CARBON-GRAPHITE PRODUCTS

C/C composite

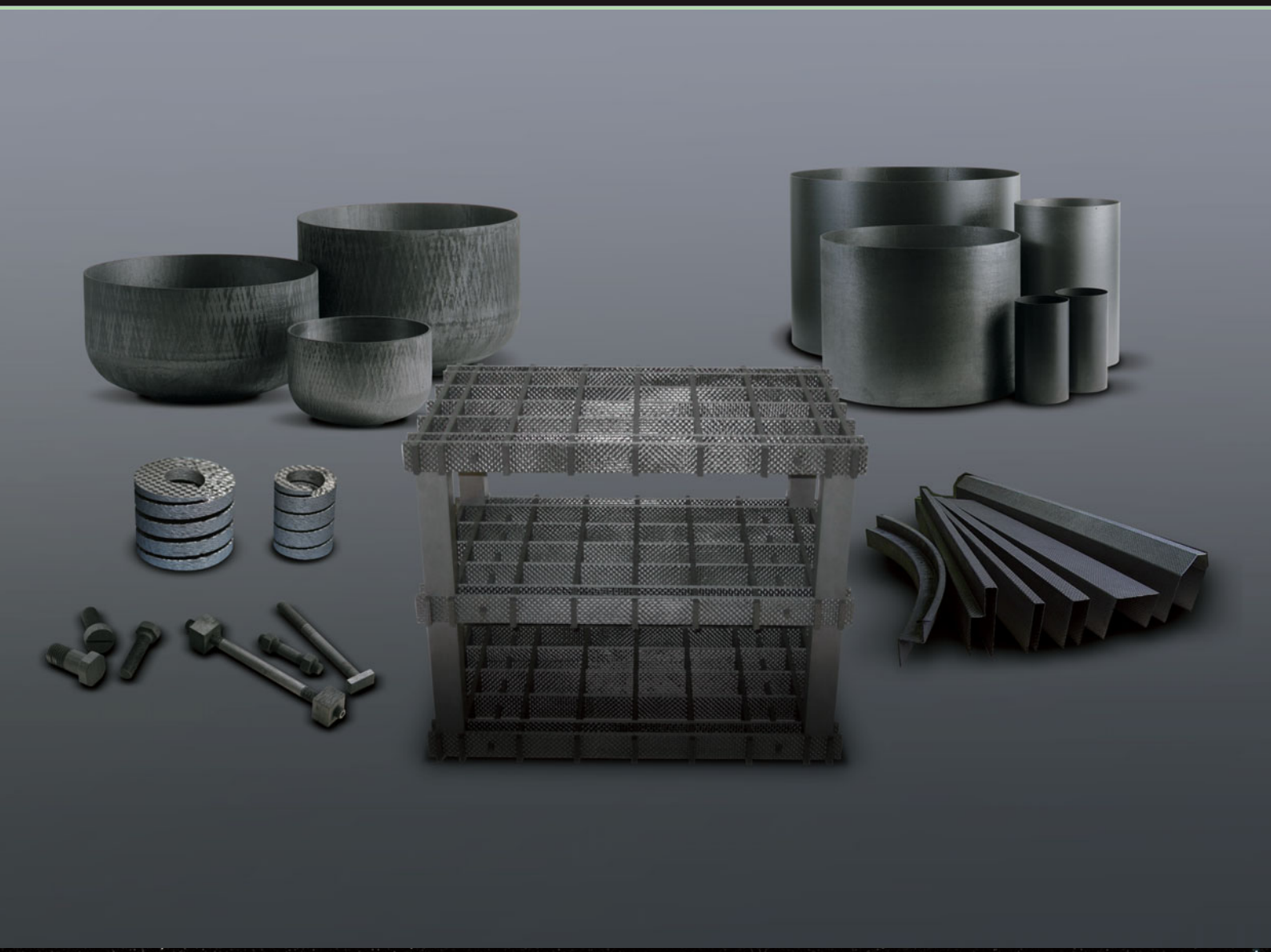
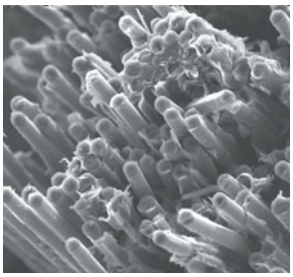


