High durability and reduced contamination
can be achieved by converting resin and metal parts to ceramics.

SiC Ceramics Adoption Guide

Asuzac Fine Ceramics Division

ASUZAC

Background of increasing use of SiC ceramics

As semiconductor devices become increasingly ultra-fine, various minute contaminants, such as particles, metal impurities, and surface adsorbed chemistry contamination, have increasingly adverse effects on the yield and reliability of semiconductor devices at semiconductor device manufacturing sites.It is no exaggeration to say that every semiconductor process is sources of contamination. Therefore, cleanliness (how to prevent contamination and keep silicon wafer surfaces clean throughout the entire process) and cleaning (how to remove contamination) of the production line are becoming more and more.

Under such circumstances, Asuzac has succeeded in reducing metal contamination, which has been a challenge of SiC materials (with excellent corrosion resistance, abrasion resistance, and heat resistance) that had long been expected as parts for semiconductor manufacturing equipment, and has increasingly been adopted by semiconductor manufacturing equipment manufacturers and foundries as alternatives to resin parts and metal parts and as upgraders of alumina parts.

keyword

Ultra-fine

More Clean

Elimination of metal pollution

Asuzac's SiC Ceramics Proposal

1 | Metal Contamination Reduced by 95% or More

Compared to conventional SiC ceramic parts, Asuzac's new SiC parts successfully reduced metal contamination by more than 95%.

2 | Providing a Higher Level of Long Life and High Quality

A new SiC of special treatment developed by Asuzac achieves high-quality, long-life parts. We offer lower running costs and particle suppression by extending the service life of parts.

3 | Design to handle resin and metal substitutions

The running cost of resins and metal parts increases as the concentration of chemical liquids increases and the environmental temperature of the process increases due to miniaturization.
When considering SiC as a material change destination, we can assist from the design of components.

SC annealing of Asuzac

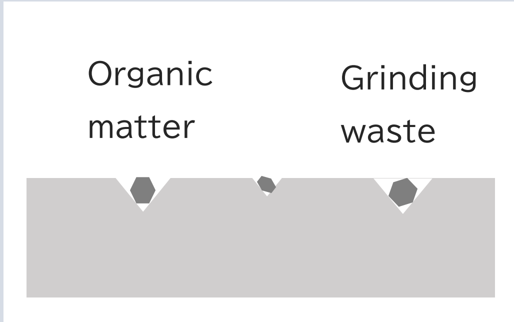
Impurities are reduced by surface modification

Asuzac has succeeded in removing organic substances and grinding debris by applying SC annealing to SiC ceramics.

SC annealed SiC ceramics are highly pure.

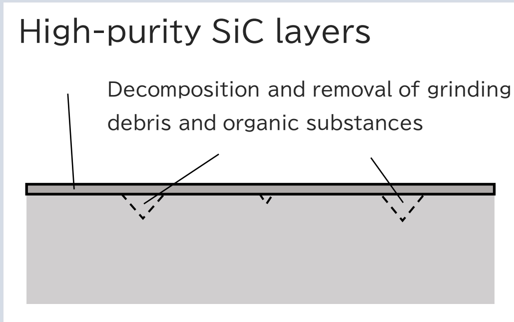
Contamination caused by ceramic parts is often originates from raw materials and adhered to the surface of parts, and it is possible to obtain a large control effect of contamination by modification of the surface.

Untreated SiC finish



Fine irregularities that are invisible even on the processed surface.
Organic matter and grinding debris are entering there.

SiC surface after SC annealing



After SC annealing treatment, high-purity SiC is generated on the surface. Grinding debris and organic matter adhering to the surface after processing are decomposed and removed, resulting in particle-less.

Asuzac's SiC dramatically reduces metallic contamination

Supports yield improvement

Asuzac's SiC ceramics products have been successfully reduced metallic contamination by special treatment.
Compared with conventional SiC ceramics, the dissolution reduction of 95% or more is realized depending on the element.
Not only transfer End Effector / Handling Arm but also ceramic parts (plates, chucks, etc.) have been adopted successfully.
It can be used for cleaner and more controllable equipment and lines.
Since the generation of metal contamination leads to the necessity of frequent cleaning and analysis, a fundamental improvement approach to the source of metal contamination itself is effective.
By adopting Asuzac's SiC ceramics, you can reduce cleaning and analytical man-hours and improve yields.

