N.B. Export of the products* in this catalog is controlled under the Japanese Foreign Exchange and Foreign Trade Law. Appropriate export procedure shall be required in case of export from Japan.

*Products: Hardware and its technical information (including software)
Nikon NIFS Series Synthetic Silica Glass

NIFS Series ADVANTAGES

Nikon's synthetic silica glass (SiO2) NIFS series is built around over 90 years experience in the field of optics. By combining our critical process controls and leading metrology capabilities, we offer materials which meet and exceed our customers’ standard requirements. With our proprietary synthesis and annealing processes, we can optimize our glass to meet our customers’ application requirements for homogeneity, birefringence and OH content. The NIFS series is the ideal choice for OEM, R&D and special project requirements for Semiconductor lithography, High - power Nd:YAG, Astronomy, Medical and FPD applications.

Optical grades

<table>
<thead>
<tr>
<th>Grade</th>
<th>Internal transmittance (%)</th>
<th>Laser durability</th>
<th>Birefringence (nm/cm)</th>
<th>Striae</th>
<th>Recommended wavelength</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIFS-V</td>
<td>99.9 on request</td>
<td>1 - 10 mm/12000</td>
<td>10 nm</td>
<td>1D Free</td>
<td>ArF excimer laser (193 nm)</td>
</tr>
<tr>
<td>NIFS-A</td>
<td>99.9 on request</td>
<td>1 - 10 mm/12000</td>
<td>10 nm</td>
<td>1D Free</td>
<td>ArF excimer laser (193 nm)</td>
</tr>
<tr>
<td>NIFS-U</td>
<td>99.9 on request</td>
<td>1 - 10 mm/12000</td>
<td>10 nm</td>
<td>1D Free</td>
<td>KrF excimer laser (248 nm)</td>
</tr>
<tr>
<td>NIFS-S</td>
<td>99.9 on request</td>
<td>1 - 10 mm/12000</td>
<td>10 nm</td>
<td>1D Free</td>
<td>UV region, Visible region</td>
</tr>
<tr>
<td>NIFS-X</td>
<td></td>
<td>1 - 10 mm/12000</td>
<td>10 nm</td>
<td>1D Free</td>
<td>UV region, Visible region</td>
</tr>
</tbody>
</table>

- Values stated above are valid for material with a diameter of 30 - 350 mm and a thickness of 5 - 100 mm. Material outside this range will be regarded as custom.
- Laser durability is classified into three groups, A, B and C, with NIFS-V represents the highest grade of material available.
- Material available in Striae 3D Free (all directions) or in the required working direction (1D Free).

NIFS Available range of homogeneity

<table>
<thead>
<tr>
<th>Homogeneity (ppm)</th>
<th>NIFS-V</th>
<th>NIFS-A</th>
<th>NIFS-U</th>
<th>NIFS-S</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1</td>
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<td>&lt; 1.5</td>
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<td></td>
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</tr>
<tr>
<td>&lt; 3</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 4</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>&lt; 5</td>
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<tr>
<td>&lt; 10</td>
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<td></td>
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</tr>
<tr>
<td>&lt; 40</td>
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</tr>
<tr>
<td>Not specified</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NIFS Transmittance range

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>NIFS-V</th>
<th>NIFS-A</th>
<th>NIFS-U</th>
<th>NIFS-S</th>
</tr>
</thead>
<tbody>
<tr>
<td>157</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>193</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>248</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>365</td>
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</tr>
<tr>
<td>436</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Transmittance data — VUV-VIS-IR region —

- NIFS-V
- NIFS-A, -U, -S

-NIKON CORPORATION-
Nikon NIFS Series Synthetic Silica Glass

NIFS Series ADVANTAGES

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Optical grades

<table>
<thead>
<tr>
<th>Grade</th>
<th>Internal transmittance (%)</th>
<th>Laser durability</th>
<th>Birefringence</th>
<th>Striae</th>
<th>Recommended wavelength</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIFS-V</td>
<td>99.9 at 193 nm</td>
<td>A</td>
<td>1 - 10 nm/cm</td>
<td>Ni line</td>
<td>ArF excimer laser (193 nm)</td>
</tr>
<tr>
<td>NIFS-A</td>
<td>99.9 at 193 nm</td>
<td>B</td>
<td>1 - 10 nm/cm</td>
<td>Ni line</td>
<td>ArF excimer laser (193 nm)</td>
</tr>
<tr>
<td>NIFS-U</td>
<td>99.9 at 248 nm</td>
<td>C</td>
<td>on request</td>
<td>KI line</td>
<td>KrF excimer laser (248 nm)</td>
</tr>
</tbody>
</table>

Values stated above are valid for material with a diameter of 30 - 350 mm and a thickness of 5 - 100 mm. Material outside this range will be regarded as custom.

