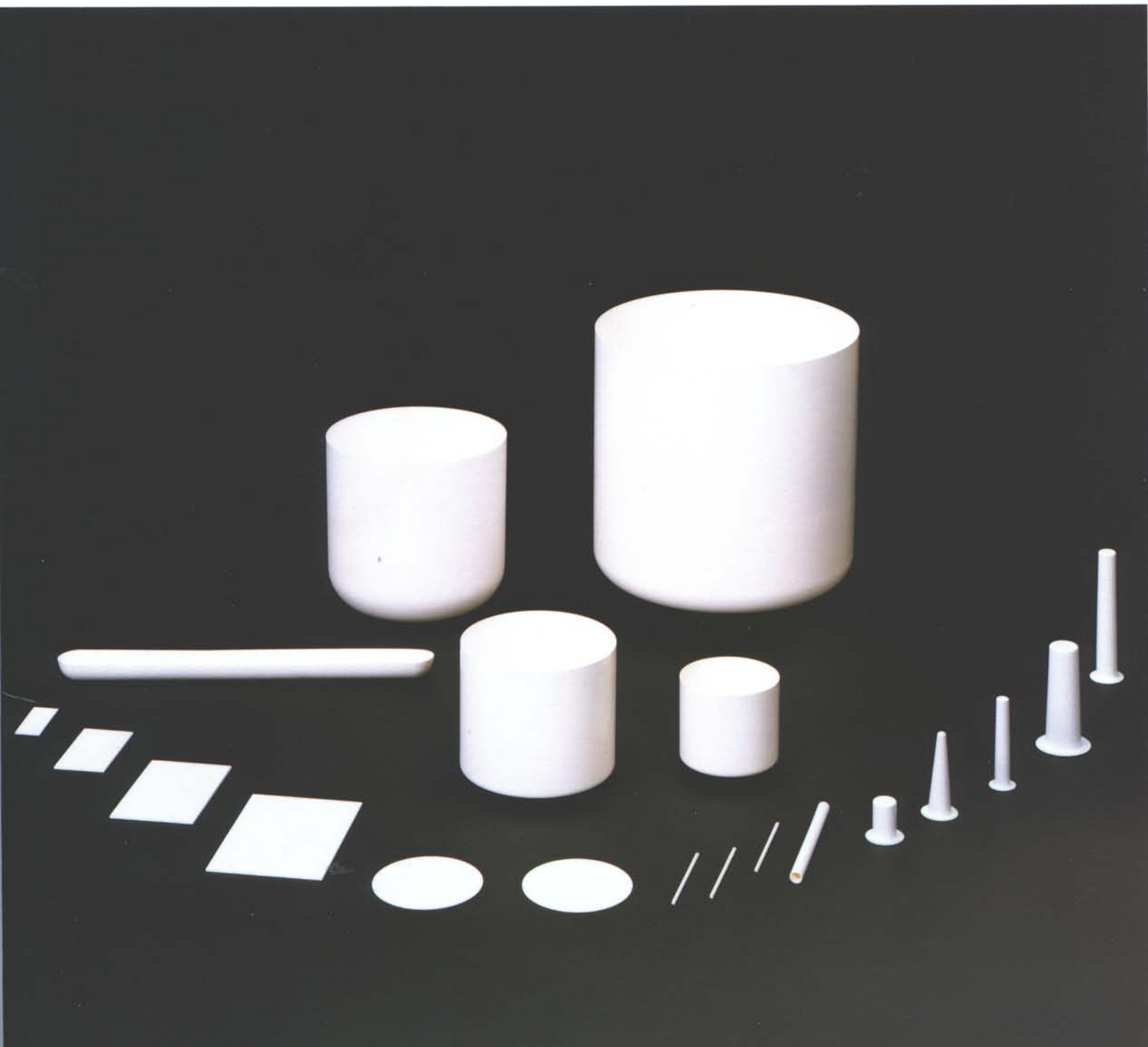


ShinEtsu

**PYROLYTIC
BORON
NITRIDE**



INTRODUCTION

Since our establishment in 1926, Shin-Etsu Chemical Co., Ltd. has grown up to be Japan's largest manufacturer of many types of plastic resins, including silicones, methylcellulose and polyvinyl chloride. We have also diversified our industry to become one of the world's leading suppliers of semiconductor silicon, synthetic quartz and GGG (gadolinium gallium garnet). Shin-Etsu also produces rare earth elements and compounds, rare earth magnets, lithium tantalate and the like for use in the electronics industry.

Shin-Etsu's present and future objectives lie in the supply of high-purity, high-precision and high-performance products essential for the currently expanding high-tech industries.

On the basis of our long experiences in these fields, we have already developed and launched on to the market new electronics materials such as NGG (neodymium gallium garnet), SGG (samarium gallium garnet), BGO (bismuth germanate), YAG (yttrium aluminum garnet), SiC (silicon carbide), SiN (silicon nitride) and BN (boron nitride). And very recently we have also introduced PBN (pyrolytic boron nitride) materials, setting up a system for the supply of a variety of PBN products, including crucibles, boats, rods, wafers, plates, tubes and graphite coatings.