Metal Dissolution Test Results

Analyses of 16 elements by ICP-MS

[ppb]	Asuzac special treatment SiC	SiC of other companies
Li	<0.02	<0. 1
Na	0.25	0.4
Al	0.03	2.5
K	0.34	4
Ca	<0.05	6.7
Ti	0.07	19.0
Cr	<0.05	11.0
Mn	<0.02	<0.1
Fe	0.07	15.0
Ni	0.02	2.2
Cu	<0.02	0.2
Zn	0.49	0.2
Ag	<0.02	<0.1
Cd	<0.02	<0.1
Pb	<0.02	<0.1

Sample
SiC specially treated products
Sample size
20×10×50mm

Analysis flow
① Cleaning
Solution:3.6%HCL
Cleaning period:1h(室温)
Cleaning method:
Immersion
② Extraction
Extract:3.6%HCL(100ml)
Duration:24h
Temperature:
Room temperature
③ Collection (4ml)

SiC ceramics physical properties: dense body

	MATERIAL	Alumina				Zirconia	Silicon Carbide	Low Thermal Conductivity Alsima L	Electrically Conductive Corseed	R&D Material Black Alumina
PROPERTY	ASUZAC Brand / Unit	AR-99.6	ARW	ARK	AR-4N	AZI	ASiC	ARSM-L	ACTR	AR(B)
Purity (Al2O3)	%	99.6	99.6	96.0	99.99	92	–	–	99.80	99.9
Color Tone	-	Ivory	White	White	White	White	Black	Gray	Black Gray	Black
Density	g/cm^3	3.94	3.90	3.75	3.94	6.00	3.14	2.41	4.24	3.75
Flexural Strength	MPa[3points]	370	400	370	330	980	410	146	310	370
Young's Ratio	GPa	390	370	340	360	210	430	115	288	363
Vickers Hardness	GPa	14.7	14.7	14.0	15.7	11.8	28.0	6.5	10.0	10.6
Poisson's Ratio	-	0.24	0.24	0.24	0.23	–	0.17	0.29	0.27	0.23
Fracture Toughness	MPa m$^{1/2}$	4.0	3.0	3.0	4.0	7.0	2~3	1.4	3.0	3.2
Thermal Expansion Coefficient	x10^{-6}[Ambient ~ 800℃]	7.7	7.7	7.7	7.7	10.0	4.1	2.1	8.8	8.1
Thermal Conductivity	W/(m·K)	32.0	28.0	23.0	31.0	4.0	170.0	2.9	5.5	31.2
Specific Heat	J/(kg·K)	0.78×10^3	0.78×10^3	0.78×10^3	0.78×10^3	–	0.68×10^3	0.75×10^3	0.67×10^3	0.80×10^3
Dielectric Constant	[1MHz]	10.2	9.7	9.5	9.5	–	–	4.8	–	16.7
Dielectric Loss	x10^{-4}[1MHz]	70	5	5	5	–	–	50	–	10
Volume Resistance	Ω·cm	$>10^{15}$	$>10^{15}$	$>10^{15}$	$>10^{15}$	$>10^{12}$	x10^6	$>10^{14}$	1	$>10^{14}$
Withstand Voltage	kV/mm	13.0	14.5	14.5	13.0	–	–	14.5	–	9.3
Reflectivity	% [Wave Length 240 thru 2600 mm, Measuring Plane : Approx. Ra0.8]	18～93	–	–	–	30～77	11.1-25.1	–	-	5.1~15.3
Features & Applications		* High Rigidity * High Dielectric Constant * Excellent Wear Resistance				* Excellent Thermal Resistance * High rigidity * Excellent wear resistance		* Low Thermal Expansion * Excellent Thermal Resistance * Low Thermal Conduction	* High Density	* Less Reflection
					* High Purity * Less Contamination	* High Breakage Tenacity * High Chemical Strength (Fluorine excluded)	* High Dielectric Constant		* High Dielectric Constant * Reduction Atmosphere at High Temperature	

* The values listed above are typical numbers and may vary depending on the products.