Material available in Striae 3D Free (all directions) or in the required working direction (1D Free).

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

Material available in Striae 3D Free (all directions) or in the required working direction (1D Free).

NIFS Available range of homogeneity

<table>
<thead>
<tr>
<th>Homogeneity (ppm)</th>
<th>&lt; 0.5</th>
<th>&lt; 1</th>
<th>&lt; 1.5</th>
<th>&lt; 2</th>
<th>&lt; 3</th>
<th>&lt; 4</th>
<th>&lt; 5</th>
<th>&lt; 10</th>
<th>&lt; 40</th>
<th>Not specified</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIFS-V</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>NIFS-A</td>
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<td></td>
</tr>
<tr>
<td>NIFS-U</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NIFS-S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. Material available in Striae 3D Free (all directions) or in the required working direction (1D Free).

NIFS Transmittance range

<table>
<thead>
<tr>
<th></th>
<th>KrF</th>
<th>i-line</th>
<th>g-line</th>
</tr>
</thead>
<tbody>
<tr>
<td>157 nm</td>
<td>193 nm</td>
<td>248 nm</td>
<td>365 nm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>NIFS-V</th>
<th>NIFS-A</th>
<th>NIFS-U</th>
<th>NIFS-S</th>
</tr>
</thead>
</table>

Transmittance data — VUV-VIS-IR region —
### Properties of NIF5-V (Nikon Synthetic Glass)

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th>Refractive Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>WaveLength (nm)</td>
<td>1.4586</td>
</tr>
<tr>
<td>T = 0°C</td>
<td>1.4601</td>
</tr>
</tbody>
</table>

**Partial Dispersion**

- **Δν**
  - F / C: 0.3187
  - F / P: 0.5769
  - F / P: 0.3102
  - F / D: 0.3277
  - P / D: 0.3269
  - P / D: 0.6232
  - P / D: 0.2588
  - P / D: 0.2374
  - P / D: 0.4693
  - P / D: 0.7243

**Abnormal Dispersion**

- **D**
  - ν = 0.0887
  - ν = 0.0133
  - ν = 0.0020
  - ν = 0.0059

**Relative Partial Dispersion**

- **λ**
  - D / C: 0.0907
  - D / C: 0.0787
  - D / C: 0.0756
  - D / C: 0.0724

### Optical Properties

- **Electric Constant** (21°C) 4.0
- **Dielectric Loss Angle (ε'ε''/ε'') 40°C) 89.93
- **Optical Reflectivity (20°C) < 1.18×10^−4

### Chemical Properties

- **Glass Content**
  - SiO₂: 21.45%
  - GeO₂: 5.96%
  - Al₂O₃: 0.05%
  - B₂O₃: 0.36%
  - CaO: 0.14%
  - TiO₂: 0.08%

**Consists for Absolute, 106°C±5°C**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Glass Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D: 2.14E-05</td>
<td>E: 2.52E-07</td>
</tr>
<tr>
<td>F: 2.00E-08</td>
<td>C: 4.56E-10</td>
</tr>
<tr>
<td>P: 1.14E-12</td>
<td>k: 4.25E-16</td>
</tr>
</tbody>
</table>

### Physical Properties

- **Relative Density**
  - 2.31E+01
- **Mohs Hardness**
  - 6.0
- **Poisson’s Ratio**
  - 0.4693

**Impurities**

- OH: < 100 ppm
- Al: < 0.2 ppm
- Cu: < 0.2 ppm
- Mg: < 0.2 ppm

### Mechanical Properties

- **Young’s Modulus**
  - Glass: 72
  - Copper: 13.5
  - Brass: 42
  - Stainless: 250
  - Steel: 724

**Hardness**

- **Mohs Hardness**
  - 6.0
- **Poisson’s Ratio**
  - 0.3102

**Bending Strength**

- **Bending Strength**
  - Glass: 1.55894

**Stress Optical Coefficient**

- **x = 1.4502
  - y = 0.4861
  - z = 0.4709

### Electrical Properties

- **Dc**
  - 1.5169704E-02
  - 9.6424081E+01

**Impurities**

- OH: < 100 ppm
- Al: < 0.2 ppm
- Fe: < 0.2 ppm
- Mg: < 0.2 ppm

**Each property is shown as a typical value.**

---

### Properties of NIF5-A (Nikon Synthetic Glass)

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th>Refractive Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>WaveLength (nm)</td>
<td>1.4584</td>
</tr>
<tr>
<td>T = 0°C</td>
<td>1.4609</td>
</tr>
</tbody>
</table>

