element can be adjusted arbitrarily, it is possible to design heaters to match the application in high or low temperature environments.

■Rapid Heating and Cooling

Incorporating aluminum nitride with high thermal conductivity and durability to thermal shocks, the heater can rapidly heat (approximately 200℃/sec) and rapidly cool.

■ Low cost

The post-fire design allows production of prototypes, small lots and mass production.

Applications

■ Industrial: Bonding heaters, soldering semiconductor electronic parts, soldering film wires.

Notices

●When this product is exported, it may require submission of documents under the Foreign Exchange and Foreign Trade Act.

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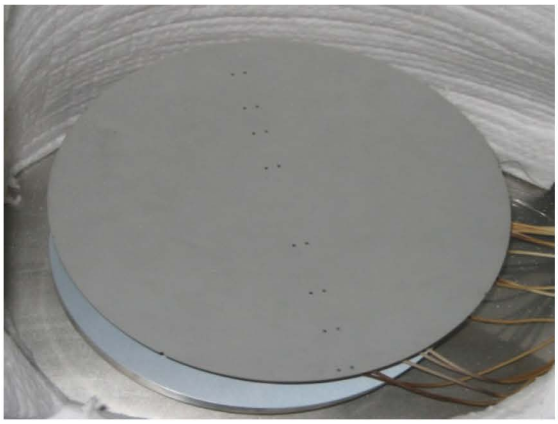
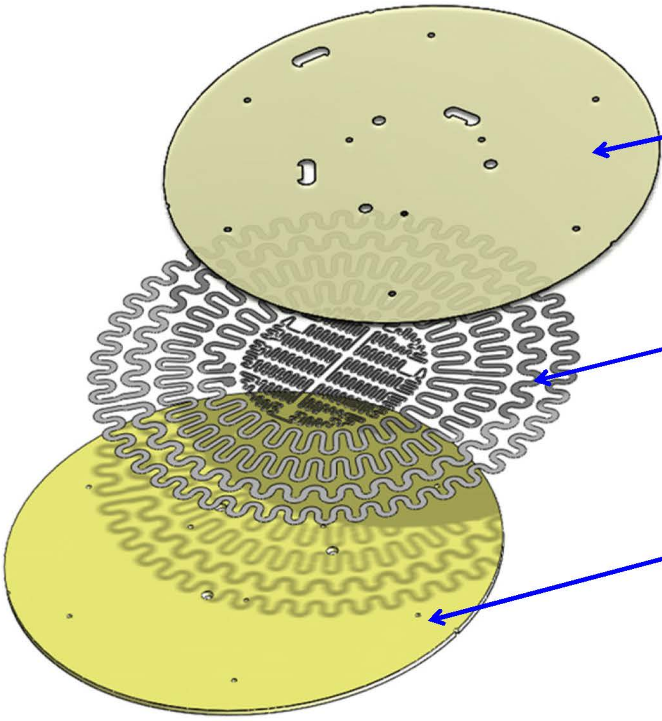
Heating Applications

AlN (Aluminum Nitride) Heater for Semiconductors

Conventional ceramic heaters with embedded elements required a complex manufacturing process limiting the ability to reduce costs.
Our aluminum nitride hot plate features an electric heating circuit made by printing and baking a heating element pattern in a sintered ceramic base. While current maximum temperatures are around 680℃, altering the material of the element pattern enables support for even higher temperatures.
The power supply terminals feature similar levels of heat resistance to the heating element pattern so terminals are protected without need for special measures.



Basic Design



● Features of the insulating cover

Printed Thickness	10～20 μm
Withstand Voltage	≧1000V/25 μm
Firing Temp.	800℃ or more
Max. Use Temp.	up to about 450℃

● Features of the element

Printed Thickness	10～20 μm
Fixed Resistance	35～475 μ Ωcm
Firing Temp.	800℃ or more
Max. Use Temp.	up to about 450℃

● Features of the base

Materials	AlN (Aluminum Nitride)
Thermal Conductivity	170W/m·K(RT) or more
Expansion Factor	4.5×10^{-6}
Max. Dimensions	450 mm dia. or more

●Gas generated during heating

Suited to semiconductor production applications since no Na, Ka, Cu or other metals are detected when used at 500℃.

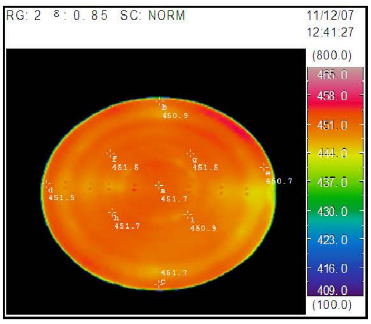
※ Please confirm that it works without issue by performing test before use.

Benefits

■ Energy Saving
Since the electrical resistance ratio of the element can be adjusted arbitrarily, it is possible to design heaters to match the application in high or low temperature environments.

■ Even heat distribution
Ceramic material features and suitability to a wide range of temperatures.

■ Low cost
The post-fire design allows production of prototypes, small lots and mass production.