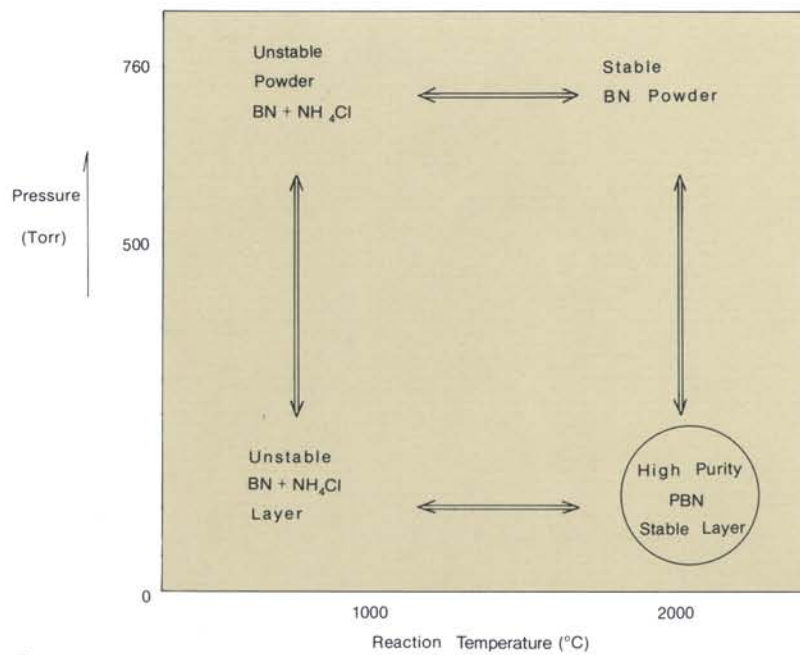
PROCESS

PBN is manufactured through a chemical vapor deposition (CVD) process with the following reaction:



PBN is deposited on a graphite substrate at a temperature over 1800°C and under a pressure of less than 1 Torr in a specially-designed reaction chamber. PBN can then be either released as a free-standing molded form or left as it is as a thin-layered, highly-oriented crystalline PBN coating on a graphite substrate. This thin layer, analogous to pyrolytic graphite in crystalline form, is composed of laminar hexagonal boron nitride.

Reaction Condition vs. Product



CHARACTERISTICS

Shin-Etsu's PBN is manufactured through our own unique, self-developed CVD process. The resulting many outstanding characteristics are as follows:

- **High purity**
- **High compositional homogeneity**
- **Uniform wall thickness in the circumferential direction**
- **Easily adjustable thickness distribution in the axial direction**
- **Excellent durability**
- **Minimal outgassing at high temperature and vacuum**
- **Non-toxic**

APPLICATIONS

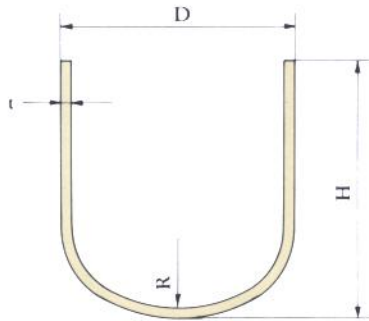
Shin-Etsu's PBN has many remarkable properties, such as excellent tensile strength at high temperature, chemical inertness, high purity, outstanding thermal conductivity and high electrical resistivity. All these properties make our PBN ideal for crucibles and boats in the crystal growth of III-V compounds used in semiconductors, and for other applications in the electronics industry such as:

- Crucibles, Dishes
- Boats, Trays
- Electrical Insulators
- Graphite Coatings
- Infrared Windows
- Furnace Components
- Vaporizing Pots
- Nozzles, Pipes, Rods
- Heat Insulators
- Boron Dopants

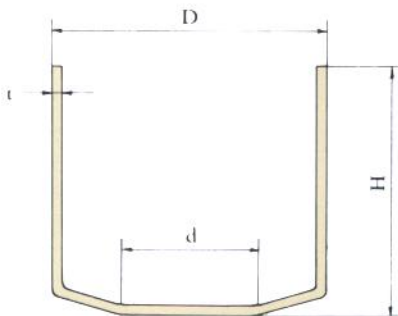


LARGE-SIZED CRUCIBLES

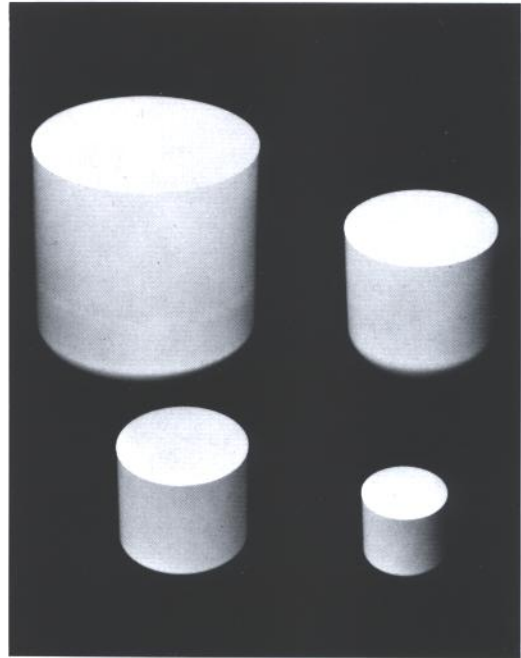
■ Crucibles for III-V compounds



(Round Bottom Type)



