Note

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*Products: Hardware and its technical information (including software)
Nikon NICF Series Calcium Fluoride

**NICF Series ADVANTAGES**

- **High laser durability**
  - Nikon's strict process control and use of ultra-high-purity raw materials during the calcium fluoride growing process results in increased durability to long-term exposure to high-power excimer lasers.

- **High quality crystals**
  - Nikon is a leading supplier of large-sized, high-quality single crystal calcium fluoride. With our continuous process improvement cycle and optimized growing conditions, we can produce material with minimal lattice and structural defects, resulting in increased laser durability.

- **High refractive index homogeneity**
  - Nikon's proprietary annealing process yields unsurpassed refractive index homogeneity.

### Optical grades

<table>
<thead>
<tr>
<th>Sample thickness</th>
<th>Optical grades</th>
<th>Internal transmittance (%)</th>
<th>Laser durability</th>
<th>Birefringence</th>
</tr>
</thead>
<tbody>
<tr>
<td>157 nm</td>
<td>NICF-S</td>
<td>99.5</td>
<td>2 - 20 nm&lt;sub&gt;c&lt;/sub&gt;</td>
<td>0.20&lt;sub&gt;b&lt;/sub&gt;</td>
</tr>
<tr>
<td>193 nm</td>
<td>NICF-A</td>
<td>99.8</td>
<td>4 - 80 nm&lt;sub&gt;c&lt;/sub&gt;</td>
<td>0.08&lt;sub&gt;b&lt;/sub&gt;</td>
</tr>
<tr>
<td>248 nm</td>
<td>NICF-U</td>
<td>99.0</td>
<td>80 nm&lt;sub&gt;c&lt;/sub&gt;</td>
<td>0.05&lt;sub&gt;b&lt;/sub&gt;</td>
</tr>
<tr>
<td>365 nm</td>
<td>NICF-V</td>
<td>99.0</td>
<td>&lt; 20 nm&lt;sub&gt;c&lt;/sub&gt;</td>
<td>0.02&lt;sub&gt;b&lt;/sub&gt;</td>
</tr>
<tr>
<td>436 nm</td>
<td>NICF-S</td>
<td>99.8</td>
<td>200 nm&lt;sub&gt;c&lt;/sub&gt;</td>
<td>0.01&lt;sub&gt;b&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

**Transmittance range**

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>NICF-S</th>
<th>NICF-A</th>
<th>NICF-U</th>
<th>NICF-V</th>
</tr>
</thead>
<tbody>
<tr>
<td>157</td>
<td>95.6</td>
<td>95.6</td>
<td>94.72</td>
<td>95.6</td>
</tr>
</tbody>
</table>

### Optical Properties

- **Wavelength [µm]**
  - 2.3652 ± 0.005454
  - 2.4061 ± 0.005452

- **Partial Dispersion**
  - F - C: 0.04545
  - F - C: 0.04542

### Chemical/Electrical Properties

- **Cubic, Fluorite type**
- **Cleavage Plane:** (111)
- **Molecular Weight:** 78.08
- **Climatic Resistance:** 1
- **Acid Resistance by Surface Method:** AR(M) [Class] 4
- **Acid Resistance by Powder Method:** AR(P) [Class] 5
- **Phosphate Resistance:** 1
- **Solubility in Water:** 0.016
- **Electrolyte Constant:** (27°C) ± ε 6.81

### Thermal Properties

- **Coefficient of Thermal Expansion**
  - (-30 ~ +70°C) [10<sup>-6</sup>/°C]: 18.4
  - (-25 ~ +25°C) [10<sup>-6</sup>/°C]: 18.4
  - (+20 ~ +80°C) [10<sup>-6</sup>/°C]: 20.8

- **Thermal Conductivity** [W/m·°C]: 9.70
- **Melting Point:** 1360
- **Specific Heat Capacity:** [J/g·K]: 0.893
- **Thermal Diffusivity** [10<sup>-5</sup>/(m·°C)]: 35.60