**Partial Dispersion**

- **Δν**
  - F / C: 0.0887
  - F / P: 0.0133
  - F / D: 0.0020
  - F / D: 0.0059

**Abnormal Dispersion**

- **D**
  - ν = 0.0887
  - ν = 0.0020
  - ν = 0.0059

**Relative Partial Dispersion**

- **λ**
  - D / C: 0.0907
  - D / C: 0.0787
  - D / C: 0.0756
  - D / C: 0.0724

### Optical Properties

- **Electric Constant** (21°C) 4.0
- **Dielectric Loss Angle (ε'ε''/ε'') 40°C) 89.93
- **Optical Reflectivity (20°C) < 1.18×10^−4

### Chemical Properties

- **Glass Content**
  - SiO₂: 21.45%
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<table>
<thead>
<tr>
<th>Condition</th>
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<tbody>
<tr>
<td>D: 2.15E-05</td>
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</tr>
<tr>
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<td>C: 4.56E-10</td>
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<tr>
<td>P: 1.14E-12</td>
<td>k: 4.25E-16</td>
</tr>
</tbody>
</table>

### Physical Properties

- **Relative Density**
  - 2.31E+01
- **Mohs Hardness**
  - 6.0
- **Poisson’s Ratio**
  - 0.4693

**Bending Strength**

- **Bending Strength**
  - Glass: 1.55894

**Stress Optical Coefficient**

- **x = 1.4502
  - y = 0.4861
  - z = 0.4709

### Electrical Properties

- **Dc**
  - 1.5169704E-02
  - 9.6424081E+01

**Impurities**

- OH: < 100 ppm
- Al: < 0.2 ppm
- Fe: < 0.2 ppm
- Mg: < 0.2 ppm

**Each property is shown as a typical value.**

---

**Nikon NIF5 Series Synthetic Glass**
Nikon NIFS Series Synthetic Silica Glass

**Properties of NIFS-V (Nikon Synthetic Silica Glass)**

**Optical Properties**
- Wavelength [µm] Refractive Indices
  - 0.33415: 1.49413
  - 0.36502: 1.48456
  - 0.65627: 1.46679
  - 0.85211: 1.46323
  - 1.0603: 1.45850
  - 1.52958: 1.45712

**Effect of Temperature on Refractive Index  n/ T**
- 0°C: 1.49413
- 20°C: 1.49105
- 50°C: 1.48897
- 100°C: 1.48689
- 150°C: 1.48481
- 200°C: 1.48273
- 250°C: 1.47965
- 300°C: 1.47657
- 350°C: 1.47349
- 400°C: 1.46740
- 500°C: 1.46241

**Partial Dispersions**
- 0.33415: 2.35E-01
- 0.36502: 2.62E-01
- 0.65627: 0.29673
- 0.85211: 0.45516
- 1.0603: 0.51375
- 1.52958: 0.65627

**Chemical Properties**
- Acid Resistance by Powder Method: < 0.2 ppb
- Acid Resistance by Surface Method: < 0.2 ppb
- Abrasion Resistance: 3 A 40
- Shear Modulus: G 80 G 360
- Compaction Strength: 0.085 GPa
- Multis Hardness: 9 G 10
- Bending Strength: (GPa) 49 G 108
- Stress Optical Coefficient: 10^{-12}/Pa
c
- Stress Optical Coefficient: 10^{-12}/Pa
c 10^{-12}/Pa
- Stress Optical Coefficient: 10^{-12}/Pa
c
- Stress Optical Coefficient: 10^{-12}/Pa
c
- Stress Optical Coefficient: 10^{-12}/Pa
c

**Thermal Properties**
- Thermal Expansion (±5°C ~ +100°C) [10^8/°C]
  - 1.52958: 0.006758
  - 1.0603: 0.00692
  - 1.45516: 0.00719
  - 1.46323: 0.00730
  - 1.45850: 0.00731

**Physical Properties**
- Weight: 2.150 E 2.720
- Electrical Loss Factor: < 0.2
- Electrical Breakdown: > 10^6 V/m
- Dielectric Strength: > 10^6 V/m
- Chemical Resistance: CLASS 4