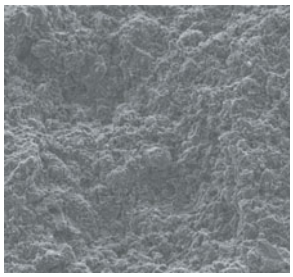
Image: provided by JAXA
Illustrated by Akihiro Ikeshita

Features of C/C Composite Products

C/C composite (Carbon Fiber Reinforced Carbon Composite) is a carbon-carbon composite material reinforced by high strength carbon fiber, which has superior properties such as light weight, high mechanical strength, and high elasticity. Because of their unique features, our C/C composites (CX series) are used in a wide range of fields such as electronics, environment and energy, general industrial furnaces, and automobiles and other means of transport.



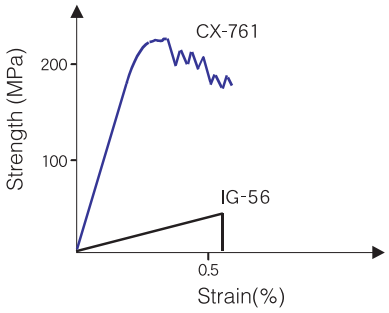
C/C composite (×1000)



Artificial graphite (×200)

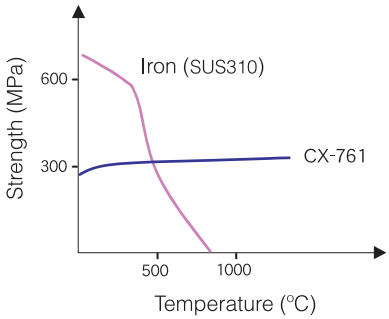
High mechanical strength, high elasticity, and high toughness

C/C composites have higher strength, higher elasticity, and resistance to cracking and chipping, compared to isotropic graphite materials. C/C composites can be used with assurance, as the fractures do not propagate rapidly in them.



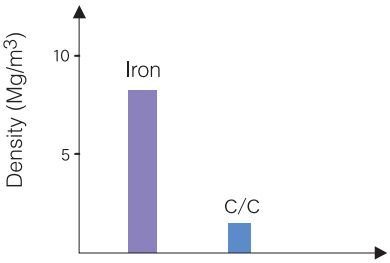
Ultra heat resistance

C/C composites have higher strength at high temperatures compared to metallic materials. They can be used even at ultra-high temperatures of 2000°C or higher in inert atmospheres.



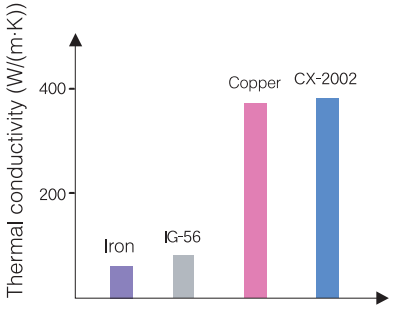
Light-weight and easy to handle

C/C composites have low density compared to metallic materials, and therefore, make light weight designing possible.