### Mechanical Properties

- **Young's Modulus** [GPa]:
  - Dynamic: 146<sub>11</sub>
  - (101<sub>11</sub>)
  - (911<sub>11</sub>)
- **Poisson's Ratio:** 0.21
- **Knoop Hardness** [kgf/mm<sup>2</sup>]: 164
- **Abrasion Hardness** [GPa]: 50.1
- **Shear Modulus** [GPa]: 34.6
- **Compressive Modulus** [GPa]: 83.8
- **Mohs Hardness:** 4
- **Stress Optical Coefficient** [GPa·mm<sup>2</sup>/°C]: 1.77
- **Specific Gravity:** 3.18

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*Note: Each property is shown as a typical value.*
Nikon NICF Series Calcium Fluoride

### NICF Series ADVANTAGES

**High laser durability**
Nikon's strict process control and use of ultra-high-purity raw materials during the calcium fluoride growing process results in increased durability to long-term exposure to high-power excimer lasers.

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Nikon is a leading supplier of large-sized, high-quality single crystal calcium fluoride. With our continuous process improvement cycle and optimized growing conditions, we can produce material with minimal lattice and structural defects, resulting in increased laser durability.

**High refractive index homogeneity**
Nikon's proprietary annealing process yields unsurpassed refractive index homogeneity.

### Optical grades

Laser durability is classified into three groups, A, B and C, with NICF-V represents the highest grade of material available.

- **NICF-V**
  - 0.009 at 157 nm
  - 2 - 20 mm/cm
  - VUV region, ArF excimer laser (193 nm)
  - 436 nm

- **NICF-A**
  - 0.00.9 at 193 nm
  - B
  - ArF excimer laser (193 nm)
  - 436 nm

- **NICF-U**
  - 0.009 at 248 nm
  - C
  - KrF excimer laser (248 nm)
  - 436 nm

### NICF Transmittance range

- **F**
  - 157 nm
  - 193 nm
  - 248 nm
  - 365 nm
  - 436 nm

### Transmittance data

- **VUV-U**
  - (193 nm)
  - (248 nm)
  - (365 nm)
  - (436 nm)

### NICF Available range of homogeneity

- Homogeneity (μm) < 0.5
- < 1
- < 1.5
- < 2
- < 3
- < 4
- < 5
- < 10
- < 40

### Properties of NICF-V, A, U

#### Optical Properties

- **Wavelength [μm]**
  - 2.35242
  - 1.42211

- **Refractive Indices**
  - F - C: 0.004554
  - F - C: 0.004552

#### Chemical/Electrical Properties

- **Cubic, Fluorite type**
- **Cleavage Plane** (111)
- **Molecular Weight** 79.08
- **Climatic Resistance**
  - (CRI) [Class]: 4
  - (ARIS) [Class]: 3
  - (ARIP) [Class]: 5
- **Phosphate Resistance**
  - [Class]: 1
- **Solvability in Water**
  - 0.016

#### Mechanical Properties

- **Young’s Modulus**
  - 146<100><101<100><91<111>
  - [GPa]
- **Poison’s ratio**
  - 0.21
- **Knoop Hardness**
  - [kg/mm²]<200
  - 164
- **Abrasion Hardness**
  - 301
- **Shear Modulus**
  - [GPa]
  - 34.6
- **Compressive Modulus**
  - [GPa]
  - 83.8
- **Mohs Hardness**
  - 4
- **Stress Optical Coefficient**
  - (10 lb/2000 in)
  - 1.77
- **Specific Gravity**
  - 3.18

*Each property is shown as a typical value.*
Glass Business Unit
Shinagawa Intercity Tower C, 2-15-3, Konan,
Minato-ku, Tokyo 108-6290, Japan
Tel +81-3-6433-3977  FAX +81-3-6433-3757
https://www.nikon.co.jp/glass/
Glass.Sales@nikon.com

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Note

\[ n^2 - 1 = \frac{B \lambda^2}{\lambda^2 - Q_1} + \frac{B \lambda^2}{\lambda^2 - Q_2} + \frac{B \lambda^2}{\lambda^2 - Q_3} - \frac{B \lambda^2}{\lambda^2 - Q_4} \]

\[ \Delta n_{\text{Dm}} = \frac{n^2 - 1}{2} \left[ D_{\text{D}} \Delta T + D_{\text{F}} \Delta T^2 + D_{\text{E}} \Delta T^3 + \frac{E_{\text{D}} \Delta T + E_{\text{F}} \Delta T^2}{\lambda^2 - \lambda_{\text{Dm}}} \right] \]