**Impurities**
- OH: < 100 ppm
- H2O: < 0.2 ppm
- Na: < 0.2 ppm
- K: < 0.2 ppm
- Mg: < 0.2 ppm
- Ca: < 0.2 ppm

**Properties of NIFS-A (Nikon Synthetic Silica Glass)**

**Optical Properties**
- Wavelength [µm] Refractive Indices
  - 0.33415: 1.49413
  - 0.36502: 1.49105
  - 0.65627: 1.48897
  - 0.85211: 1.48689
  - 1.0603: 1.48481
  - 1.52958: 1.47965

**Effect of Temperature on Refractive Index  n/ T**
- 0°C: 1.49413
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- 1.0603: 0.51375
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**Chemical Properties**
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- Acid Resistance by Surface Method: < 0.2 ppb
- Abrasion Resistance: 3 A 40
- Shear Modulus: G 80 G 360
- Compaction Strength: 0.085 GPa
- Multis Hardness: 9 G 10
- Bending Strength: (GPa) 49 G 108
- Stress Optical Coefficient: 10^{-12}/Pa
c
- Stress Optical Coefficient: 10^{-12}/Pa
c 10^{-12}/Pa
- Stress Optical Coefficient: 10^{-12}/Pa
c
- Stress Optical Coefficient: 10^{-12}/Pa
c

**Impurities**
- OH: < 100 ppm
- H2O: < 0.2 ppm
- Na: < 0.2 ppm
- K: < 0.2 ppm
- Mg: < 0.2 ppm
- Ca: < 0.2 ppm

*Each property is shown as a typical value.*
### Properties of NIFS-U
(Nikon Synthetic Silica Glass)

**Optical Properties**
- Wavelength (µm)
  - 1.355, 1.550, 1.550
- Refractive Index
  - 1.484, 1.484, 1.484
- Abnormal Dispersion
  - 0.0392
- Abnormal Dispersion Curve
  - 0.0055

**Relative Refraction Index**
- P10: 1.3489
- P20: 1.3102
- P30: 1.2888
- P40: 1.2725
- P50: 1.2631
- P60: 1.2554
- P70: 1.2473
- P80: 1.2407
- P90: 1.2347
- P100: 1.2297

**Properties of NIFS-S**
(Nikon Synthetic Silica Glass)

**Effect of Temperature on Refractive Index**
- Constant for Absolute Temperature
  - 3.84E-08
- 2.15E-05
- -5.68E-13
- 1.84E-01

**Chemical Properties**

**Impurities**
- Li < 1200 ppm
- Al < 50 ppm
- Si < 50 ppm
- Na < 50 ppm
- K < 50 ppm
- Mg < 50 ppm
- Ca < 50 ppm

Each property is shown as a typical value.

---

### Properties of NIFS-U
(Nikon Synthetic Silica Glass)

**Optical Properties**
- Wavelength (µm)
  - 1.355, 1.550, 1.550
- Refractive Index
  - 1.4609, 1.4609, 1.4609
- Abnormal Dispersion
  - 0.0392
- Abnormal Dispersion Curve
  - 0.0055

**Relative Refraction Index**
- P10: 1.3489
- P20: 1.3102
- P30: 1.2888
- P40: 1.2725
- P50: 1.2631
- P60: 1.2554
- P70: 1.2473
- P80: 1.2407
- P90: 1.2347
- P100: 1.2297

**Properties of NIFS-S**
(Nikon Synthetic Silica Glass)

**Effect of Temperature on Refractive Index**
- Constant for Absolute Temperature
  - 3.84E-08
- 2.15E-05
- -5.68E-13
- 1.84E-01

**Chemical Properties**

**Impurities**
- Li < 1200 ppm
- Al < 50 ppm
- Si < 50 ppm
- Na < 50 ppm
- K < 50 ppm
- Mg < 50 ppm
- Ca < 50 ppm

Each property is shown as a typical value.
## Properties of NIFS-U (Nikon Synthetic Glass)

### Optical Properties

<table>
<thead>
<tr>
<th>Wavelength [µm]</th>
<th>Refractive Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2158</td>
<td>1.4799</td>
</tr>
<tr>
<td>0.3289</td>
<td>1.4671</td>
</tr>
<tr>
<td>0.5770</td>
<td>1.4671</td>
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<td>1.0612</td>
<td>1.4568</td>
</tr>
<tr>
<td>1.5894</td>
<td>1.4508</td>
</tr>
<tr>
<td>2.204</td>
<td>1.4508</td>
</tr>
<tr>
<td>2.9273</td>
<td>1.4508</td>
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<tr>
<td>3.9244</td>
<td>1.4508</td>
</tr>
<tr>
<td>5.5602</td>
<td>1.4508</td>
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### Electrical Properties