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Non-combustible & energy saving Heater for piping

JACKET HEATER

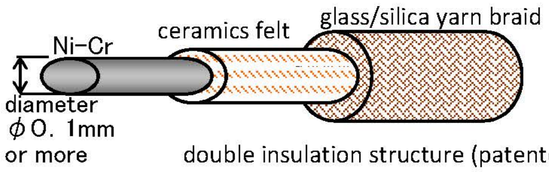
Our Jacket Heater has efficient heating capability for small or large piping/equipment and has excellent heat resistance and safeness. In addition, piping maintainability is good because the heater can be removed and installed easily.

We are ready to design and deliver optimum products in accordance with customer's specific requirements. Heaters with complicated shape and heaters for small piping are also available. Because the heater is heated before shipment, it emits almost no gas after installation.

Advantages

■Heating element with high reliability and excellent durability
Heating element with double insulation makes it possible to ensure high insulating capacity and high mechanical strength after long-term usage.

■Usable in high-temperature range
Heater is made of noncombustible inorganic materials and has heat resistance of approx. 800℃



double insulation structure (patented)

heat resistance: 800℃

Usages

■semiconductor / LCD manufacturing equipment, related vacuum pump, scrubber

Temperature control unit

■PID control
High accuracy (±1℃)
Long life
Wide controllable range (up to 1000℃)

■Thermostat

PID

thermostat

Application products

JACKET FOAM

■High heat insulating properties, approx. 1.5 times that of silicon rubber sponge at temperature range of 200℃ or less.

■Easy machining (cutting, punching, etc.) with scissors, etc.

■Good workability because of its light weight (less than half of silicon rubber sponge).

WDS® Ultra

Characteristics

WDS® Ultra is a microporous insulation material with an extremely low coefficient of thermal conductivity, i.e. with very good insulating properties.

WDS® Ultra consists of inorganic silicates. The main constituent is fumed silica, the other components are opacifiers for minimizing infrared radiation.

WDS® Ultra is not flammable and meets the requirements acc. to DIN ISO 4102 for fire protection class A1.

Application

Tried and tested applications for WDS® Ultra include insulation for heat-treatment furnaces in the aluminum industry, or back-up insulation in the industrial furnace industry.

In these applications, WDS® Ultra fulfills several functions, such as:

- Precisely controlled energy emission
- Reduction of weight and volume
- Increase of heat retention
- Increased effective volume

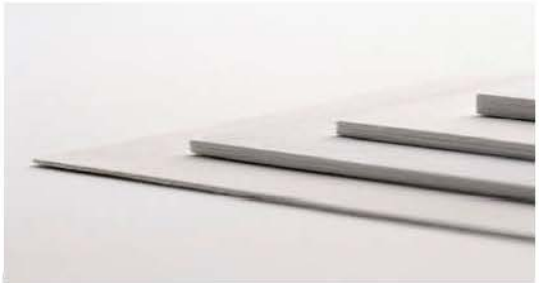
WDS® Ultra is also successfully used as insulation material in the following areas:

- Heat treatment systems for glass
- Fire protection equipment
- Electronic devices
- Measurement equipment
- Plant construction parts
- Chimneys, pipes

Form of delivery

1. **Standard sizes:**
   - 1000 mm * 650 mm * X

2. **Standard thicknesses (X):**
   - 10 mm, 15 mm, 20 mm, 25 mm,
     30 mm, 35 mm, 40 mm, 45 mm, 50 mm
   - Tolerances acc. to DIN ISO 2768
     → Tolerance class "c", coarse.
   - also available in customized panel forms
   - max. Size 1320 mm x 1000 mm x thickness



Restrictions on application

WDS® Ultra is sensitive to all liquids that can wet it, such as water, oil, petroleum spirit, since they can destroy the nanoporous structure.

The moisture sensitivity of WDS® Ultra can be greatly improved or eliminated altogether by suitable surfact treatment (e.g. PE film, aluminum foil, or liquid coatings)

Shelf life

WDS® Ultra has an unlimited shelf life. WDS® Ultra must be handled and stored in dry conditions.
WDS® Ultra is resistant to diffusion by atmospheric humidity (water vapor).

Composition

Silicon dioxide	SiO_2	approx. 80%
Silicon carbide	SiC	approx. 15%
Others		approx. 5%.

Electrical resistance

Panel unhardened	
Stored under dry conditions	> 2000 MΩ

Thermal shock resistance

WDS® Ultra is insensitive to high and low temperature thermal shocks.