(Flat Bottom Type)

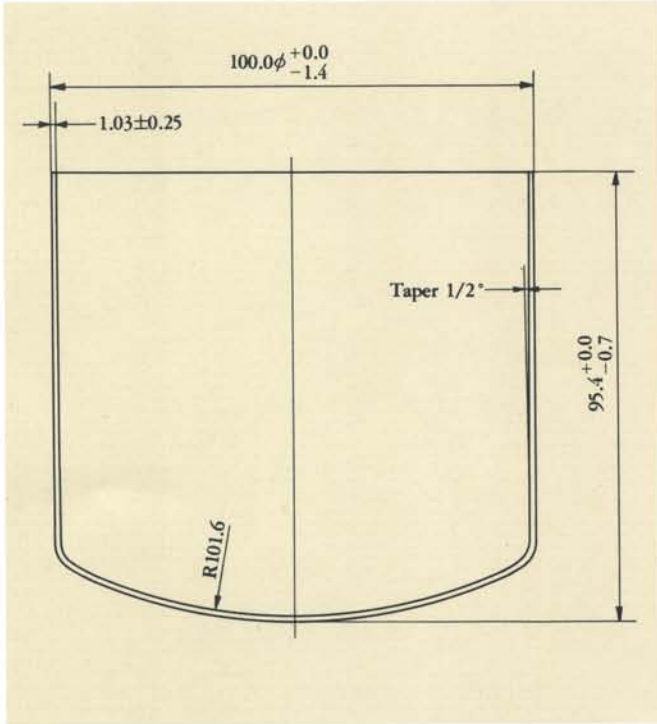


Standard Size

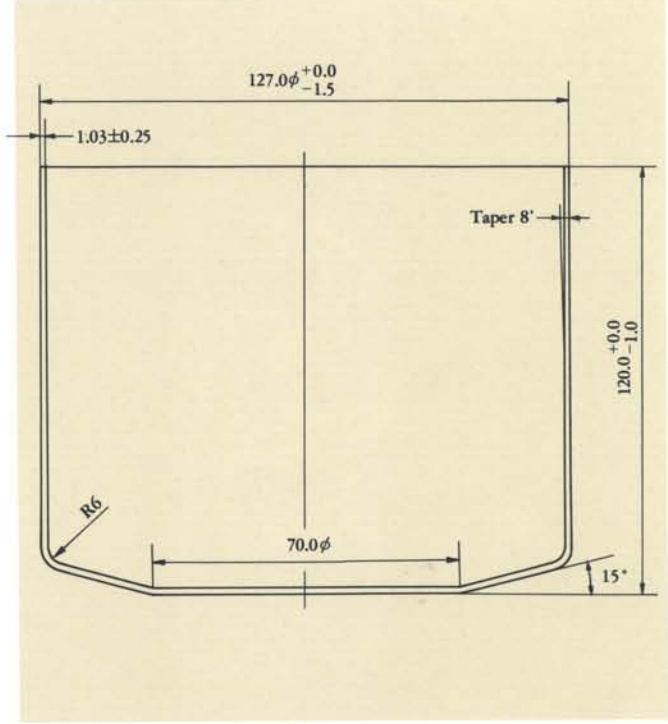
	D (mm)	H (mm)	R (mm)	d (mm)	t (mm)
KC-400	100.0	95.4	101.6	—	1.03
KC-500	127.0	120.0	—	70.0	1.03
KC-600	155.4	140.0	—	73.0	1.05
KC-730	I 186.2 ₀	168.0	457	—	1.15
	II 186.2	176.0	124	—	1.15
KC-800	203.0	183.0	317	—	1.15
KC-1000	254.0	245.0	310	—	1.15
KC-1200	302.0	290.0	304	—	1.15

