CARBON-GRAPHITE PRODUCTS

C/C composite

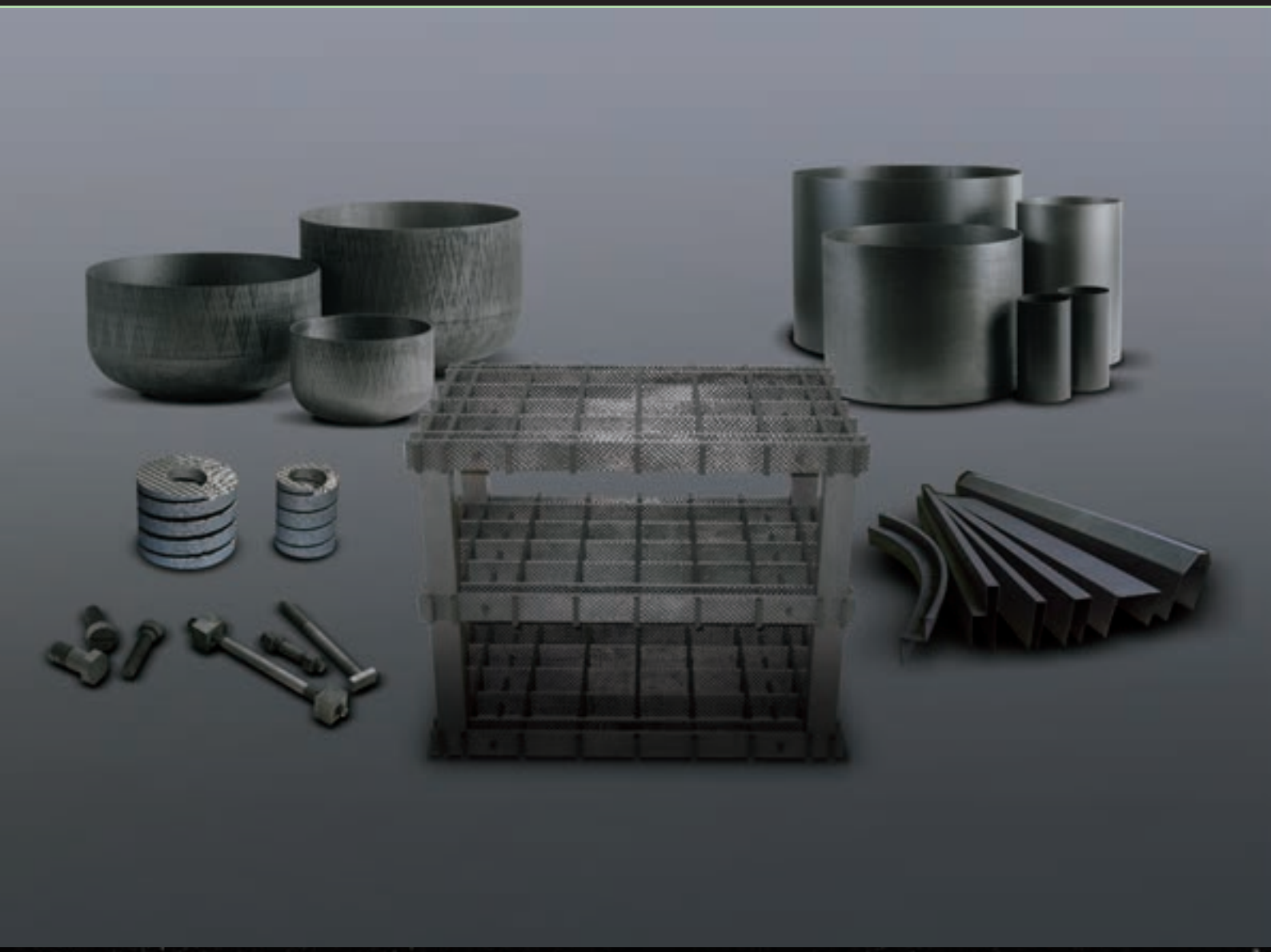
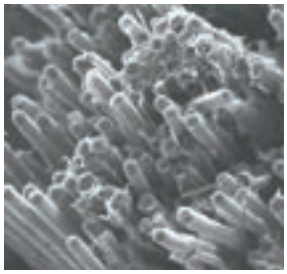