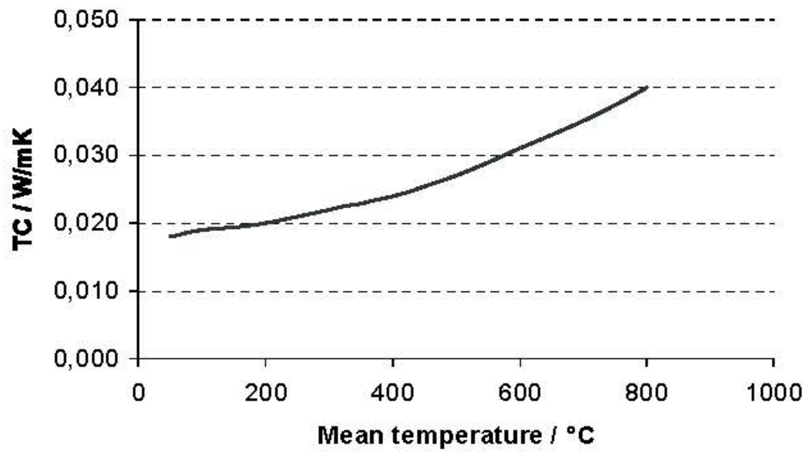
Product data

Physical properties		Standards	Units	Values
Color				Gray
Bulk density			kg / m³	230 ± 10%
Max. application temperature			°C	950
Low-temp. flexural strength		DIN 53423	N / mm²	0.16
Shrinkage	Temperature applied to one side		0.5% at 1000 °C / 12h	
Linear shrinkage / long term	Temperature at all sides		800 °C	1.0%
			1000 °C	4.8%

Compression		400 °C	800 °C
	1 %	0.090 MPa	0.117 MPa
	3 %	0.288 MPa	0.364 MPa
	5 %	0.494 MPa	0.617 MPa
	10 %	1.029 MPa	1.263 MPa

Thermal conductivity		DIN 51046		
	50 °C		W / mK	0.018
	100 °C		W / mK	0.019
	200 °C		W / mK	0.020
	300 °C		W / mK	0.022
	400 °C		W / mK	0.024
	500 °C		W / mK	0.027
	600 °C		W / mK	0.031
	700 °C		W / mK	0.035
	800 °C		W / mK	0.040

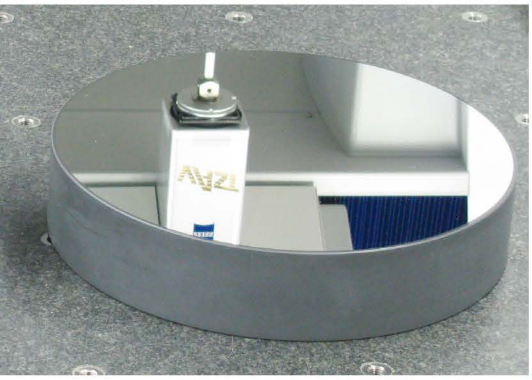
Thermal conductivity as a function of mean temperature (DIN 52612)



NEXCERA™

Ceramics featuring ultra-low CTE

NEXCERA™ is a revolutionary cordierite ($2MgO$-$2Al_2O_3$ -$5SiO_2$) based polycrystalline ceramic material having both an extremely low coefficient of thermal expansion (CTE) of < 0.03 $\times 10^{-6}$/K and superior mechanical properties. NEXCERA™ has high dimensional stability resisting aging and temperature changes above and beyond generic low thermal-expansion glass.
NEXCERA™ supports applications requiring high accuracy including precision optical components and metrological calibration tools and primary standards.



ϕ 340 X 70 t Mirror
with an aluminum coating

ADVANTAGES

>>Zero Thermal Expansion Coefficient
0.0 ± 0.03 $\times 10^{-6}$/K (at 23°C)

>>Excellent Dimensional Stability
Long-term passage and heat cycles

>>Light-weight Bulk density 2.55 g/cm³
Lighter than aluminum alloy

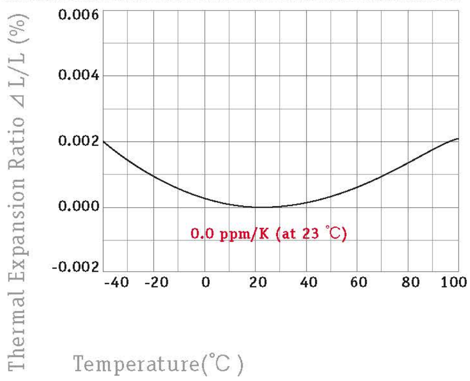
>>High Stiffness Stiffness 140 GPa
High stiffness and high strength, 1.5 times that of general low thermal expansion glass

>>High Accuracy Mirror Surfaces
Average-roughness of less than 1 nm due to pore-less properties

>>Near-net Shape Sintering
Simplifies manufacturing of complex shapes using green machining before sintering

>>Others
Does not rust or magnetize

THERMAL EXPANSION RATIO



CHARACTERISTICS

		N113B	N117B	N118C	N119C
Materials		Zero- α	Zero- α	Pore-less large size	Large size
Color		Black	Black	Blue-gray	Light blue-gray
Bulk Density	g/cm³	2.50	2.55	2.58	2.50
Young's Modulus	GPa	130	140	140	130
Poisson's Ratio		0.30	0.31	0.31	0.31
Flexural Strength @ RT	MPa	210	230	220	166
Fracture Toughness (SEPB)	MPam$^{1/2}$	1.2	1.2	1.4	1.3
Hardness HV (98N)	GPa	8.0	8.1	8.1	8.0
Coefficient of Linear Thermal Expansion (α)	$\times 10^{-6}$/K (23℃)	<0.03	<0.03	<0.05	<0.05
Thermal Conductivity @ RT	W/m・K	3.7	4.2	4.5	4.3
Specific Heat	J/g・K	0.83	0.78	0.79	0.78
Thermal Shock Resistance	⊿T℃	---	---	---	---
Electrical Resistivity @ RT	Ωcm	>10^{13}	>10^{15}	>10^{15}	>10^{15}
Dielectric Constant (1MHz)		4.7	6.0	4.7	4.4
Dielectric loss (tan σ)	$\times 10^{-4}$	60	20	---	---