Special Sizes and Shapes

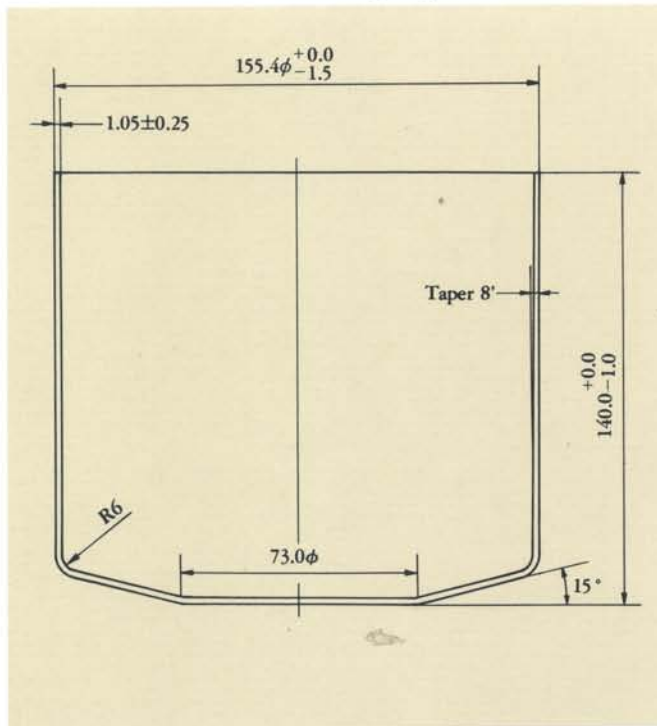
KC-400 (4"φ)



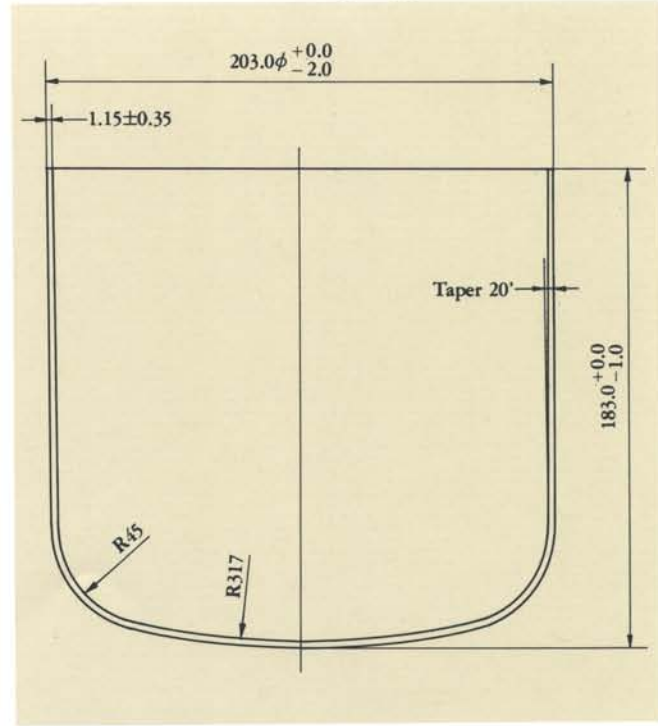
KC-500 (5"φ)



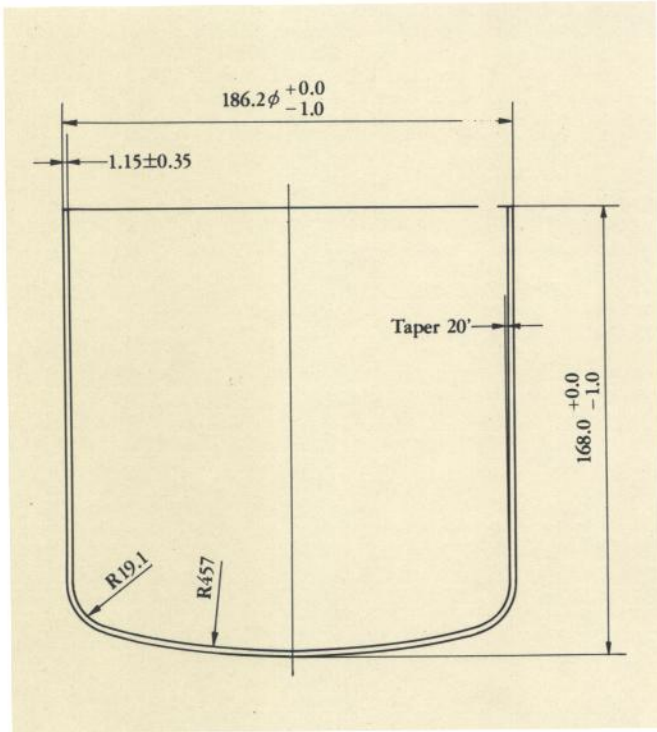
KC-600 (6"φ)



