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.

- **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

Forming
- FW forming
- Hot pressing
- Hot rolling

Processing
- Baking
- Impregnation
- Graphitizing

Post-Processing
- Inspection
- Finish Machining
- Material Shipment
- Surface treatment
- Scrubber
- Halogen Gas
- Exhaust Gas
- Purification
- Shipment
- Inspection

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Application

- **Electronics**
  - For production of single crystal silicon

- **Environment and Energy**
  - For production of silicon for solar cells
  - For nuclear energy plants

- **Automobiles, other means of transport, etc**
  - For sliding components

※Photographs provided by the Japan Atomic Energy Agency

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**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

- Rods

- Die
### Property Data

#### Typical properties

<table>
<thead>
<tr>
<th>Shape</th>
<th>Material</th>
<th>Bulk Dens. (g/ml)</th>
<th>Electrical Resistivity (×10^12 Ω·cm)</th>
<th>Thermal Expansion (β)</th>
<th>Pencil hardness (HB)</th>
<th>Tensile strength (MPa)</th>
<th>Tensile elongation (%)</th>
<th>Coefficient of Thermal Expansion (α)</th>
<th>Thermal Conductivity (W/m·K)</th>
<th>C/C type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat plate</td>
<td>CX-741</td>
<td>1.51</td>
<td>23</td>
<td>140</td>
<td>45</td>
<td>185</td>
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<tr>
<td></td>
<td>CX-761</td>
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<td>55</td>
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<td></td>
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<td>130</td>
<td>42</td>
<td>170</td>
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<td>80</td>
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<td>147</td>
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<td>127</td>
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<td>216</td>
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<td>Profiles with high strength</td>
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<td>CX-47</td>
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<td>Crucible</td>
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<tr>
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<td>C/C-FW1</td>
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<td>-</td>
<td>245</td>
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<td>30</td>
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<td>Tiles</td>
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*The figures above are typical values, and are not guaranteed.

1) Manufactured by Ohawa Carbon Industrial Co., Ltd.
2) The direction of rotation of the left is designated as the X-axis and the directions within the plane as X- and Y-axes.

#### Available sizes

**Grade**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Dimensions (mm)</th>
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</thead>
<tbody>
<tr>
<td>CX-741</td>
<td>1000×1500×8–30</td>
</tr>
<tr>
<td>CX-742</td>
<td>1000×1500×8–30</td>
</tr>
<tr>
<td>CX-51</td>
<td>Max.850×1400 3.2–80</td>
</tr>
<tr>
<td>C/C-201</td>
<td>1020×700×12 700×720×12</td>
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<tr>
<td>C/C-501</td>
<td>Max.300×300×20</td>
</tr>
<tr>
<td>CX-45-CX-47</td>
<td>Inner diameter 300–1400, 1400L</td>
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</table>

**Grade**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Dimensions (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CX-743</td>
<td>U-oriented 800×20×145×12×1000</td>
</tr>
<tr>
<td>CX-742</td>
<td>U-oriented 107×54×8×1000</td>
</tr>
<tr>
<td>CX-510V</td>
<td>Max. inner diameter 188×48 crucibles available</td>
</tr>
<tr>
<td>C/C-FW1</td>
<td>Max.950×800×20–1500</td>
</tr>
<tr>
<td>C/C-55</td>
<td>Inner diameter 10–1400, 1400L</td>
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<tr>
<td>CX-2002U</td>
<td>40×150×80 (X×Y×Z)</td>
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</table>

**Element**

<table>
<thead>
<tr>
<th>Element</th>
<th>Na</th>
<th>Mg</th>
<th>Al</th>
<th>K</th>
<th>Ca</th>
<th>Ti</th>
<th>V</th>
<th>Cr</th>
<th>Fe</th>
<th>Ni</th>
<th>Cu</th>
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<tr>
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<td>&lt;0.02</td>
<td>&lt;0.08</td>
<td>&lt;0.1</td>
<td>&lt;0.04</td>
<td>&lt;0.08</td>
<td>&lt;0.07</td>
<td>&lt;0.07</td>
<td>&lt;0.04</td>
<td>&lt;0.1</td>
<td>&lt;0.08</td>
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</tbody>
</table>

**Method of measurement**

AAS, ICP-AES, ICP-AES, AAS, ICP-AES, AAS, ICP-AES, 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

#### An example of impurity analysis of CX-510V

(A high purity treated product)

Unit mass ppm

#### Different surface treatments

Advantageous properties are imparted by using Toyo Tanso’s proprietary surface treatment technologies,

**Details of surface treatments and their effects**

- **CVD treatment (Glasstix Kote®)**
  - Improves oxidation resistance, and prevents dust formation.

- **CVD treatment**
  - Improves oxidation resistance, and prevents dust formation.

- **Thermal protection**
  - Improves resistance against SiO gas.

- **CVD treatment**
  - Improves oxidation resistance, and prevents dust formation.

- **G CVD treatment**
  - Improves oxidation resistance, and prevents dust formation.

- **Oxidation loss (%)**
  - untreated: 9, CVD treatment: 5

- **Reactivity with SiO gas (%)**
  - untreated: 30, CVD treatment: 20

*Abbreviation for Chemical Vapor Infiltration
### Flexural strength

- CX-781
- CX-31
- Isotropic graphite

### Tensile strength

- CX-781
- CX-31
- Isotropic graphite

### Strength of screw thread

- Load (kN)
- Screw size (M4, M6, M8, M10, M12, M16, M18, M20)

### Electrical resistivity

- CX-781
- CX-31
- Isotropic graphite

### Linear thermal expansion coefficient

- Thermal expansion coefficient (%)

### Specific heat

- Specific heat (J/kg K)

### Thermal conductivity (⊥)

- Coefficient of thermal conductivity (W/m K)

### Thermal conductivity (∥)

- Coefficient of thermal conductivity (W/m K)

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

<table>
<thead>
<tr>
<th>Parts</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>C/C die</td>
<td>C/C-FW</td>
</tr>
<tr>
<td>Outer sleeve with die</td>
<td>C/C-FW01</td>
</tr>
<tr>
<td>Two-piece inner sleeve</td>
<td>D=70</td>
</tr>
<tr>
<td>C/C spacer</td>
<td>C/C-201</td>
</tr>
<tr>
<td>Upper punch</td>
<td>860×86</td>
</tr>
<tr>
<td>Receiver groove</td>
<td>D=70</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Tensile strength</th>
<th>Die outer diameter</th>
<th>Die weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>C/C-FW die</td>
<td>245MPa</td>
<td>φ 340</td>
</tr>
<tr>
<td>Carbon die</td>
<td>31MPa</td>
<td>φ 520</td>
</tr>
</tbody>
</table>

The tensile strength of the C/C composite is higher than 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.

- **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.

- **Designing**