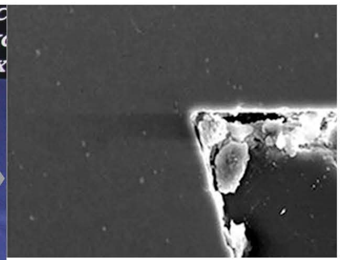
* The values given above are typical values obtained from reliable testing and should only be used for design guidance.

BONDING TECHNOLOGY

Extremely light mirrors can be attained by bonding together top-plates and ribbed bodies to form box structures that are free from defects around the bonding layer.

Ribbed structure 3 mm in rib thickness

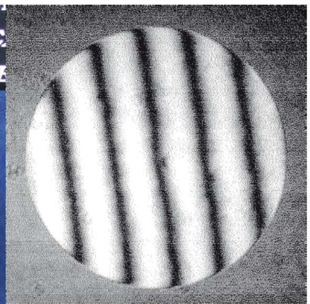
Light box structure ϕ340 X 70 t



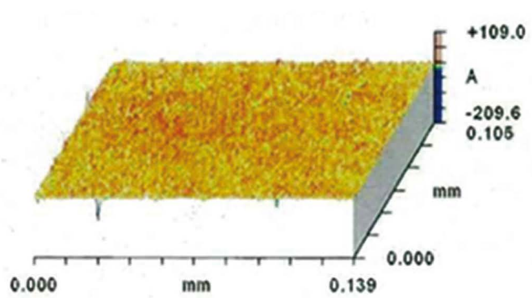
Bonding interface

MIRROR POLISH

Polishing allows us to create an extremely smooth surface with an average roughness of 0.3 nm and flatness of less than λ /10; 52 nm.



ϕ 340 mm
Flatness: 52nm



Roughness Ra: 0.3 nm

SiC Ceramics C101R and C201

Silicon Carbide (SiC) has long been used as an abrasive due to its high ranking hardness as a material, surpassed only by diamond and c-BN. Recent developments in ceramics molding technologies have seen new applications extending to wear-resistant parts such as sand blasting nozzles. SiC features high heat conductivity, It has found a place as a material used in ultra precision stages for semiconductor manufacturing equipment.

CHARACTERISTICS

			C101R	C201
	Materials		Standard	High thermal conductivity
	Color		Black	Black
Mechanical Properties	Bulk Density	g/cm^3	3.16	3.17
	Young's Modulus	GPa	430	430
	Poisson's Ratio		0.16	0.16
	Flexural Strength @ RT	MPa	490	470
	Fracture Toughness (SEPB)	MPam$^{1/2}$	3.5	2.4
	Hardness HV (98N)	GPa	21.6	20.1
Thermal Properties	Coefficient of Linear Thermal Expansion (α)	$\times 10^{-6}$/K (23°C)	2.3	2.3
	Thermal Conductivity @ RT	W/m·K	128	186
	Specific Heat	J/g·K	0.63	0.67
	Thermal Shock Resistance	ΔT°C	350	---
Electrical Properties	Electrical Resistivity @ RT	Ωcm	10^3	10^5

* The values given above are typical values obtained from reliable testing and should only be used for design guidance.

ADVANTAGES

1. **Low weight, high stiffness and high hardness**
   SiC is light and stiff, even compared to other ceramics. Its high hardness make it resistant to scratching and give it excellent wear resistance.

2. **Near Net Shape Sintering Technology**
   Lower cost production of complex shapes is enabled by machining into near net shape before sintering.

3. **Bonding Technology**
   More complicated shapes can be produced by using our silver brazing method.

4. **Thermal stability**
   Able to withstand high temperatures with unusually good heat conductivity, SiC excels in thermal stability.

