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- Numerical values given in this catalog are for reference only and are not guaranteed as absolute.
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- As a result of continuing improvements, products and/or specifications contained in this catalog may be changed or their manufacture discontinued without notice.

Products Profile
Fine Ceramics & Machinable Ceramics
The creative power of ceramics: the future of precision products.

Fine technologies lead the way into the future. Ceramics perform a key material as ultra-pure, super wear-resistant, high-machinability, ultra-precise, and superior-characteristics to manufacture the most-advanced products.

No matter what the product is, quality is fundamentally based on the materials. Now, technological innovations and advancements take place in every field. The demand for higher-performance, easier-to-use, and cheaper products is increasing. Consequently, there are high expectations for wider applications of new ceramics material, as well as a development of products with a special and advanced properties of ceramics. Ferrotec Ceramics is moving steadily forward to meet the continuously advancing needs of society. Customer satisfaction is our highest objective, operating under the motto “Manufacturing good products quickly and economically.” In the future, we will continuously improve our independent applied technologies and ultra-precision machining technologies, fully demonstrate the capabilities we possess, and further intensify our R&D to respond quickly to the wide-ranging needs of our customers.

In the 21st century, the use of new ceramic materials with their superior characteristics, and in particular the use of the two key materials from our company – fine ceramics with a diverse range of advanced functions, and machinable ceramics that can be easily machined to precise and fine specifications – will expand into all parts of our society and daily lives, including the rapidly advancing IT, electronics, medical devices, and automotive products. Working actively with these two ceramic materials, Ferrotec Ceramics will utilize our original fine technologies that combine advanced materials and production techniques with a state-of-the-art quality control in order to support the creation of a prosperous future society and the realization of dreams.
Ferrotec Ceramics offers a wide range of materials for high strength, high purity, and other superior qualities to create commercially successful products in industries, from basic goods to advanced technology.

Utilizing advanced materials and production techniques, our fine ceramics materials are manufactured through integrated production based on quality control that achieves the highest industry standards. These materials offer advanced functions and superior characteristics that meet the absolute-highest customer requirements for product development and production across a variety of fields and applications. They are especially optimal for parts and components used in the manufacture of liquid crystals displays semiconductor manufacturing (wafer fabrication, processing, assembly, and inspection), where high purity, high rigidity, and high precision are mandatory. In general industrial machineries, our materials provide superior resistance to wear, heat, and chemicals.

**Features**
- High purity
- High rigidity
- High precision
- Plasma resistance
- Heat resistance
- Wear resistance
- Insulation

**For Manufacturing Semiconductor & Liquid Crystal Displays**
- Chamber Parts
- Low Thermal Expansion Ceramics Parts
- Low Dielectric Loss Alumina Chamber Parts
- High-temperature Chamber Trays
- Vacuum Chucks

**For General Industrial Machines**
- Transfer Parts

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**Alumina ceramics, Al₂O₃**
Alumina, mainly comprised of aluminum oxide, has excellent insulation performance and wear resistance, with competitive cost. Alumina is utilized for a range of purposes. Also, ultra-pure alumina, reaching a purity level of at least 99%, is particularly suited for use in plasma-resistant parts in semiconductor manufacturing equipment.

**Main applications**
- Parts for water transfer systems and chambers in semiconductor manufacturing equipment, parts for liquid crystal display manufacturing equipment, vacuum equipment, and general industrial machinery.

**Silicon nitride ceramics, Si₃N₄**
Often used as a substitute material for alumina, silicon nitride has superior high-temperature strength and thermal shock resistance. It is widely used as a structural material that can withstand thermal loads.

**Main applications**
- Semiconductor manufacturing equipment parts, burner nozzles, and welding jigs

**Silicon carbide ceramics, SiC**
With regard to heat resistance, wear resistance, and corrosion resistance, silicon carbide exhibits characteristics not found in other materials. Since it maintains strength even at high temperatures, it has particularly attracted attention as a high-temperature structural material.