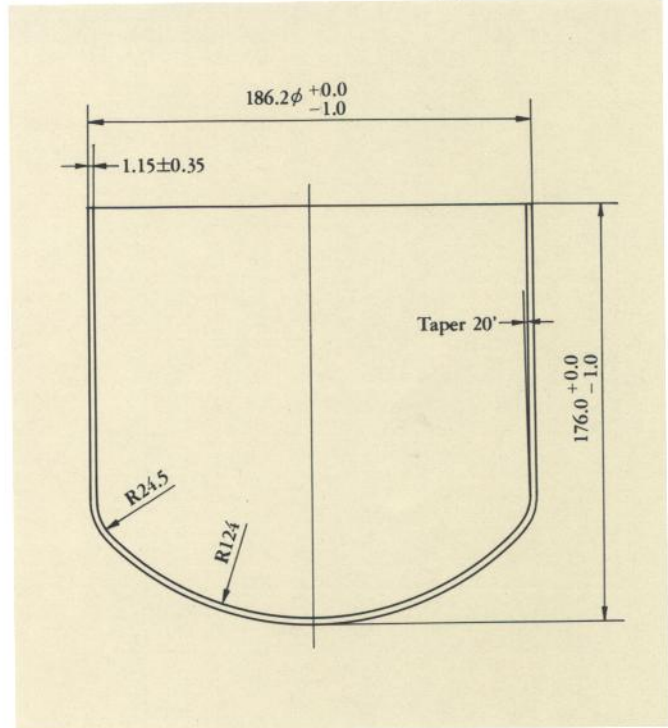
KC-800 (8"φ)



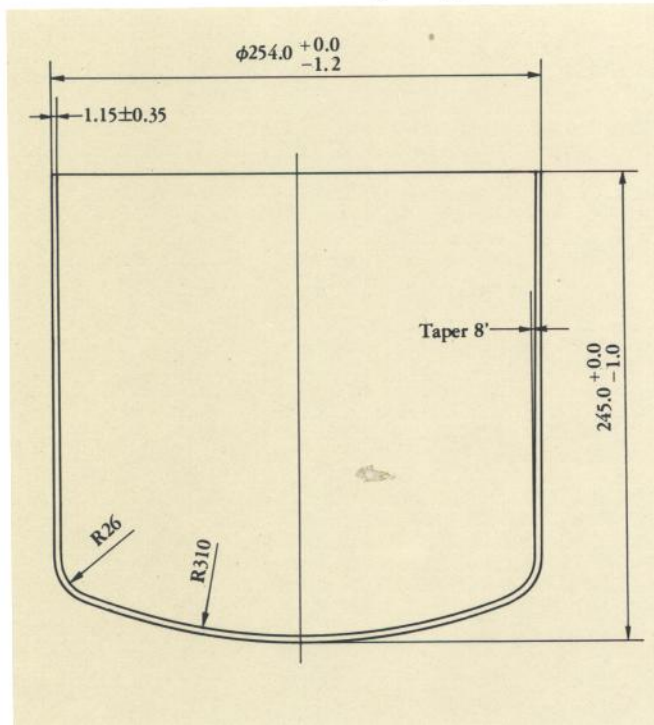
KC-730 I (7.3"φ)



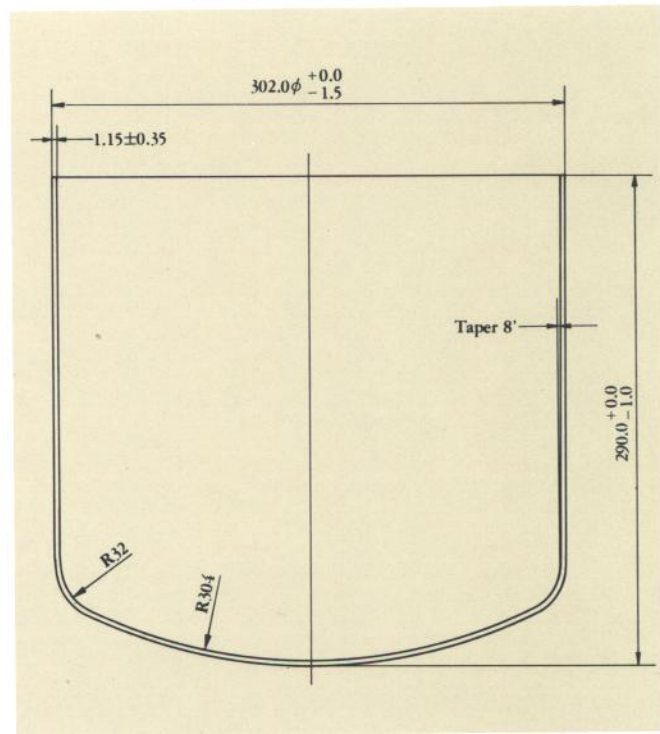
KC-730 II (7.3"φ)



KC-1000 (10"φ)



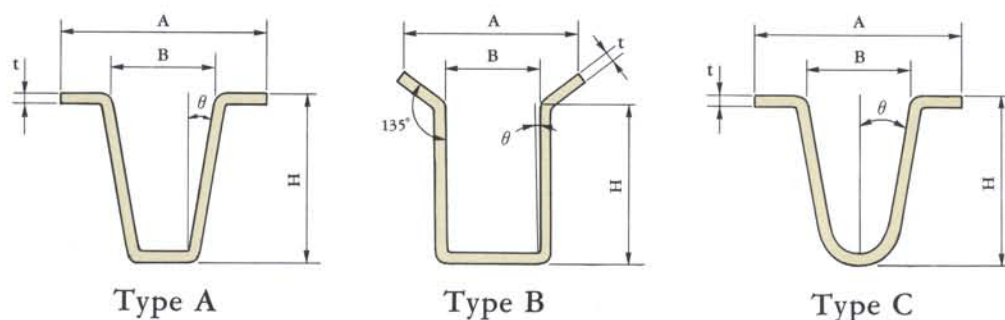
KC-1200 (12"φ)