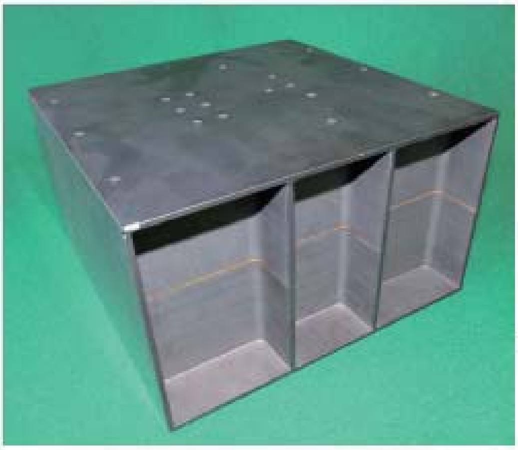


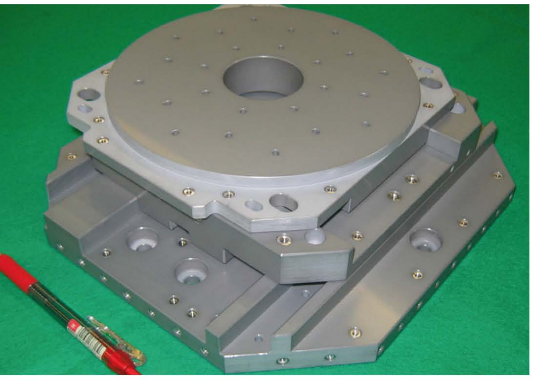
Fig: Bonding model

Fig: Bonding model

Sialon

Ceramics with Low Thermal Expansion & High Stiffness

Sialon ($Si_{6-z}Al_zO_zN_{8-z}$, Z=0~4) is a Si_3N_4 based ceramic featuring superior strength at high temperatures. We additionally researched the benefits inherent to Sialon at room temperature and discovered its superior shape stability performance. This can be seen in sialon's low thermal expansion, high stiffness and low weight. Since then we have continued to develop applications that maximize the potential of sialon as including application in structural components of stages for LSI lithography. A recent development has been the adoption of Sialon in ultra precision machine tools and measuring instruments.



Work adjusting stage

ADVANTAGES

>>Low Thermal Expansion

Equal to invar alloy (as low as 1/10 of cast iron)

>>Low Weight

40% of cast iron

>>High Stiffness

2 times that of cast iron

>>Easy to Achieve High Precision and Accuracy by General Working

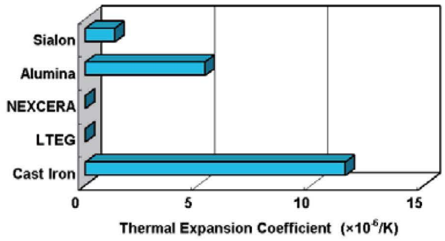
Flatness, parallelism, roundness ≦ 0.5 μm

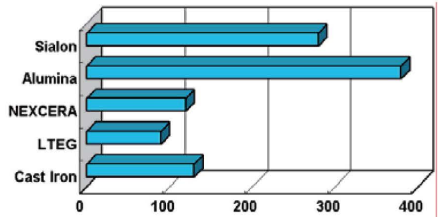
>>Nonmagnetic & Rust Free

>>High Wear Resistance

Free from burrs and scraches

COMPARISON OF FEATURES





*LTEG: Low Thermal Expansion Glass

CHARACTERISTICS

Materials		S110	S110H	S120	S150
		High strength	Pore-less High strength	Standard	Standard
Color		Light gray	Light gray	Light gray	Gray
Bulk Density	g/cm³	3.24	3.25	3.22	3.20
Young's Modulus	GPa	290	300	300	280
Poisson's Ratio		0.27	0.27	0.27	0.29
Flexural Strength @ RT	MPa	880	1180	690	590
Fracture Toughness (SEPB)	$MPam^{1/2}$	6.5	6.5	6.0	5.0
Hardness HV (98N)	GPa	14.5	14.7	12.7	12.7
Coefficient of Linear Thermal Expansion (α)	$\times 10^{-6}$/K (23℃)	1.3	1.3	1.3	---
Thermal Conductivity @ RT	W/m・K	21	21	21	21
Specific Heat	J/g・K	0.68	---	0.63	---
Thermal Shock Resistance	⊿T℃	750	---	700	---
Electrical Resistivity @ RT	Ωcm	$>10^{14}$	$>10^{14}$	$>10^{14}$	

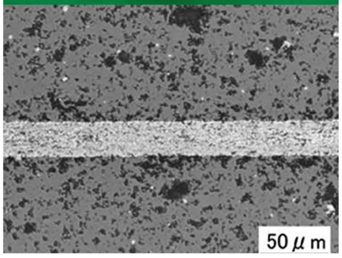
* The values given above are typical values obtained from reliable testing and should only be used for design guidance.

NEAR NET SHAPE SINTERING

Compacted green Sialon can be machined into a thin-ribbed structure in a near-net shape before sintering lowering manufacturing cost.

(3 mm rib structure after sintering)

BONDING METHOD



Sialon parts can be bonded to each other using our silver brazing technology.

The bonding layer is 50 μ m or thinner with a bonding strength equivalent to 70% of the bulk portion.

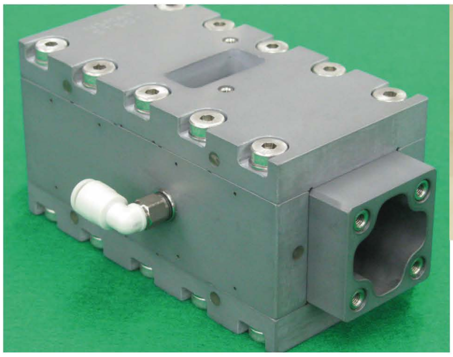
(Cross section of a joined-box)