**Main applications**
- Semiconductor manufacturing equipment parts and burner nozzles, Susceptor

**Zirconia ceramics, ZrO₂**
Zirconia ceramics, the main component is partially stabilized zirconium dioxide, is especially valued for outstanding mechanical strength and fracture toughness.

**Main applications**
- Semiconductor transfer guides rails, bearing parts, and industrial cutters

**Low thermal-expansion ceramics**
Low thermal-expansion ceramics are materials that perform zero expansion at room temperature. They also have high strength and a high Young’s modulus.

**Main applications**
- Semiconductor manufacturing equipment parts and precision machine parts.
World’s strongest ceramic with variable thermal conductivity

“Photoveel” Machinable Ceramics

Superior machinability, quick delivery of high-precision, and high-quality products, provides customers an efficient production.

Machinable ceramics provide easy machinability by conventional machining machine. Various precision machining are possible with synthetic diamond-based cutting tools and also with general carbide tools. Inspection jigs and parts for the manufacture of liquid crystals display and semiconductors required in a large-variety, and a small-quantity production. In the face of growing expectations for shorter lead time in all production processes, from design to trial production, the machinable ceramics are widely used from their precision-machining and quick-delivery.

Features
- Electrical insulation
- Heat resistance
- Precision machinability
- Heat insulation
- Short lead time

“Photoveel”

This is a dense, high-grade compound mica-ceramic created through a fusion process that uses glass as a matrix and uniformly separates out mineralized fluorite microparticles and zirconia microcrystals.

Main applications
- Parts for semiconductor manufacturing equipment, liquid crystal displays manufacturing equipment, heat-resistant and heat-insulating elements, vacuum equipment, electrical insulation, sensors, and medical devices

“Photoveel I”

This mica-ceramic has fine-machining characteristic of “Photoveel”, and adds low thermal expansion and high reflectivity.

Main applications
- Analyzer insulating parts, circuit boards, positioning jigs, soldering jigs, and light-condensing parts

“Photoveel II”

The special characters of this ceramic material are its low thermal expansion and excellent mechanical strength. It is particularly suitable for small parts that require ultra-precision machining.

Main applications
- Inspection equipment parts and micromachine insulating parts

“Photoveel II-5”

The strongest point of this ceramic material is the thermal expansion similar to silicon. It is also suitable for parts that require ultra-precision machining like Photoveel II.

Main applications
- Inspection equipment parts and micromachine insulating parts

“Photoveel II-5 Black”

This material has all the characteristics of Photoveel II-5, in black color for use in optical components.

Main applications
- Optical components, medical camera components

“Photoveel II-4/70”

This ceramic combines high thermal conductivity, high strength, and low thermal expansion. It is suitable for heat radiating parts and circuit boards. “Photoveel II-4/70” also has the highest bending strength in our machinable ceramic. It is widely used in structural parts that require high strength.

Main applications
- Heat sinks, insulating parts around heaters, welding nozzles, etc.

“Photoveel a3.4”

This ceramic is characterized by its thermal expansion coefficient of 3.4. In the same way as Photoveel II and II-5, it is suitable for parts that require ultra-precision machining.

Main applications
- Jigs for package board inspection

“Photoveel” Microstructure
Ferrotec Ceramics implements vertically with a strict quality control, supported by and the latest equipment.

Integrated production process, advanced production techniques

Fine Ceramics Manufacturing Process

- Spray Dryer
- 400t Press
- Air Furnace
- Atmosphere Furnace
- Atmosphere Furnace
- Gate Type Surface Grinding Machine
- Large Lapping Machine

Flowchart:

1. Raw Material → Pressing
2. Machining of Greenbody → Sintering
3. Machining Grinding Lapping
4. Shipping
5. Cleaning
6. Inspection・Analysis
7. Coordinate Measuring Machine
8. Ultrasonic Flaw Detector
9. Scanning Electron Microscope (SEM)
10. Cleaning in Clean Room
11. Cleaning Room

Images:

- Machining Machine
- Sintering Furnace
- Grinding Machine
- Inspection Equipment
- Clean Room
- Laboratory Equipment
Fine ceramics

Dimensional tolerance

- As Andrews: ±1.5% (minimum: ±0.3 mm)
- Grinding: According to JIS B 0405 medium grade
- Precision machining: Flawless ±1.5 μm (conformance specification)

Surface roughness

- General machining: JIS B 0301 5.5 or equivalent
- Precision machining: ±0.2 μm or equivalent

Adhesion

- Ceramics: Real adhesive, glass adhesive
- Metal: Metallization adhesive

Surface finishing

- Mirror finish, mirror polish, etc.