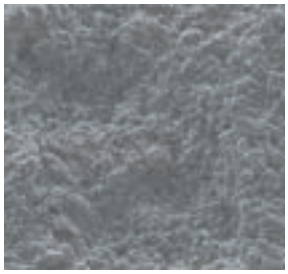
Image: provided by JAXA
Illustrated by Akihiro Ikeshita

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.



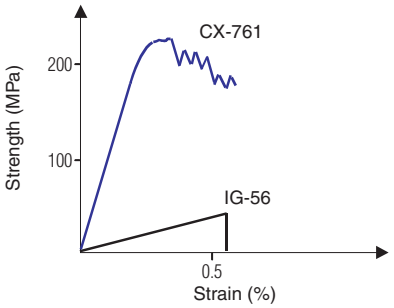
C/C composite (×1000)



Artificial graphite (×200)

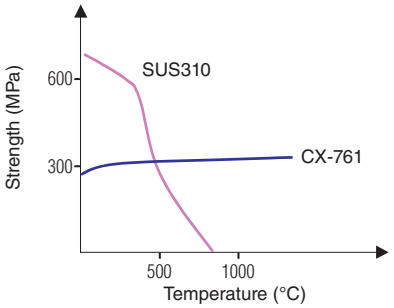
■ High mechanical strength, high elasticity, and high toughness

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.



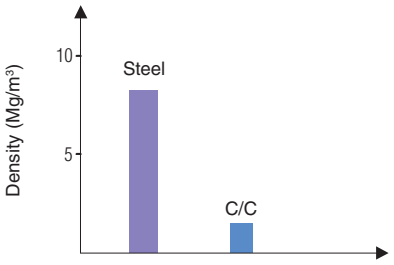
■ Ultra heat resistance

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.