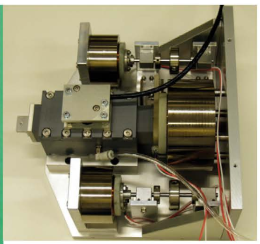
APPLICATIONS

Sialon Slider & Stage

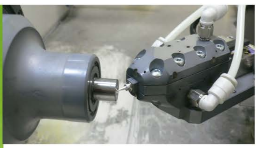
>> Dramatically **reduces thermal drift** in precision machines.
   Capable of **extended continuous operation**
>> High dimensional stability enables **high repeatability of action**
>> High stiffness and light promotes **enhanced gain of servo control**
>> High toughness eliminates cracking and chipping, **facilitating handling**

- Air hydrostatic bearing slider, guide bar, slide base, rotary table
- Oil hydrostatic bearing slider, guide bar, slide base, rotary table
- On machine measuring systems (small air slider) for ultra precision machine tools
- Vacuum chucks, work mounts, tool holders,
- Work adjusting stages

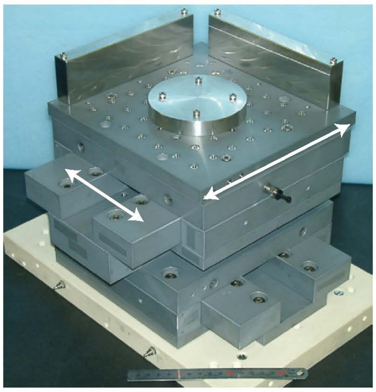




Fast tool servo (air slider)

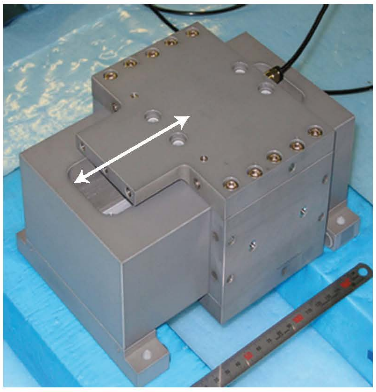


Integrated measuring system



X-Y axis: Piled-up /
T-type slide

310 x 310 x 184 (mm)
(stroke 100 mm)

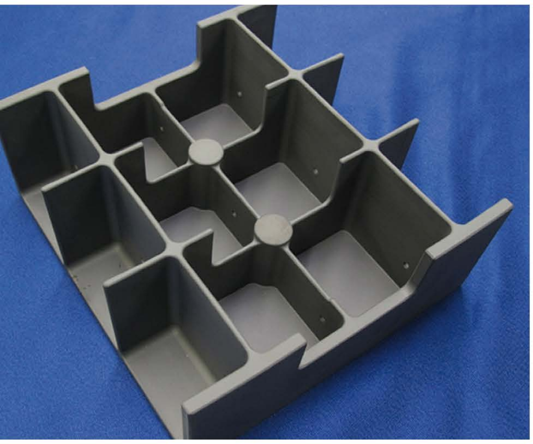


Z-axis:
Drive a center of gravity

220 x 156 x 102 (mm)
(stroke 60 mm)

B_4C Ceramics BC101

Boron carbide (B_4C) has long been used as an abrasive due to its high ranking hardness as a material, surpassed only by diamond and c-BN. Recent developments have seen new applications extending to wear-resistant parts such as sand blasting nozzles with advances in ceramics molding technologies. Characterized by its extremely low weight and high stiffness, it is also used in ultra precision stages in the field of semiconductor manufacturing equipment.



CHARACTERISTICS

			BC101
	Materials		Standard
	Color		Black
Mechanical Properties	Bulk Density	g/cm^3	2.42
	Young's Modulus	GPa	385
	Poisson's Ratio		0.17
	Flexural Strength @ RT	MPa	400
	Fracture Toughness (SEPB)	$MPam^{1/2}$	3.1
	Hardness HV (98N)	GPa	20.4
Thermal Properties	Coefficient of Linear Thermal Expansion (α)	$\times10^{-6}/K$ (23˚C)	2.3
	Thermal Conductivity @ RT	W/m・K	37
	Specific Heat	J/g・K	0.95
	Thermal Shock Resistance	⊿T˚C	---
Electrical Properties	Electrical Resistivity @ RT	Ωcm	8×10^{0}

* The values given above are typical values obtained from reliable testing and should only be used for design guidance.

ADVANTAGES

1. **Low weight, high stiffness and high hardness**
   The specific rigidity (Young's modulus / bulk density) which represents the degree of weight reduc- tion, is 15% higher than that of silicon carbide. The extremely high hardness provides excellent resistance to abration.

2. **Near Net Shape Sintering Technology**
   Lower cost production of complex shapes is enabled by machining into near net shape before sintering.

3. **Bonding Technology**
   More complicated shapes can be produced by using our silver brazing method.