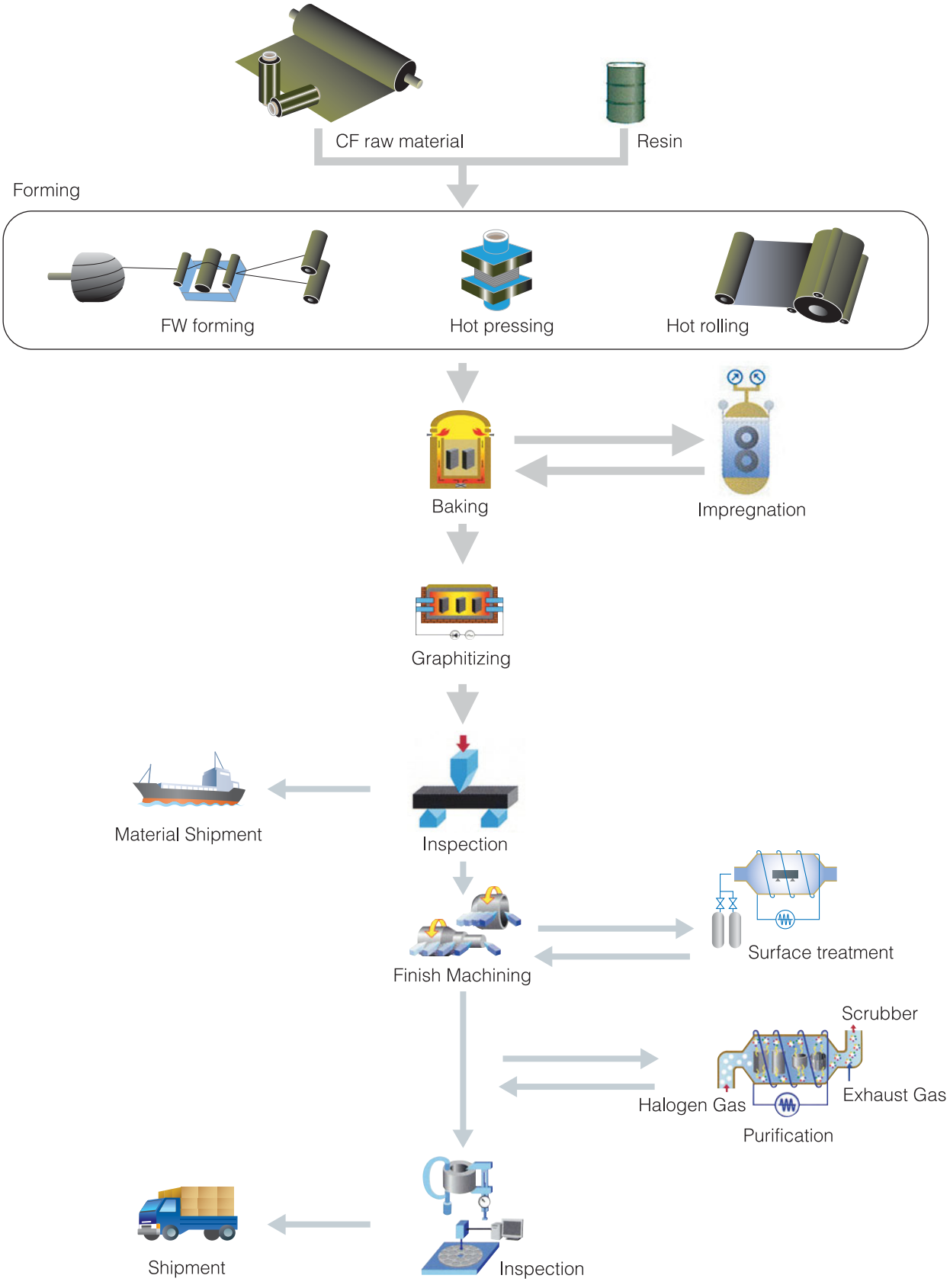


High thermal conductivity

A thermal conductivity higher than copper has been achieved (in CX-2002) through the use of carbon structure control technology, which involves our superior chemical vapor infiltration (CVI) treatment.



Manufacturing Process



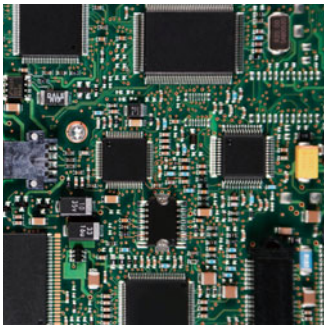
Application

Electronics

- For production of single crystal silicon

Crucibles

Heat shields



Environment and Energy

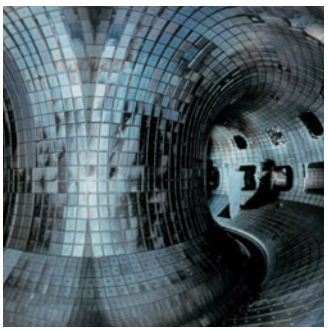
- For production of silicon for solar cells