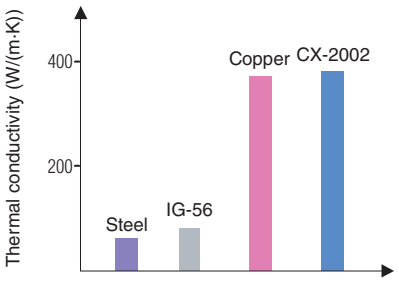
■ Light-weight and easy to handle

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

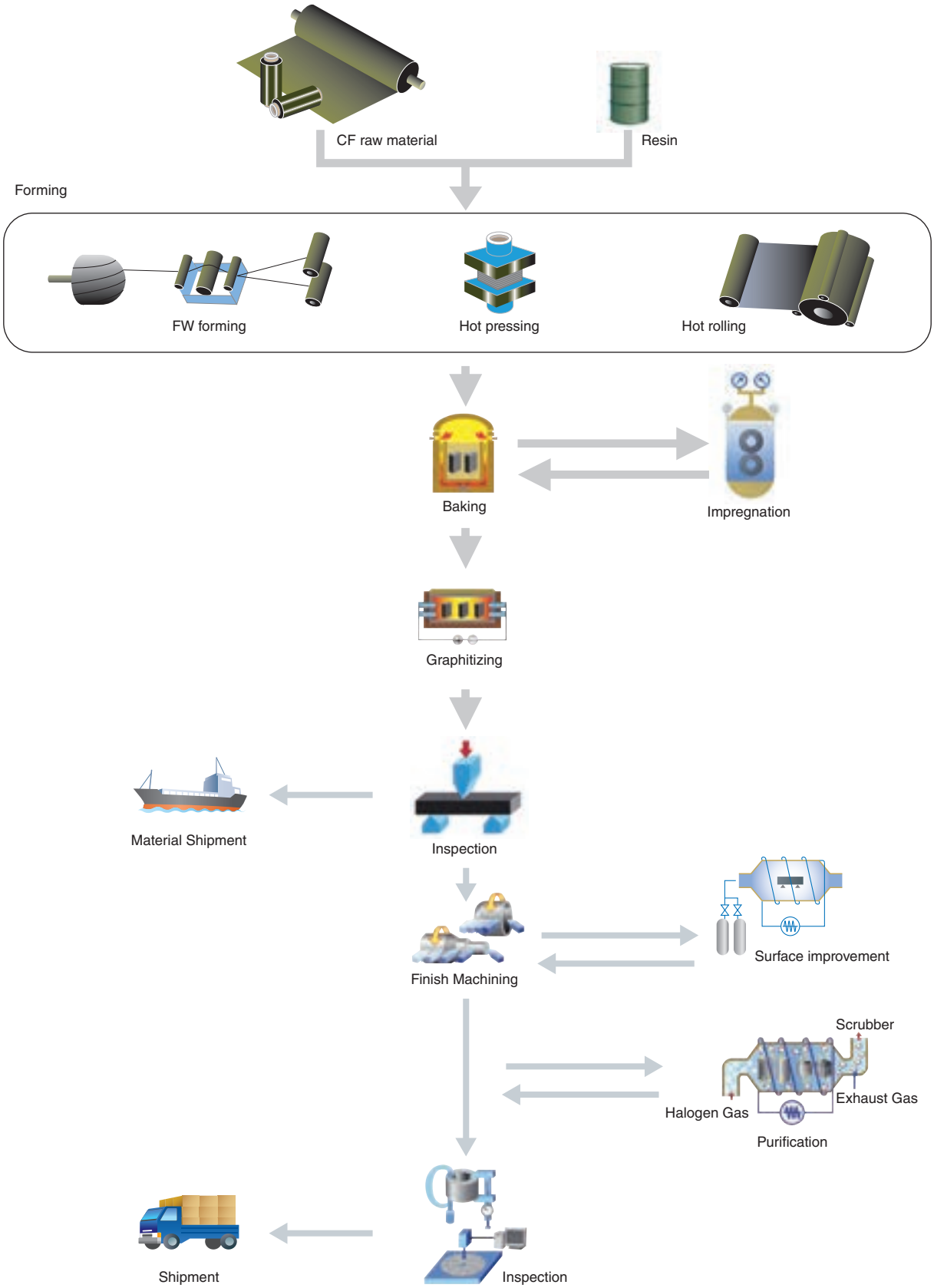


■ High thermal conductivity

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

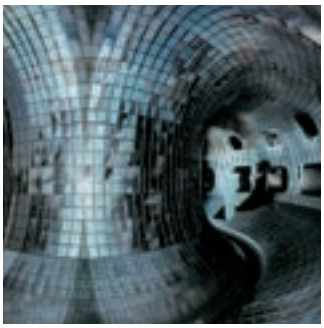
● For production of silicon for solar cells