Contact us about special cleaning and packaging, or any other special requirements you may have.

"Photoveel"

Dimensional tolerance

- General machining: According to JIS B 0405 medium grade
- Precision machining: ±5 μm or less (tensile, parallelism, etc.)

Microscopic hole drilling

- Minimum 0.5 mm thickness (0.1 mm), diameter and pitch tolerance (±2 mm)

Thread cutting

- Minimum M2, HELDERT minimum M2.5

Reference

JIS B 0405 (extracted)

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<tr>
<th>Dimensional Classification</th>
<th>Medium Grade</th>
<th>Coarse Grade</th>
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<tr>
<td>0.5 to 3</td>
<td>±0.1</td>
<td>±0.2</td>
</tr>
<tr>
<td>Over 3 and up to 8</td>
<td>±0.1</td>
<td>±0.3</td>
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<tr>
<td>Over 8 and up to 30</td>
<td>±0.2</td>
<td>±0.5</td>
</tr>
<tr>
<td>Over 30 and up to 120</td>
<td>±0.3</td>
<td>±0.8</td>
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<tr>
<td>Over 120 and up to 400</td>
<td>±0.5</td>
<td>±1.2</td>
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<tr>
<td>Over 400 and up to 1000</td>
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<td>±2.0</td>
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JIS B 0601 (extracted) (μm)

<table>
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<tr>
<th>Finish Symbol</th>
<th>Surface Roughness Classification Value</th>
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<td>Ra, Rq</td>
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<tr>
<td>0.2μm</td>
<td>(0.2μm)</td>
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<tr>
<td>0.3μm</td>
<td>(0.3μm)</td>
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<tr>
<td>0.5μm</td>
<td>(0.5μm)</td>
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<tr>
<td>0.8μm</td>
<td>(0.8μm)</td>
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<tr>
<td>1.6μm</td>
<td>(1.6μm)</td>
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<tr>
<td>2.5μm</td>
<td>(2.5μm)</td>
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Use Ra (average roughness at centerline) when designing ceramics.
## Fine Ceramics