Rectangular crucibles

Carrier tray for PECVD

- For nuclear energy plants

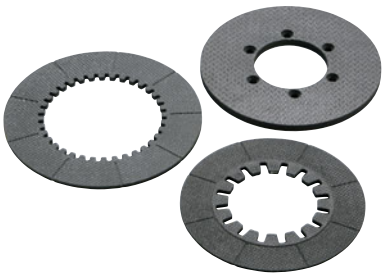
Armor tiles



※Photographs provided by the Japan Atomic Energy Agency

Automobiles, other means of transport, etc

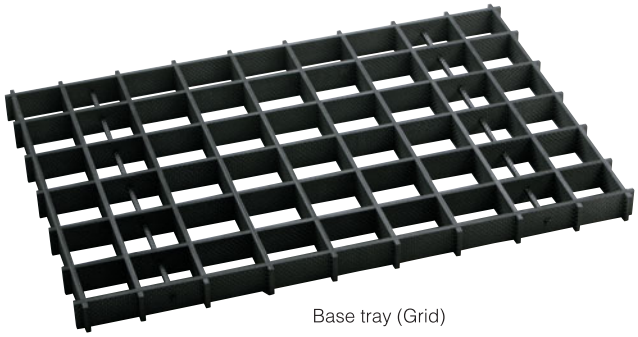
- For sliding components



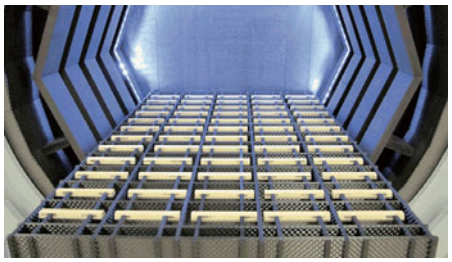
Clutch

General industrial furnaces

● For heat treatment furnaces



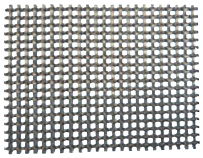
Base tray (Grid)



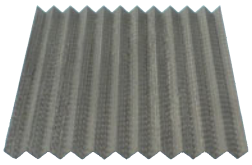
Heat treatment furnace

Basket

Multi-layer tray



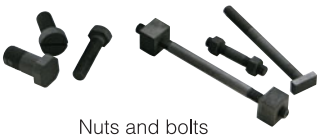
Mesh tray



Wavy tray

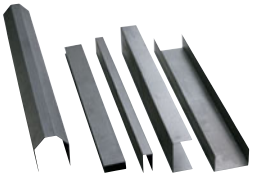
Internal driving parts of furnaces

Heaters



Nuts and bolts

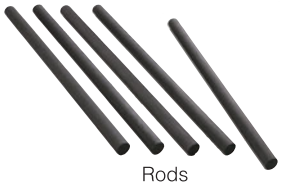
Spring



Protective cover for thermal insulation

● For hot press furnaces

Die



Rods

C/C composite

Property Data

Typical properties

Shape	Material	Bulk Density (Mg/m³)	Electrical Resistivity (μΩ·m)	Flexural Strength (MPa)	Flexural modulus (GPa)	Tensile strength (MPa)	Coefficient of Thermal Expansion RT~1273K (10⁻⁶/K)		Thermal Conductivity (W/(m·K))		C/C type	Description
		-	-	-	-	-	(⊥)	(//)	(⊥)	(//)		
Flat plate	CX-741	1.51	23	140	46	185	8.1	<1	6	35	2DC/C	Medium strength (Molding method A)
	CX-761	1.58	20	185	55	250	8.4	<1	9	44		High strength (Molding method A)
	CX-742	1.48	24	130	42	170	7.8	<1	5	34		Medium strength (Molding method B)
	CX-762	1.58	21	170	50	185	8.2	<1	8	42		High strength (Molding method B)
	CX-31	1.61	22	90	23	98	4.1	<1	12	52		Nut and bolt components
	C/C-201[1)]	1.50	30	147	47	127	8.2	<1	5	20		Medium strength, nut and bolt components
	C/C-501[1)]	1.50	29	216	50	147	-	<1	5	20		High strength, nut and bolt components
Profiles	CX-743	1.48	24	130	-	-	7.8	<1	5	34		Profiles
	CX-763	1.58	21	170	-	-	8.2	<1	8	42		Profiles with high strength
Cylinders	CX-45	1.44	24	105	34	114	8	<1	4	34		Medium strength cylinder
	CX-47	1.52	23	140	45	154	8	<1	6	35		High strength cylinder
Crucibles	CX-510V	1.57	13	195	-	290	7	<1	7	-	FWC/C	FW crucibles
Cylinders	C/C-FW[1)]	1.50	12	245	-	245	-	<1	5	30		FW hot press molds
	CX-55	1.60	11	195	-	290	7.4	<1	7	-		FW cylinders
Tiles	CX-2002U[2)]	1.65	2.7,3.4,5.1 (X,Y,Z)	47,43,17 (X,Y,Z)	-	35,30,11 (X,Y,Z)	5.3 (Z)	1.7,2.3 (X,Y)	190 (Z)	390,320 (X,Y)	felt C/C	Use in nuclear energy plants
	Isotropic graphite (IG-56)	1.77	12	43	10	27	4.7		104			