Rectangular crucibles

Carrier tray for PECVD

● For nuclear energy plants

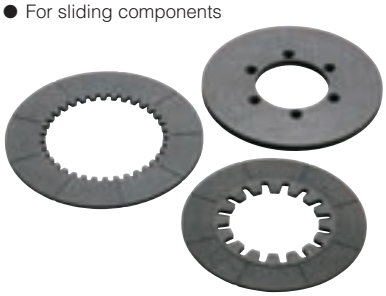
Armor tiles



* Photographs provided by the Japan Atomic Energy Agency

■ Automobiles, other means of transport, etc

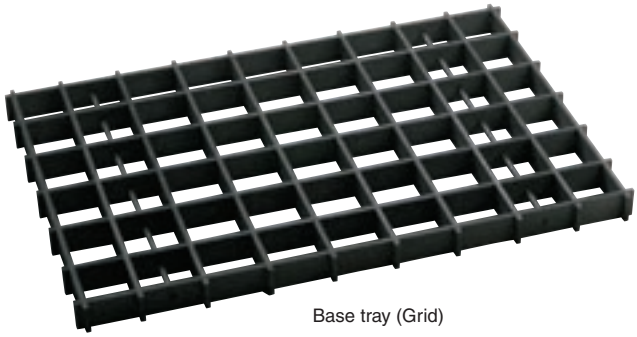
● For sliding components



Clutch

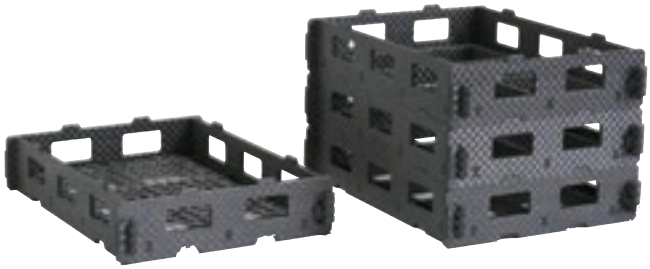
■ General industrial furnaces

● For heat treatment furnaces



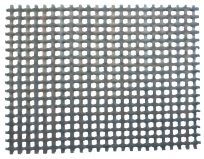
Base tray (Grid)

Heat treatment furnace

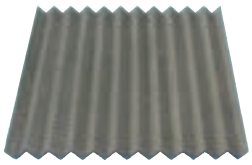


Basket

Multi-layer tray

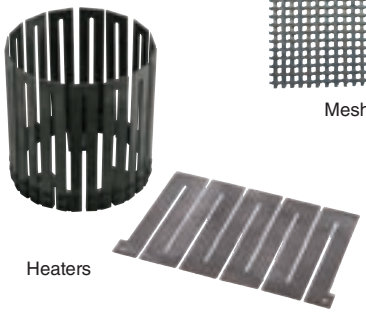


Mesh tray

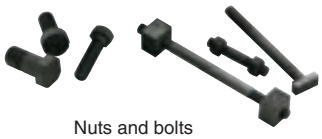


Wavy tray

Internal driving parts of furnaces



Heaters



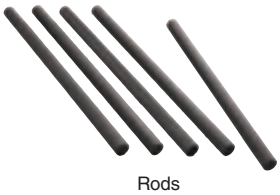
Nuts and bolts

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 strenght (MPa)	Coefficient of Thermal Expansion RT to 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
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]	150	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.

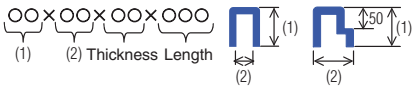
■ Available sizes

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
CX-45, CX-47	Inner diameter ø300-1400, 1400L
CX-743, CX-763	U-profile 80*20-145*1.2*1000

Grade	Dimensions (mm)
CX-743, CX-763	h-profile 107*44*1.5*1000
CX-510V	Max.inner diameter ø1168 (46" crucibles available)
C/C-FW	Max. ø950*800h, 20-150t
CX-55	Inner diameter ø10-1400, 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 improvements

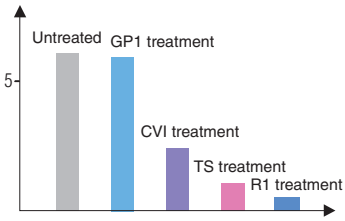
Advantageous properties are imparted by using Toyo Tanso's proprietary surface improvement technologies.

■ Details of surface improvements and their effects

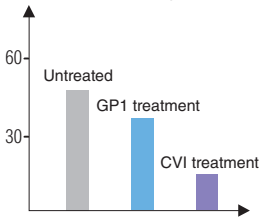
Glassy carbon coated GLASTIX KOTE™ (GP1 treatment)	Impregnation/coating with glassy carbon; it prevents dust formation.
Pyrolytic graphite impregnation (CVI treatment)	Impregnation/coating with pyrolytic carbon; it improves resistance against SiO gas.
Inorganic compound-impregnation (R1 treatment)	Impregnation with inorganic matter; it improves oxidation resistance.
SiC/C composites (TS treatment)	A treatment to convert the surface into SiC; it improves oxidation resistance and prevents dust formation.