<table>
<thead>
<tr>
<th>Abnormal Dispersions</th>
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</thead>
<tbody>
<tr>
<td>²Pc</td>
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<tr>
<td>²Pd</td>
</tr>
<tr>
<td>³Pc</td>
</tr>
<tr>
<td>³Pd</td>
</tr>
</tbody>
</table>

### Mechanical Properties

<table>
<thead>
<tr>
<th>Relative Permittivity</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>²Pd</td>
</tr>
<tr>
<td>³Pr</td>
</tr>
<tr>
<td>³Pd</td>
</tr>
</tbody>
</table>

### Chemical Properties

<table>
<thead>
<tr>
<th>Specific Gravity</th>
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<tbody>
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### Impurities

<table>
<thead>
<tr>
<th>Impurities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Li &lt; 1200 ppm</td>
</tr>
<tr>
<td>Al &lt; 50 ppm</td>
</tr>
<tr>
<td>Mg &lt; 50 ppm</td>
</tr>
<tr>
<td>K &lt; 50 ppm</td>
</tr>
<tr>
<td>Na &lt; 50 ppm</td>
</tr>
<tr>
<td>Ti &lt; 50 ppm</td>
</tr>
<tr>
<td>Cr &lt; 50 ppm</td>
</tr>
<tr>
<td>Ce &lt; 50 ppm</td>
</tr>
<tr>
<td>Fe &lt; 50 ppm</td>
</tr>
</tbody>
</table>

### Constants for Absolute 25 °C

<table>
<thead>
<tr>
<th>Constants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dc</td>
</tr>
<tr>
<td>Dr</td>
</tr>
<tr>
<td>Dr-</td>
</tr>
<tr>
<td>Dr-</td>
</tr>
</tbody>
</table>

### Effect of Temperature in 25 °C

<table>
<thead>
<tr>
<th>Effect of Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°C</td>
</tr>
<tr>
<td>100°C</td>
</tr>
</tbody>
</table>

### Effect of Humidity in 25 °C

<table>
<thead>
<tr>
<th>Effect of Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>50% Humidity</td>
</tr>
<tr>
<td>90% Humidity</td>
</tr>
</tbody>
</table>

### Conditions

- Temperature: 25.5 °C
- Humidity: 50%
- Atmospheric Pressure: 1013.25 hPa

---

## Properties of NIFS-S (Nikon Synthetic Glass)

### Optical Properties

<table>
<thead>
<tr>
<th>Wavelength [µm]</th>
<th>Refractive Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2158</td>
<td>1.4799</td>
</tr>
<tr>
<td>0.3289</td>
<td>1.4671</td>
</tr>
<tr>
<td>0.5770</td>
<td>1.4671</td>
</tr>
<tr>
<td>1.0612</td>
<td>1.4568</td>
</tr>
<tr>
<td>1.5894</td>
<td>1.4508</td>
</tr>
<tr>
<td>2.204</td>
<td>1.4508</td>
</tr>
<tr>
<td>2.9273</td>
<td>1.4508</td>
</tr>
<tr>
<td>3.9244</td>
<td>1.4508</td>
</tr>
<tr>
<td>5.6002</td>
<td>1.4508</td>
</tr>
</tbody>
</table>

### Electrical Properties

<table>
<thead>
<tr>
<th>Abnormal Dispersions</th>
</tr>
</thead>
<tbody>
<tr>
<td>²Pc</td>
</tr>
<tr>
<td>²Pd</td>
</tr>
<tr>
<td>³Pc</td>
</tr>
<tr>
<td>³Pd</td>
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### Mechanical Properties

<table>
<thead>
<tr>
<th>Relative Permittivity</th>
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<tbody>
<tr>
<td>²Pr</td>
</tr>
<tr>
<td>²Pd</td>
</tr>
<tr>
<td>³Pr</td>
</tr>
<tr>
<td>³Pd</td>
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### Chemical Properties

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<tr>
<td>2.20</td>
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### Conditions

- Temperature: 25.5 °C
- Humidity: 50%
- Atmospheric Pressure: 1013.25 hPa

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### Notes

- Each property is shown as a typical value.
N.B. Export of the products* in this catalog is controlled under the
Japanese Foreign Exchange and Foreign Trade Law. Appropriate
export procedure shall be required in case of export from Japan.

*Products: Hardware and its technical information (including software)