*The figures above are typical values, and are not guaranteed.
1) Manufactured by Ohwada Carbon Industrial Co., Ltd.;
2) The direction of lamination of the felt is designated as the Z-axis and the directions within the plane as X- and Y-axes.

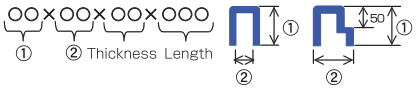
Available sizes

Grade	Dimensions (mm)
CX-741,CX-761	2000*1500*0.8 –30
CX-742,CX-762	3000*1500*0.8 –30
CX-31	Max.850*400 3.2–90t
C/C-201	1020*970*1–12 970*720*1–12
C/C-501	Max.300*300*20
CX-45,CX-47	Inner diameterφ300–1400, 1400L

Grade	Dimensions (mm)
CX-743,CX-763	U-profile 80*20 –145*1.2*1000
CX-743,CX-763	h-profile 107*44*1.5*1000
CX-510V	Max.inner diameterφ1168(46" crucibles available)
C/C-FW	Max.φ950*800h, 20–150t
CX-55	Inner diameterφ10–1400, 1400L
CX-2002U	40*150*150 (X*Y*Z)

*Please contact us for other sizes

U-and h-profiles' dimensions



An example of impurity analysis of CX-510V (A high purity treated product)

Unit: mass ppm

Element	Na	Mg	Al	K	Ca	Ti	V	Cr	Fe	Ni	Cu
Content	< 0.05	< 0.02	< 0.08	< 0.1	< 0.04	< 0.09	< 0.07	< 0.07	< 0.04	< 0.1	< 0.08
Method of measurement	AAS	ICP-AES	ICP-AES	AAS	ICP-AES	ICP-AES	AAS	ICP-AES	ICP-AES	ICP-AES	ICP-AES

*The figures above are examples of measured values and are not guaranteed.
*ICP-AES: Inductively coupled plasma atomic emission spectroscopy, AAS: Atomic absorption spectrometry
*CX-510V is a high purity material

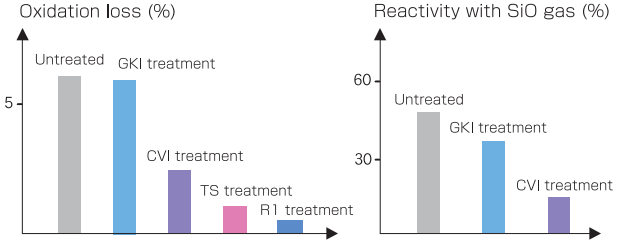
Different surface treatments

Advantageous properties are imparted by using Toyo Tanso's proprietary surface treatment technologies.

■ Details of surface treatments and their effects

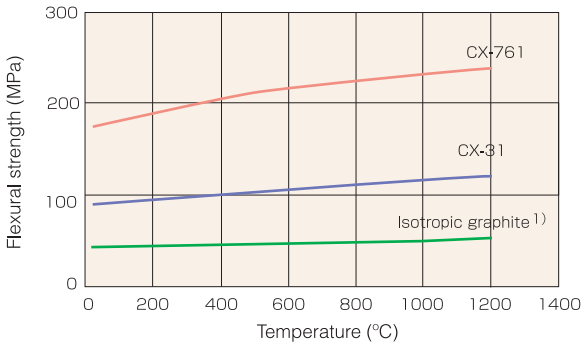
GK1 treatment (Glastix Kote®)	Impregnation/coating with glassy carbon; it improves oxidation resistance, and prevents dust formation.
CVI treatment *	Impregnation/coating with pyrolytic carbon; it improves resistance against SiO gas.
R1 impregnation	Impregnation with inorganic matter; it improves oxidation resistance.
TS treatment	A treatment to convert the surface into SiC; it improves oxidation resistance and prevents dust formation.