SMALL-SIZED CRUCIBLES



■ Crucibles for MBE



Standard Size

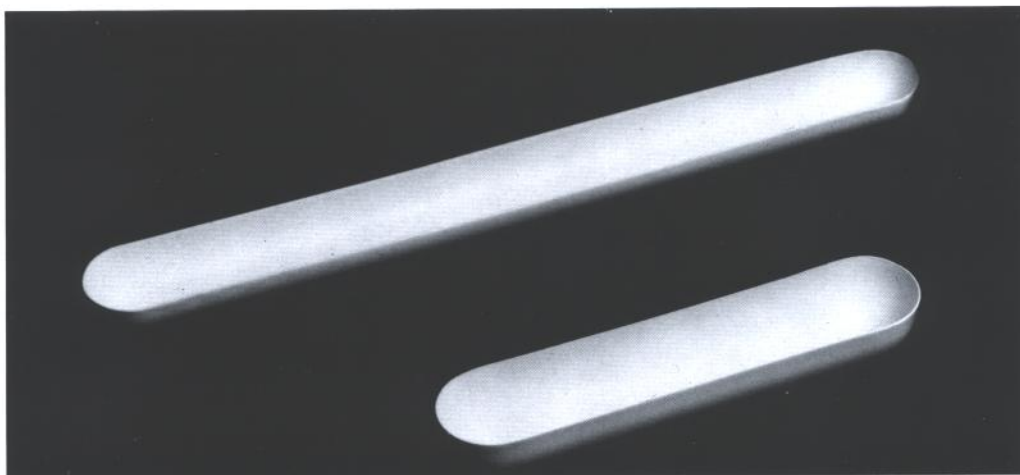
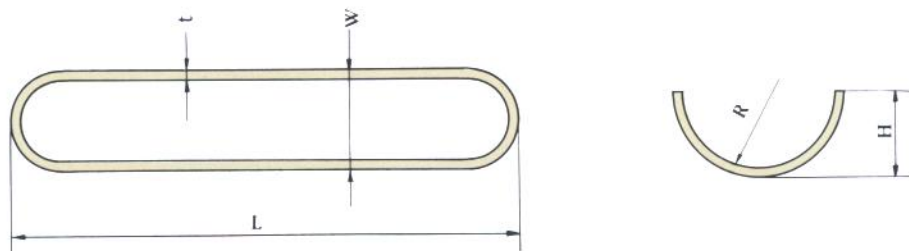
Catalog No.				Manufacturers of MBE System	Description	Type	θ	A (mm)	B (mm)	H (mm)	t (mm)
Standard	Double wall	Polished	Double wall & Polished								
KM-10	KM-10D	KM-10P	KM-10DP	Riber, ULVAC	Riber BN-110L ULVAC 8cc	A	1°	26.6	12.9	77	0.9
KM-11	KM-11D	KM-11P	KM-11DP	Riber	Riber BN-125L	A	1°	32.7	19.0	90	0.9
KM-12	KM-12D	KM-12P	KM-12DP	Riber	Riber BN-135L	A	1°	36.8	23.1	90	0.9
KM-13	KM-13D	KM-13P	KM-13DP	Intevac (Varian) ANELVA, ULVAC	40cc	A	1°	36.3	20.8	141	0.9
KM-14	KM-14D	KM-14P	KM-14DP	Varian	16cc	A	5.5°	36.3	20.8	83	0.9
KM-15	KM-15D	KM-15P	KM-15DP	Perkin Elmer	2cc	B	1°	17.2	10.5	26	0.75
KM-16	KM-16D	KM-16P	KM-16DP	Perkin Elmer	20cc	B	1°	28.7	16.7	77	0.9
KM-17	KM-17D	KM-17P	KM-17DP	VG Semicon	40cc	A	1°	50.4	21.1	151	0.9
KM-18	KM-18D	KM-18P	KM-18DP	ULVAC	20cc	A	1°	37.0	21.0	71	0.9
KM-19	KM-19D	KM-19P	KM-19DP	ANELVA	10cc	A	1°	37.0	21.0	36	0.75
KM-20	KM-20D	KM-20P	KM-20DP	ANELVA	100cc	A	2°	60.0	35.0	106	0.9
KM-21	KM-21D	KM-21P	KM-21DP	Intevac (Varian)	5cc	C	10°	36.3	18.5	41	0.75
KM-22	KM-22D	KM-22P	KM-22DP	Intevac (Varian)	60cc	A	7°	54.2	38.1	108	0.75
KM-23	KM-23D	KM-23P	KM-23DP	Intevac (Varian)	125cc	A	1°	54.1	37.1	108	0.75
KM-24	KM-24D	KM-24P	KM-24DP	Perkin Elmer	60cc	A	6°	53.3	38.1	89	0.9
KM-25	KM-25D	KM-25P	KM-25DP	VG Semicon	5cc	C	15°	60.5	23.5	38	0.75
KM-26	KM-26D	KM-26P	KM-26DP	VG Semicon	10cc	C	5.7°	34.0	20.0	60	0.75
KM-27	KM-27D	KM-27P	KM-27DP	VG Semicon	25cc	C	13°	51.0	34.0	60	0.75
KM-28	KM-28D	KM-28P	KM-28DP	VG Semicon	40cc (New)	C	6°	51.0	32.5	110	0.75
KM-29	KM-29D	KM-29P	KM-29DP	VG Semicon	70cc	C	10°	59.9	44.0	115	0.75
KM-30	KM-30D	KM-30P	KM-30DP	VG Semicon	150cc	C	1°	45.0 59.9	35.0	167	0.75