Fig: Thin ribbed structure
210x196x65(mm), Rib thickness 3mm

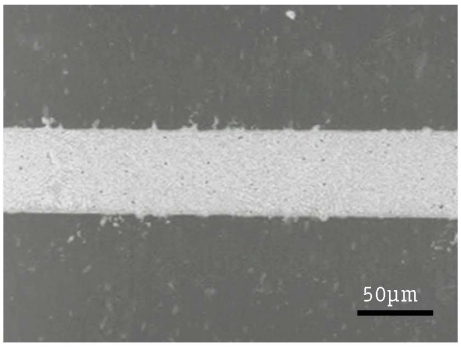
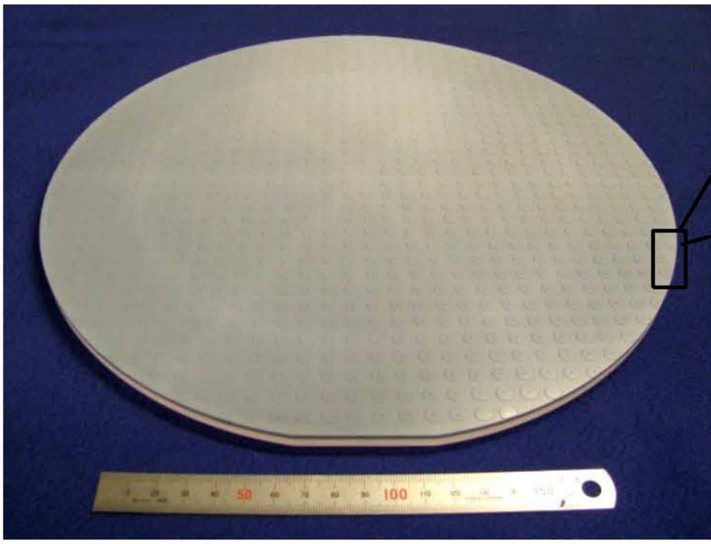


Fig: SEM image of bonding layer

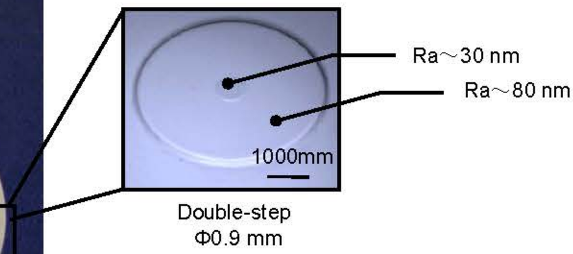
Electrostatic Wafer Chuck

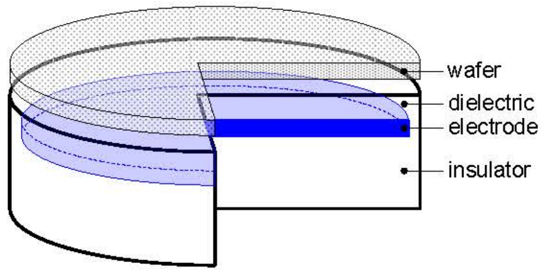
Advanced Johnsen-Rahbek Type Wafer Chuck

Our advanced Johnsen-Rahbek type chuck is being used for wafer fixing and wafer flatness correction in semiconductor production process in vacuum.



Johnsen-Rahbek type electrostatic chuck model (ϕ300mm)





Features

① High De-chucking Response

Our chuck has a high de-chucking response owing to precise controlling of a micro structure and crystal phase of dielectric material and can contribute to significant improvement of customer's process throughput.

② Strong chucking force and Small number of particles

Pore-less microstructure and extremely smooth polished surface of our material result in a strong chucking force and small number of particles on a wafer as Johnsen-Rahbek type chuck.

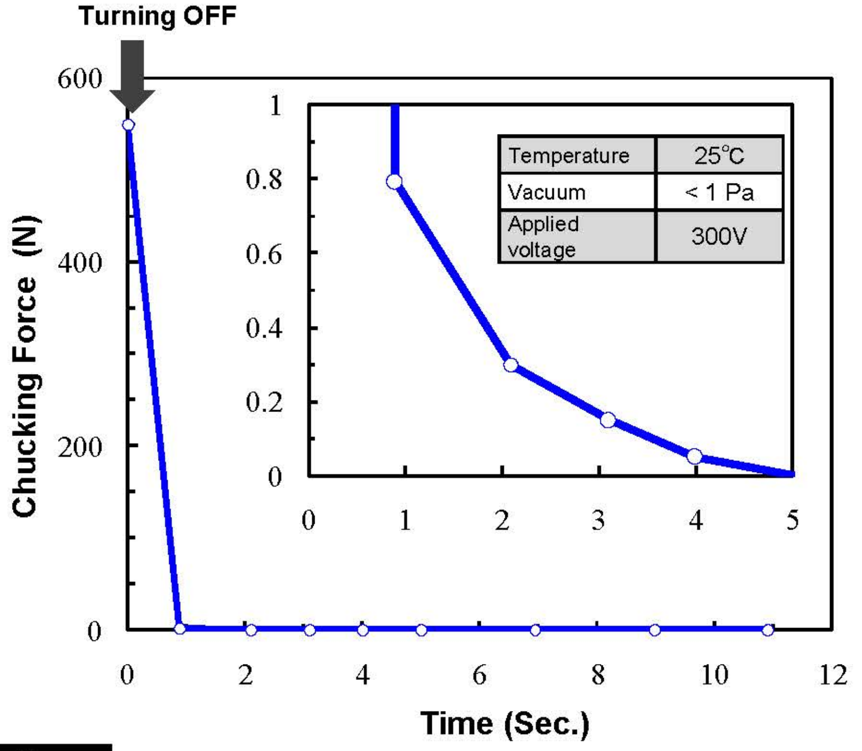
③ High durability

Our chuck has high durability because the dielectric, electrode and insulator parts can be bonded integrally in a single sintering process.