*Abbreviation for Chemical Vapor Infiltration

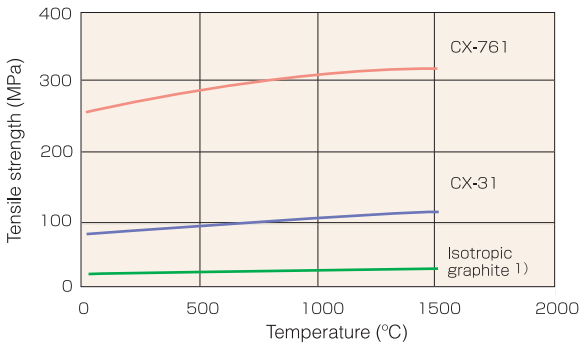


C/C composite

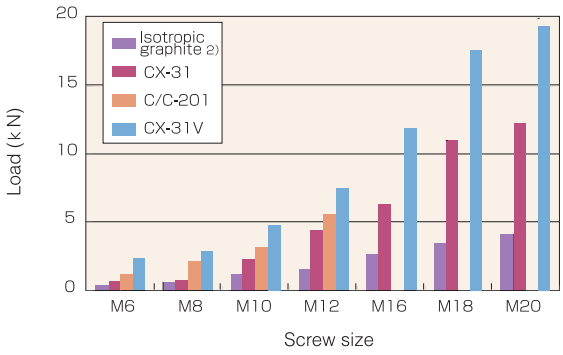
Flexural strength



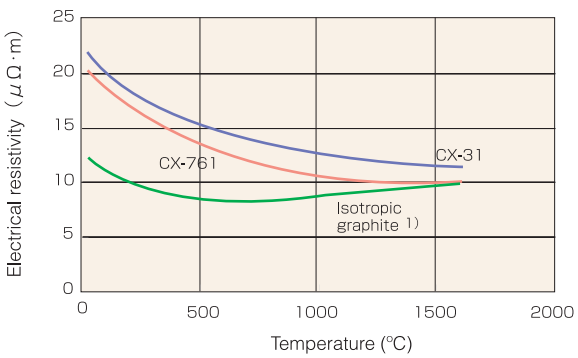
Tensile strength



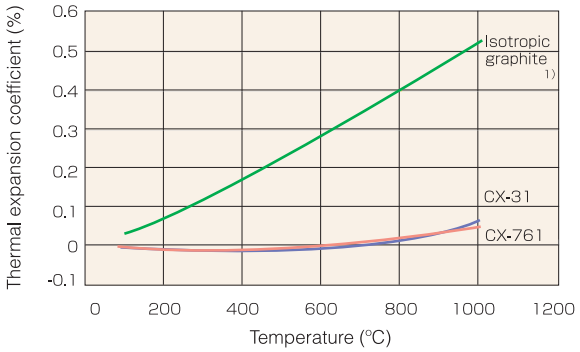
Strength of screw thread



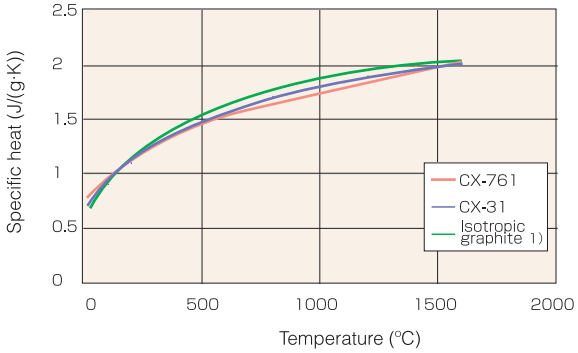
Electrical resistivity



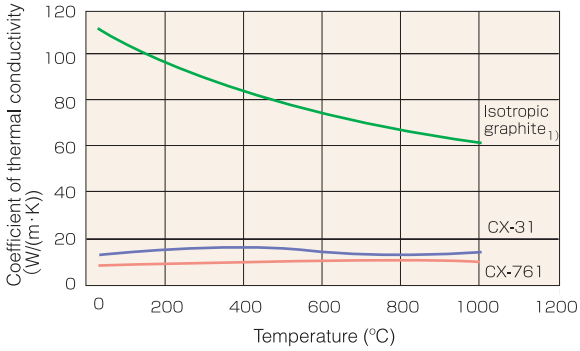
Linear thermal expansion coefficient



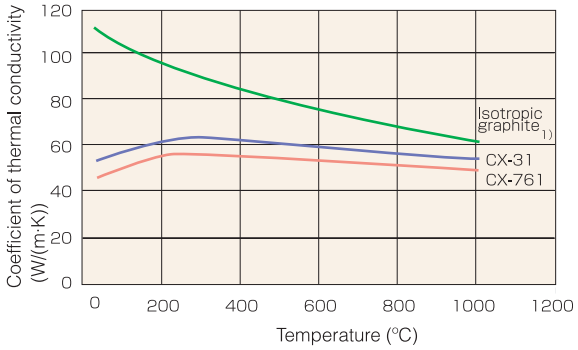
Specific heat



Thermal conductivity (⊥)



Thermal conductivity (//)



1) Our product: Large-sized isotropic graphite material, IG-56
2) Our product: High strength isotropic graphite material, ISO-68

Examples of Designing C/C Composite Products

We select suitable materials and design products according to customer's use conditions and requirements.

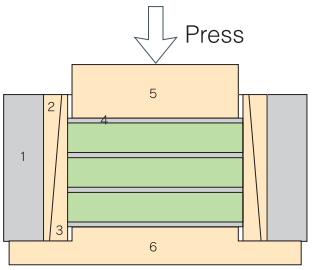
Hot press mold

Features

1. The device can be made smaller, and the cost of installing the facility reduced.
2. Large-sized sintered bodies can be made, which improves productivity.
3. Heat capacity is less, which can reduce energy costs.

Designing

<Design example> Molding pressure: 30MPa; Job diameter: 200mm; Height: 250mm



	Parts	Material
1	C/C die	C/C-FW
2	Outer sleeve with slit	OP-4800N
3	Two-piece inner sleeve	IG-70
4	C/C spacer	C/C-201
5	Upper punch	ISO-68
6	Receiver cradle	IG-70

C/C composite
Graphite
Sintered body