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SiC ceramics: porous material

Porous Ceramics – Property Chart

As of May, 2021

		Alumina Type						SiC Type	
		AZP50	AZP60	AZP60B	AZPW40	AZPWB40	AZPV60	AZPS40	AZPVS60
Porosity	%	50	60	73	40	35	60	40	60
Pore diameter	μm	5~40	5~40	5~40	50~100	50~200	20~40	5~30	10~30
Bulk density	g/cm^3	1.82	1.57	1.04	2.56	2.48	1.54	1.9	1.32
Air penetration rate	$(\times 10^{-13} m^2)$	0.8	5.73	-	100	270	200	6.1	160
Purity	%	96	96	-	95	90	*	98	*
Flexural strength	MPa	60	35	30	76	22	28	80	4
Dielectric constant	1MHz	-	-	-	4.1		3.8	-	35.8
Thermal conductivity	W/(m·K)	-	-	-	3	5	13.4	70	70.4
Thermal expansion coefficient	$\times 10^{-6}$ (RT-800℃)	-	-	-	7.6 (RT-700℃)	7.6	8	4.4	4.4
Color	-	White	White	Black	White	Black	White	Gray	Black
Application	Weight reduction	✓	✓	✓	N/A	✓	✓	N/A	✓
	Heat insulation	✓	✓	✓	N/A	✓	N/A	N/A	N/A
	Vacuum Chuck	N/A	✓	✓	✓	✓	✓	✓	✓
	Filter, Rectification (Air/Fluid), Spraying	N/A	✓	✓	✓	✓	✓	✓	✓
	Features	Light, Heat insulation	Fine surface, able to grip films and thin wafers.	Suitable for image processing and anti-reflection.	Large pore and good air penetration suitable for chucks and bubblers	Suitable for image processing and anti-reflection.	Larger pre and better air penetration than AZP60.	Similar to AZP60 with higher flexural strength. Polished as required.	SiC version of AZPV60 suitable for setters to avoid reaction with works.

※ The above values are just for refeence, and not guaranteed.

※ The purity of AZPV60 and AZPVS60 is under measurement.

※ AZPW45 is the discontinued material and no longer available.

※ ✓ = Applicable N/A= Not Available

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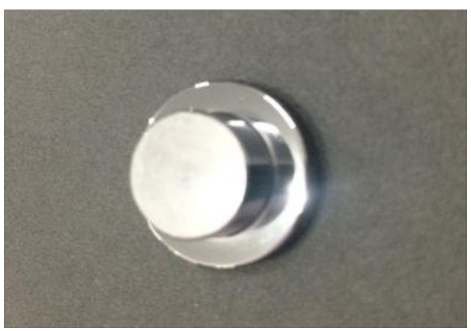
Selection of materials and finishes for SiC ceramics parts

SiC3N recommended for high surface roughness parts

Asuzac's SiC special treatment is characterized by a thin film thickness.
This feature makes post-processing finishing (e.g., mirror finishing of the surface) difficult after the special treatment.
If mirror or high surface roughness finish is required for a part, ASUZAC recommends SiC3N instead of special treatment.
This material also has significantly less metallic contamination than conventional SiC ceramics.

For SiC3N, up to surface roughness Ra0.03

It can also be used on sealing surfaces.



Metal Dissolution Test Data

[ppb]	Asuzac special treatment SiC	asuzac SiC 3N(99.9%)	SiC of other companies
Li	<0.02	<0.5	<0.1
Na	0.25	<0.5	0.4
Al	0.03	2.9	2.5
K	0.34	<0.5	4
Ca	<0.05	<0.5	6.7
Ti	0.07	0.8	19.0
Cr	<0.05	<0.5	11.0
Mn	<0.02	<0.5	<0.1
Fe	0.07	<0.5	15.0
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Ag	<0.02	<0.5	<0.1
Cd	<0.02	<0.5	<0.1
Pb	<0.02	<0.5	<0.1

※Test parameters are the same as those of P4 dissolution test (24h dissolution).

To assist in designing SiC ceramic parts

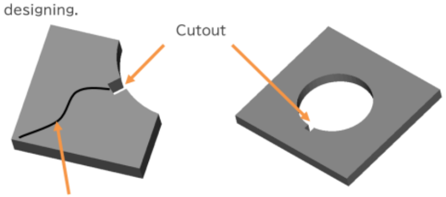
Assign all materials selection, shape-design, and VE suggestions to Asuzac.

It is important to select the appropriate material for ceramic parts according to the application and usage environment.
In addition, even if the drawings are satisfied without problems, there are cases where machining costs are high or machining is impossible, so it is important to design ceramic parts by grasping the points of machining.
Asuzac helps you select materials and design shapes, and we constantly propose VE.
Please feel free to consult with us.