Material Properties

Material		TiO_2-doped Al_2O_3
Bulk Density	g/cm^3	3.98
Young's Modulus	GPa	400
Poisson's Ratio		0.24
Flexural Strength	MPa	480
Electrical Resistivity	Ωcm	10^9-10^{11}
Dielectric Constant (1MHz)		10.7

De-chucking Response

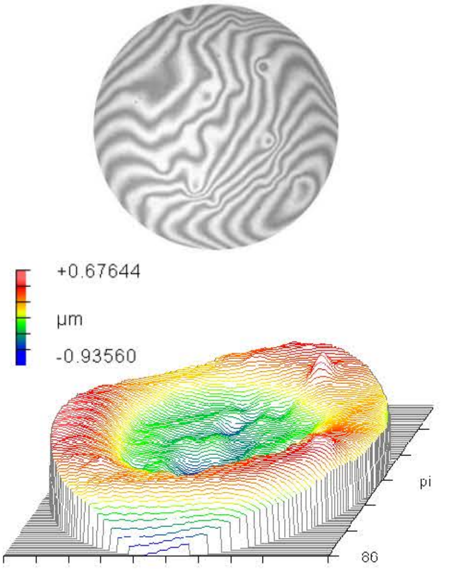


Chucking Properties

Chucking Behavior		Johnsen-Rahbek Type
Electrode Configuration		Bipolar
Applied Voltage		+300V / -300V
Diameter		300 mm
Pin	Structure	Double-step
	Diameter	0.9 mm
	Area	0.75 % of the whole area
Roughness R_a		< 30 nm
Flatness of wafer		< 5μm
Chucking Force	per unit area (for all flat surface)	1 MN/m^2
	per unit area (for 0.75% pin surface)	8 kN/m^2
	The whole area (ϕ 300, 0.75% pin surface)	560 N
Electrical Leak Current		15 μA

*The data in the tables above are representative properties and are not guaranteed values.

Flatness: 1.6 μm
(measured with a Si-wafer chucked)

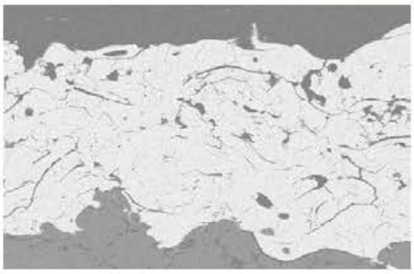


【PLATECT®】 ～Setter for Electronics components～

PLATECT® is a setter for firing process of manufacturing electronics components. We succeeded in the development of the Plasma thermal spray coated setter for the first time in the world. Many customers have adopted our setter since we developed it owing to highly stable quality. and today PLATECT is supplied for MLCC, ferrite, varistor, thermistor, and piezoelectric element.

< Strong point of our Plasma spray>

Our Plasma spray can generate approximately 30,000 degrees Celsius of flame. it makes zirconia melt efficiently and that is why the high quality ceramics coat is generated.



< Comparison of Platect and other method >

	Platect (Plasma Spray)	Sintered Zirconia	Slurry Spray
Reactivity resistance	◎	△	○
Peeling resistance	◎	ー	△
Wear resistance	◎	ー	×
Durability	◎	×	○

◎: Excellent　○ : Good　△:Passing　×:Failure　ー:n/a

<The material for Plasma spray coating>

Name of coat		Y	H	F	L 2	J	A	M	S P
Chemical composition (%)	ZrO_2	91.0	95.0	94.5	78.8	99.4	-	-	-
	CaO	-	-	5.0	20.5	-	-	-	-
	Y_2O_3	8.0	4.0	-	-	-	-	-	-
	Al_2O_3	-	-	-	-	-	99.5	77.0	72.5
	SiO_2	-	-	-	-	-	0.3	22.5	-
	MgO	-	-	-	-	-	-		26.5
Remarks		FSZ	PSZ	FSZ	Calcium zirconate + others	m-ZrO2	Alumina	Mullite	Spinel

※FSZ: Fully stabilized zirconia　PSZ: Partially stabilized zirconia　m-ZrO2: Monoclinic zirconia

<The material for substrate>

Name of substrate		E 5	F 7	K D	K E	K H	W 1
C.C. (%)	Al2O3	86.2	90.9	86.2	90.0	75.0	75.9
	SiO2	13.4	8.9	13.3	9.3	24.5	23.5
P.P.	Apparent porosity %	28.5	18.6	20.0	17.8	26.2	37.0
	Bulk density	2.43	2.94	2.74	2.95	2.37	2.04
	Modulus of Rupture MPa	10	12	12	13	50	20
Remarks		Lightweight	Thinner	Spalling resistance	Spalling resistance	Spalling resistance Creep resistance	Ultra lightweight

※C.C.: Chemical composition　P.P.: Physical property