Sialon

Ceramics with Low Thermal Expansion & High Stiffness

Sialon (Si$_{1-x}$Al$_x$O$_{2x/3}$N$_{2x}$, Z=0~4) is a Si$_3$N$_4$ based ceramic featuring superior strength at high temperatures. We additionally researched the benefits inherent to Sialon at room temperature and discovered its superior shape stability performance. This can be seen in sialon’s low thermal expansion, high stiffness and low weight. Since then we have continued to develop applications that maximize the potential of sialon as including application in structural components of stages for LSI lithography. A recent development has been the adoption of Sialon in ultra precision machine tools and measuring instruments.

**Advantages**

- **Low Thermal Expansion**
  - Equal to inner alloy (as low as 1/10 of cast iron)
- **Low Weight**
  - 40% of cast iron
- **High Stiffness**
  - 2 times that of cast iron
- **Easy to Achieve High Precision and Accuracy by General Working**
  - Flatness, parallelism, roundness ≤ 0.5 μm
- **Nonmagnetic & Rust Free**
- **High Wear Resistance**
  - Free from burrs and scratches

**Comparison of Features**

<table>
<thead>
<tr>
<th>Material</th>
<th>Thermal Expansion Coefficient ($10^{-6}$/K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sialon</td>
<td><em>LTG: Low Thermal Expansion Glass</em></td>
</tr>
</tbody>
</table>

**Characteristics**

<table>
<thead>
<tr>
<th>Materials</th>
<th>S110</th>
<th>S110H</th>
<th>S120</th>
<th>S150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Light gray</td>
<td>Light gray</td>
<td>Light gray</td>
<td>Gray</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>g/cm$^3$</td>
<td>3.24</td>
<td>3.25</td>
<td>3.22</td>
</tr>
<tr>
<td>Young’s Modulus</td>
<td>GPa</td>
<td>290</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Poisson’s Ratio</td>
<td></td>
<td>0.27</td>
<td>0.27</td>
<td>0.27</td>
</tr>
<tr>
<td>Flexural Strength @ RT</td>
<td>MPa</td>
<td>880</td>
<td>1180</td>
<td>690</td>
</tr>
<tr>
<td>Fracture Toughness (SEP)</td>
<td>MPa$^{1/2}$</td>
<td>6.5</td>
<td>6.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Hardness HV (98N)</td>
<td>GPa</td>
<td>14.5</td>
<td>14.7</td>
<td>12.7</td>
</tr>
<tr>
<td>Coefficient of Linear Thermal Expansion (α)</td>
<td>×10$^{-6}$/K</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>Thermal Conductivity @ RT</td>
<td>W/m·K</td>
<td>21</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Specific Heat</td>
<td>J/g·K</td>
<td>0.68</td>
<td>---</td>
<td>0.63</td>
</tr>
<tr>
<td>Thermal Shock Resistance</td>
<td>J/T°C</td>
<td>750</td>
<td>---</td>
<td>700</td>
</tr>
<tr>
<td>Electrical Resistivity @ RT</td>
<td>Ωcm</td>
<td>&gt;10$^{14}$</td>
<td>&gt;10$^{14}$</td>
<td>&gt;10$^{14}$</td>
</tr>
</tbody>
</table>

* The values given above are typical values obtained from reliable testing and should only be used for design guidance.
NEAR NET SHAPE SINTERING

Compacted green Sialon can be machined into a thin-ribbed structure in a near-net shape before sintering lowering manufacturing cost.

(3 mm rib structure after sintering)

APPLICATIONS

Sialon Slider & Stage

- Dramatically reduces thermal drift in precision machines.
- Capable of extended continuous operation.
- High dimensional stability enables high repeatability of action.
- High stiffness and light promotes enhanced gain of servo control.
- High toughness eliminates cracking and chipping, facilitating handling.

Fast tool servo (air slider)

BONDING METHOD

Sialon parts can be bonded to each other using our silver brazing technology.

The bonding layer is 50 µm or thinner with a bonding strength equivalent to 70% of the bulk portion.

(Cross section of a joined-box)

- Air hydrostatic bearing, slider, guide bar, slide base, rotary table.
- Oil hydrostatic bearing, slider, guide bar, slide base, rotary table.
- On machine measuring systems (small air slider) for ultra precision machine tools.
- Vacuum chucks, work mounts, tool holders.
- Work adjusting stages.

Integrated measuring system

X-Y axis: Filed-up / T-type slide
310 x 310 x 184 (mm)
(stroke 100 mm)

2-axis:
Drive a center of gravity
220 x 156 x 102 (mm)
(stroke 60 mm)