Example of design points for ceramic parts

Avoid cutouts

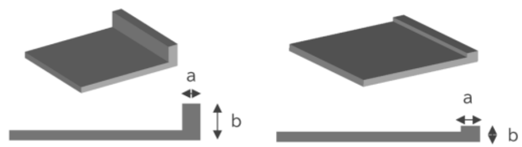
When machining, cracks are easily generated by machining cutouts.Therefore, if there is a notch in the ceramic part, the yield will be reduced.
It is important to avoid cutouts as much as possible when designing.



Cracks tend to develop from the notch.

Restrain the high standing

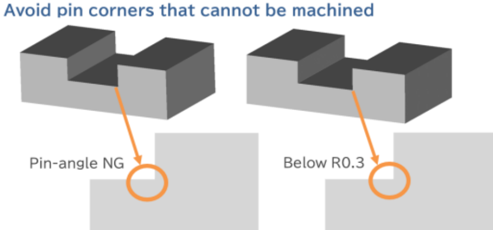
If the wall height (b) is higher than the wall width (a), clipping is more likely to occur, resulting in lower yields and higher costs.
It is effective to make the width thicker or the height lower.
※a = 1 mm or less is particularly vulnerable



a < b (high face to face)
Standing surface is easily scratched

a > b
(with a smaller standing surface)

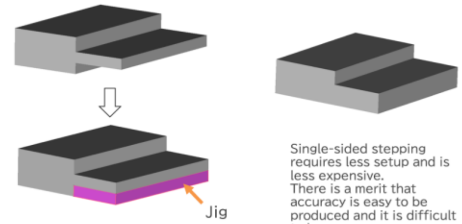
Avoid pin corners that cannot be machined



Basically, it is impossible to machine the pin corners of ceramic parts.
Since the tool used is an object with diamond granules attached to the base metal, the R shape is attached to the corner.
If the corner of the mating part needs 90 degrees, it can be handled by providing a relief groove.

Avoid machining from both sides

Shapes that require machining from both sides increase the number of set-ups and cost because jig manufacturing is also required.It is important to design so that the number of machining operations is as small as possible.When a jig other than the plane is required, it becomes a special jig, so the jig manufacturing cost is also high.

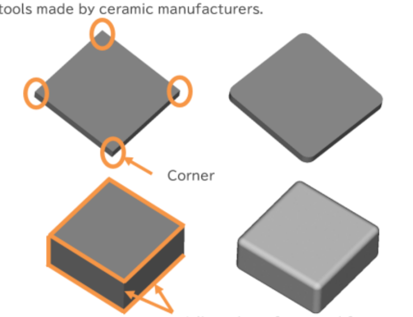


Since double-sided machining is required, jigs are required.
In addition, the risk of cracks increases.

Single-sided stepping requires less setup and is less expensive.
There is a merit that accuracy is easy to be produced and it is difficult to be worn.

Avoid edges

It will also reduce machining costs, but it is effective to use C-chamfered or R-shaped edges such as corners and ridgelines of ceramic parts.
Edges are easily chipped when machining or when parts are used.
R1, R1.5, R2, R2.5, R3, R3.5, R4, R5 when designing with R-shape
Then, it can be machined with Asak and other general-purpose tools made by ceramic manufacturers.



Example of adopting SiC ceramics parts

Changed from resin material to SiC ceramics, achieving 8 times durability.

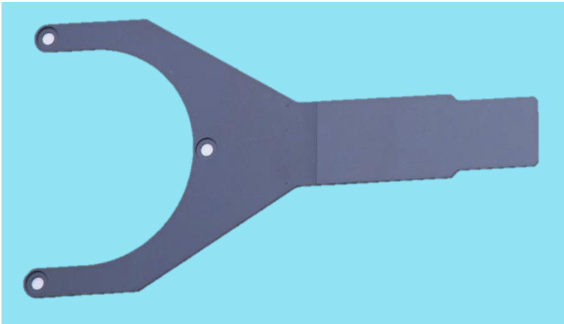
Examples of semiconductor cleaning equipment manufacturers

Semiconductor cleaning equipment designer

Problems	PEEK materials were used for parts that contacted chemical liquids.Faster consumable rates have led to more frequent maintenance and higher costs.
Possible causes	To be found to be used in more severe environments than expected among end users.
Countermeasures	**Considering the use of ceramics, it is about eight times more durable than PEEK materials**
Results	**Reduced maintenance frequency + reduced costs**