*Abbreviation for Chemical Vapor Infiltration

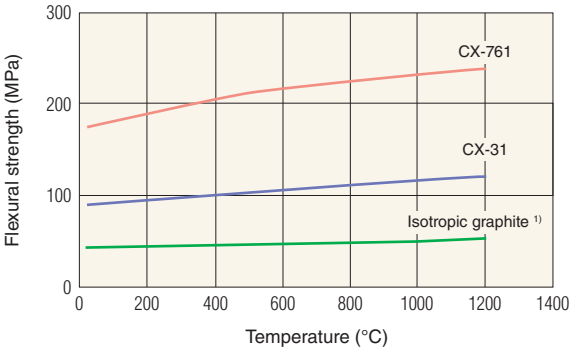
Oxidation loss (%)



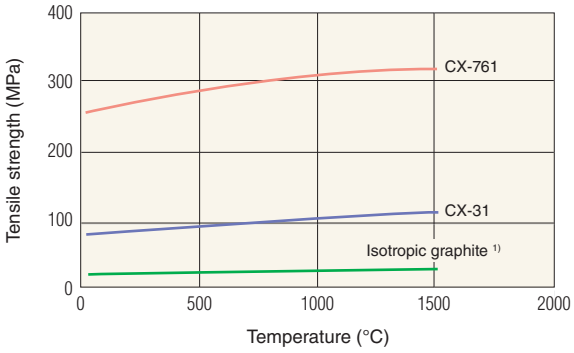
Reactivity with SiO gas (%)