	Tensile strength	Die outer diameter	Die weight
C/C-FW die	245MPa	φ 340	23kg
Carbon die	31MPa	φ 520	83kg

The tensile strength of the C/C composite is higher than of ordinary carbon, which permits a small die outer diameter to be used, This enables the designing of compact equipment.
Manufacturer: Ohwada Carbon Industrial Co., Ltd.

[Examples of products]

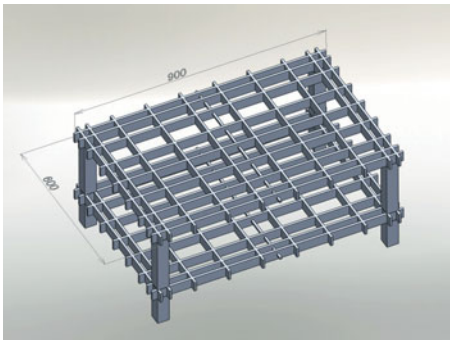
Heat treatment tray

Features

1. Light weight :
   The density is one fifth of iron and it is easy to handle.
   Weight comparison example: A 900×600×40 tray made of iron weighs about 85kg, whereas one made of C/C composite would weigh about one tenth as much, i.e., 8.5kg,
   (In this calculation, the thickness of the iron tray was kept at twice that of the C/C tray, taking the high temperature strength into account.)
2. High mechanical strength :
   About 10 times that of iron at 1000˚C
3. Ultra heat resistant :
   The strength is not reduced, and there is no deformation, even at 2000˚C in non-oxidizing atmospheres.
4. Energy saving and environment-friendly :
   The electricity needs for heating the tray is about a quarter of what is needed for the iron tray.
5. Maintenance-free :
   No repairs are needed as there is no deformation.

*The details may differ depending on the design and use conditions.

Designing



Load capacity (Kgf)	Size (mm)
≦500	900×600×40
≦750	900×600×45
≦1000	900×600×50

[Examples of products]