Special Sizes and Shapes

Shin-Etsu is ready to manufacture special sizes and shapes, upon request.

BOATS

■ Boats for III-V compounds



Standard Size

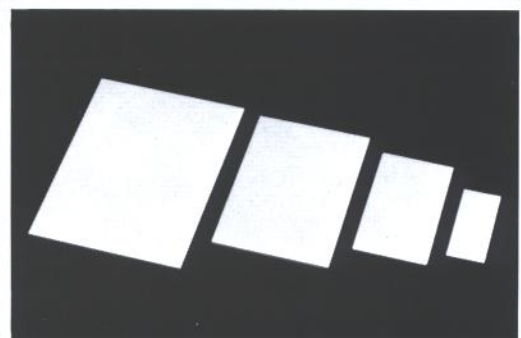
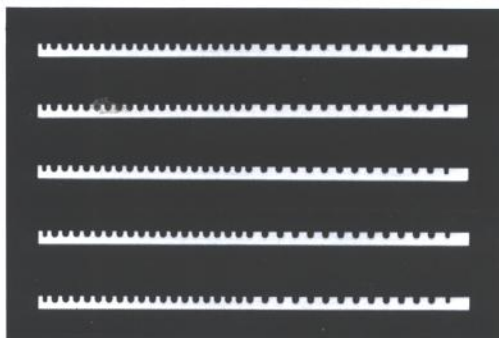
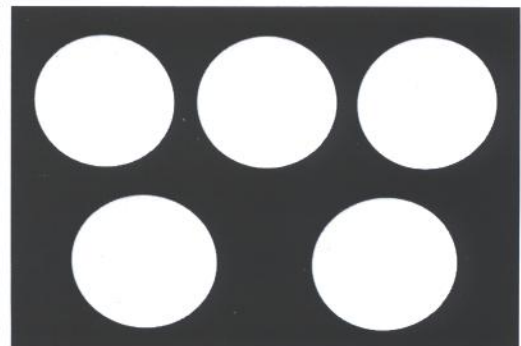
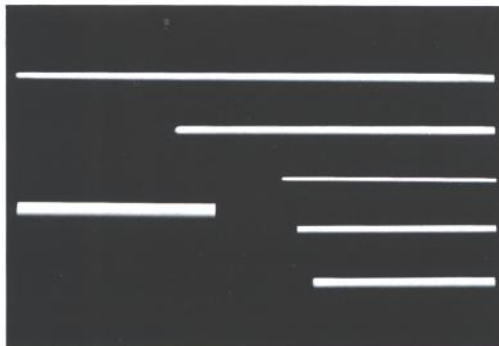
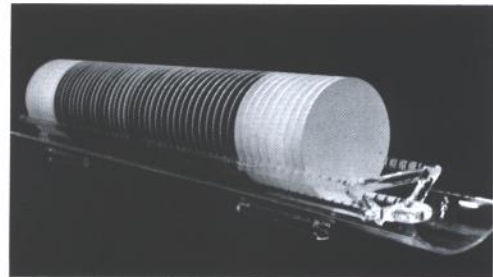
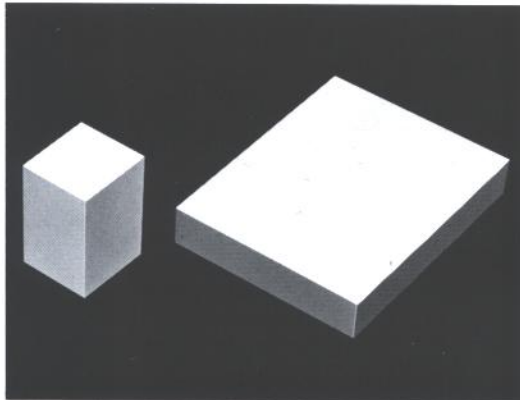
	L (mm)	W (mm)	R (mm)	H (mm)	t (mm)
KB-150	150	40	20	20	1.1
KB-200	200	45	22.5	22.5	1.1
KB-250	250	50	25	25	1.2
KB-300	300	50	25	25	1.2
KB-350	350	55	27.5	27.5	1.2
KB-400	400	60	30	30	1.2

Special Sizes and Shapes

Shin-Etsu is ready to manufacture special sizes and shapes, upon request.