<table>
<thead>
<tr>
<th>Material code</th>
<th>Alumina $\text{Al}_2\text{O}_3$</th>
<th>Silicon nitride $\text{Si}_3\text{N}_4$</th>
<th>Silicon carbide $\text{SiC}$</th>
<th>Aluminum nitride $\text{AlN}$</th>
<th>Zirconia $\text{ZrO}_2$</th>
<th>Low thermal-expansion ceramics</th>
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<tbody>
<tr>
<td><strong>Main component purity</strong></td>
<td>wt%</td>
<td>99.9, 99, 99.7, 99.7, 99.5, 96</td>
<td>90, 97</td>
<td>99, 94</td>
<td>94</td>
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<td><strong>Color</strong></td>
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<td>White</td>
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<td>Whitish yellow</td>
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<td><strong>Density</strong></td>
<td>g/$\text{cm}^3$</td>
<td>3.95, 3.92, 3.93, 3.93, 3.93, 3.94</td>
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<td><strong>Water Absorption</strong></td>
<td>%</td>
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<td>0, 0</td>
<td>0, 0</td>
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<td><strong>Bending Strength</strong></td>
<td>MPa</td>
<td>390, 400, 390, 390, 370, 350</td>
<td>750, 490</td>
<td>295, 345</td>
<td>880, 200</td>
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<td><strong>Young's Modulus</strong></td>
<td>GPa</td>
<td>380, 385, 375, 385, 370, 320</td>
<td>285, 400</td>
<td>320, 320</td>
<td>245, 140</td>
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<td><strong>Vickers Hardness</strong></td>
<td>GPa</td>
<td>18, 16</td>
<td>16, 17</td>
<td>16, 14</td>
<td>16, 11</td>
<td>16, 11</td>
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<td>°C</td>
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<td>1000, 1000</td>
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<td>1/(°C×10⁻⁶)</td>
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<td>2.7, 3.8</td>
<td>4.4, 4.4</td>
<td>8.9, &lt;0.5</td>
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<tr>
<td><strong>Coefficient of Thermal Conductivity</strong></td>
<td>W/m·K</td>
<td>33, 34, 33, 33, 32, 24</td>
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<td>80, 150</td>
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<td><strong>Thermal Shock Resistance</strong></td>
<td>$\Delta T$(°C)</td>
<td>200, 200, 200, 200, 250, 200</td>
<td>700, 300</td>
<td>400, 280</td>
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<td><strong>Volume Resistivity</strong></td>
<td>$\Omega$·cm</td>
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<td>$10^{14}$</td>
<td>$10^{14}$</td>
<td>$10^{13}$</td>
<td>$10^{14}$</td>
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<td><strong>Dielectric Loss(tanδ)</strong></td>
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<td>$10^4$</td>
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<td><strong>Q Factor (1/tanδ)</strong></td>
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<td><strong>Dielectric Breakdown Voltage</strong></td>
<td>kV/mm</td>
<td>18</td>
<td>17</td>
<td>18</td>
<td>18</td>
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</table>

### Main Characteristics

- Chemical-resistant Microwave-transmissive
- Heat-resistant Chemical-resistant Microwave-transmissive
- Low dielectric loss
- High strength Wear-resistant Thermal shock-resistant
- High thermal conductivity Heat resistant High strength
- High thermal conductivity Microwave-transmissive
- High strength Wear-resistant Microwave induction plates
- Machine parts Sliding parts Machine parts

### Application

- Micro- and RF partsInsulating parts
- Machine partsSliding parts Machine parts
- Machine partsSliding parts Machine parts
- Machine partsSliding parts Machine parts

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Numerical values for properties presented in this table are for reference only.
<table>
<thead>
<tr>
<th>Material</th>
<th>Photoveel</th>
<th>Photoveel L</th>
<th>Photoveel II</th>
<th>Photoveel II-S</th>
<th>Photoveel II-S Black</th>
<th>Photoveel α3.4</th>
<th>Photoveel II-k70</th>
<th>Aluminum nitride</th>
<th>Boron nitride</th>
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<tr>
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<td>Gray</td>
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<td>Coefficient of Thermal Expansion</td>
<td>1/°C×10⁻⁹ (RT~400°C)</td>
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<td>&lt;RT~150°C&gt; 4.7</td>
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<td>200</td>
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<td>10⁻¹⁴</td>
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<td>&lt;1THz&gt; 0.04</td>
<td>&lt;1THz&gt; 0.01</td>
<td>&lt;1THz&gt; 0.04</td>
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<tr>
<td>Dielectric Breakdown Voltage</td>
<td>kV/mm</td>
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<td>18</td>
<td>35</td>
<td>30</td>
<td>30</td>
<td>20</td>
<td>65</td>
<td>40</td>
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</table>

**Main Characteristics**
- Precision machining
- Electrical insulation
- High thermal expansion
- High reflectance
- Heat insulation
- Quick delivery
- Insulating parts
- Heat-insulating parts
- Prototype/emergency parts
- Insulating parts
- Positioning jigs
- Light-condensing parts
- Inspection: Insulating parts
- Inspection: Micromachine parts
- Optical parts
- Package substrate: inspection jigs
- Heater peripheral: insulating parts
- Welding nozzle: parts
- Insulating parts
- Molten metal corrosion resistance material
- Insulating parts
- Precision machining jigs

**Application**
- Osaka Sales Office
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