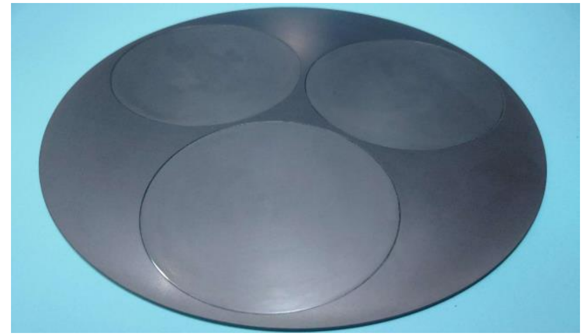
Although the cost of materials and processing costs for a single item increased with the use of SiC ceramics, the durability increased eightfold, resulting in a total cost reduction. The frequency of replacement could also be reduced, leading to improved productivity of the equipment.

Achievements of SiC ceramics parts

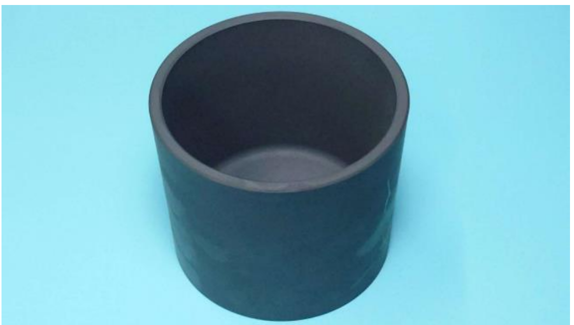


End Effector

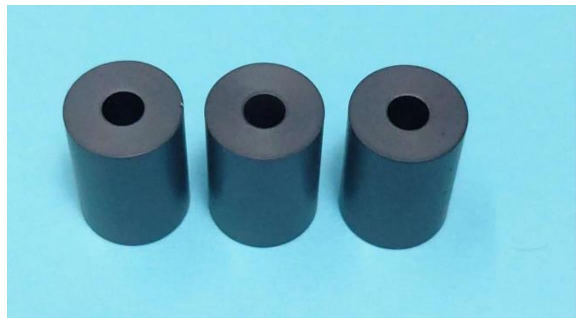
Porous SiC Chuck (Body Alumina)



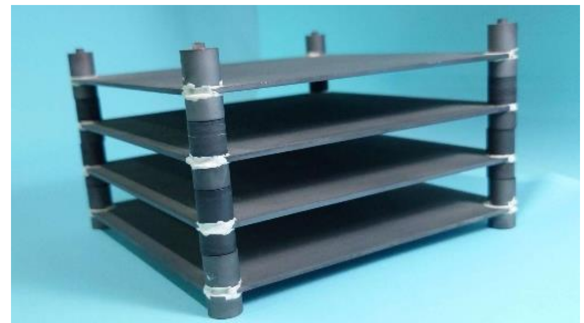
Wafer tray (counterbore type)



Crucible



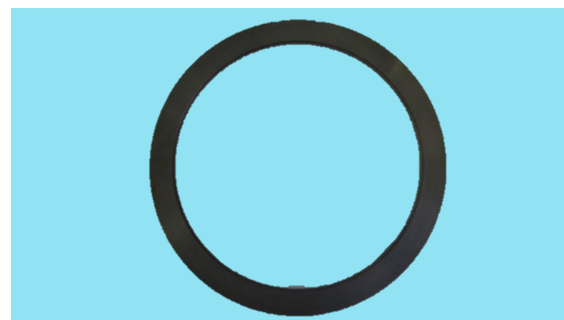
Roller



Baking setter

Porous SiC chuck (body SiC)

Heat platen



SiC ring

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SiC Ceramics Adoption Guide

Contact Asuzac for SiC Ceramic Parts !

Please tell us that you saw the technical data of Ceramics Parts Design Lab, and provide us with the name of the material you are inquiring about so that we can guide you smoothly.

【Please contact us by phone (free of charge)】

▼Please contact us by dialing the number below

+81-26-248-1626

Hours: Weekdays 9:00 a.m. to 5:00 p.m. (except Saturdays, Sundays, national holidays, and year-end and New Year holidays)

【For inquiries and inquiries from Web here (free)】

▼Please visit the website from URL below.

https://ceramics-design-lab.com/en/