OTHERS

- Coating: Wafer Holders
Heaters
LPE Hardwares
- Pipes: Thermocouple Covers
Furnace Tubes
- Wafers: Boron Dopants
Heat Sink Substrates
- Rods: Supports
Bolts
- Plates: Insulators
Heat Shields
Wafer Holders



PROPERTIES

Mechanical Properties

PBN has a high tensile strength. It is perfect for use in a range of high temperature because of the special characteristic of increasing its strength the higher the temperature becomes.

Thermal Properties

The thermal conductivity of PBN is very good and has a high degree of anisotropy; conductivity in the "a" direction is higher than in the "c" direction by approximately 20 times. The secret of this high anisotropy is in PBN's laminar structure, which also give many other unique properties to PBN.

Electrical Properties

The electrical resistivity of PBN is high and anisotropic. In this respect, PBN is largely different from graphite which has a good electrical conductivity. It is therefore useful as a high-temperature insulation material.

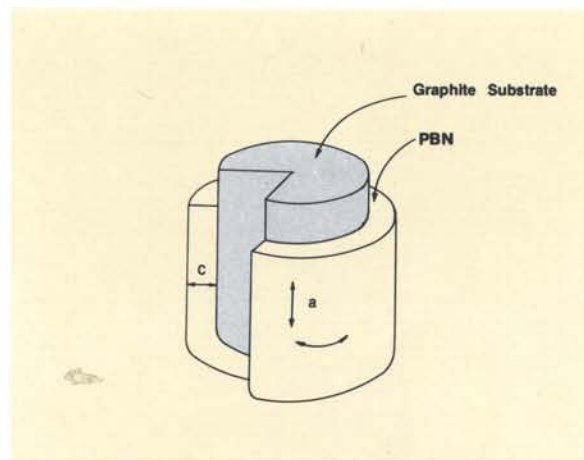
Chemical Properties

PBN is chemically stable and non-toxic. It is superior to graphite in its resistance to oxidation, while impurities are almost undetectable. This very high degree of purity comes up from the CVD process at high temperature, under reduced pressure. PBN does not react with metal, glass and III-V compounds, and withstand shocks of rapid heating or quenching.

Processability

PBN is easily machine-processed, such as cutting, boring and polishing. Even intricate shapes can be made.

Anisotropic Properties of PBN



"a" Direction Properties

1. Low Thermal Expansion
2. High Thermal Conductivity
3. High Tensile Strength

"c" Direction Properties

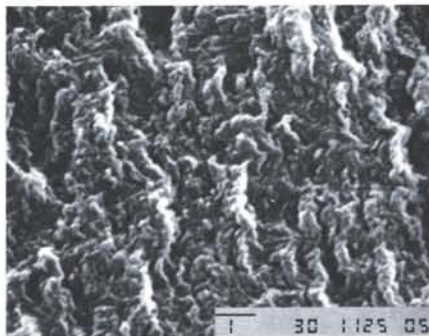
1. Low Dielectric Constant
2. High Electric Resistivity
3. High Compressive Strength

Impurities

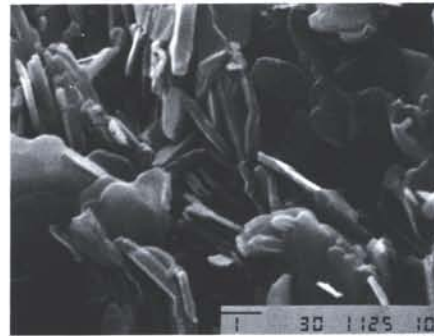
N.D. stands for "Not Detected."
I.C.P. stand for "Inductively Coupled Plasma A.E.S."

Impurities	Concentration	Methods
Ca	N.D.	I.C.P.
Cu	N.D.	I.C.P.
Co	N.D.	I.C.P.
Fe	N.D.	I.C.P.
Mn	N.D.	I.C.P.
Ni	N.D.	I.C.P.
Zn	N.D.	I.C.P.
Na	N.D.	Flameless Atomic Absorption
Si	N.D.	D.C. Arc

Microstructure of PBN and Hot Pressed BN



PBN × 1000



Hot Pressed BN × 1000

Comparison between PBN and Hot Pressed BN

	PBN	Hot Pressed BN
Manufacturing Method	CVD	Hot Press
Composition	hBN	hBN, Binder (B ₂ O ₃ , CaO, SiO ₂ , etc.)
Structure	Anisotropy	Isotropy
Electrical Resistivity at 1000°C (Ω-cm)	5 × 10 ⁹	5 × 10 ⁴
Tensile Strength 1000°C (kg/mm ²)	5.0	0.8
Metal Impurity (ppm)	<1	<100,000
Application	Thin Materials Coatings	Thick Materials

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