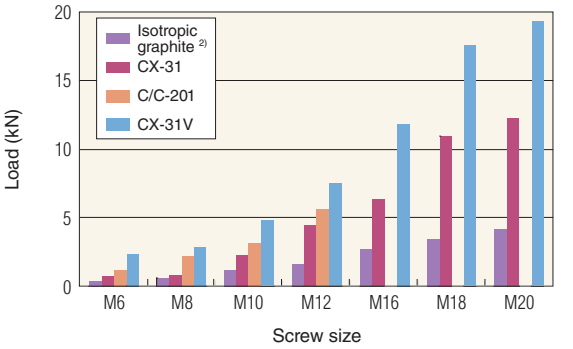
■ Flexural strength



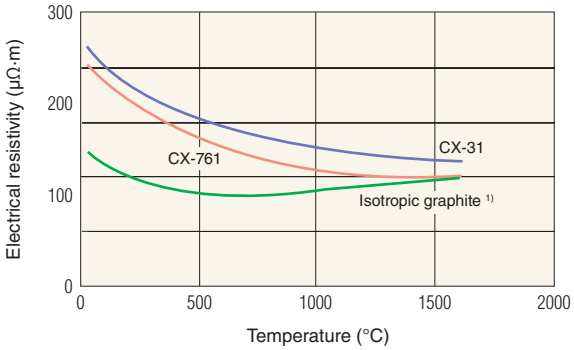
■ Tensile strength



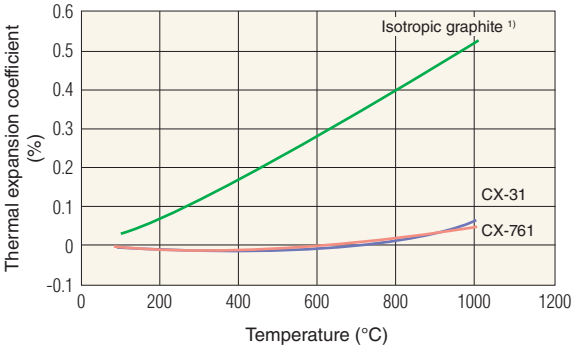
■ Strength of screw thread



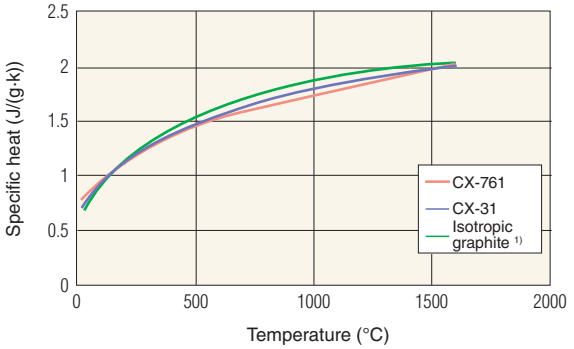
■ Electrical resistivity



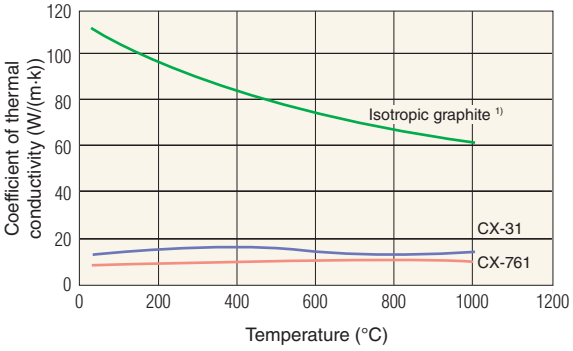
■ Linear thermal expansion coefficient



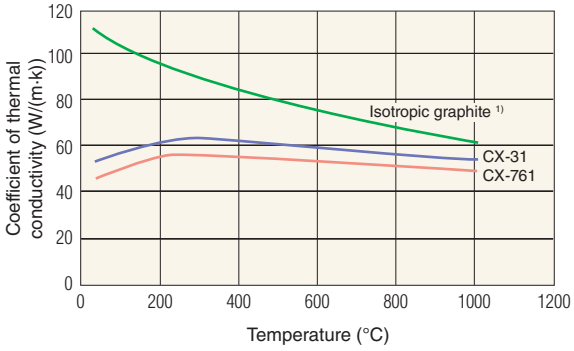
■ Specific heat



■ Thermal conductivity (⊥)



■ Thermal conductivity (//)



1) Our product: Large-sized isotropic graphite material, IG-56
2) Our product: High strength isotropic graphite material, ISO68

Examples of Designing C/C Composite Products

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

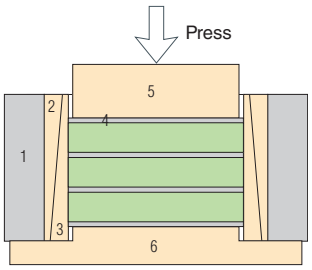
■ Hot press mold

■ 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: 30 MPa; Job diameter: 200 mm; Height: 250 mm



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

C/C compsite
Graphite
Sintered body

	Tensile strength	Die outer diameter	Die weight
C/C-FW die	245 MPa	ø340	23 kg
Carbon die	31 MPa	ø520	83 kg

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]

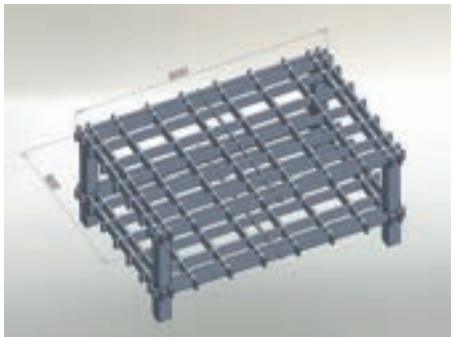
■ Heat treatment tray

■ Features

1. Light weight:
   The density is one fifth of steel and it is easy to handle.
   Weight comparison example: A 900 x 600 x 40 tray made of steel weighs about 85 kg, whereas one made of C/C composite would weigh about one tenth as much, i.e., 8.5 kg.
   (In this calculation, the thickness of the steel 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 steel 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 steel 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 x 600 x 40
≤750	900 x 600 x 45
≤1000	900 x 600 x 50

[Examples of products]