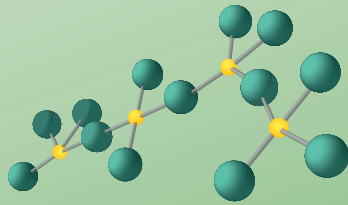




Nikon Synthetic Silica Glass (SiO₂)

NIFS

S e r i e s



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

Grade	Internal transmittance [%] Sample thickness:10 mm	Laser durability	Birefringence	Striae	Recommended wavelength
NIFS-V	≥99.9 (at 193 nm)	A	1 - 10 nm/cm on request	3D Free	ArF excimer laser (193 nm)
NIFS-A	≥99.9 (at 193 nm)	B		3D Free 1D Free	ArF excimer laser (193 nm)
NIFS-U	≥99.9 (at 248 nm)	C	on request	3D Free 1D Free	KrF excimer laser (248 nm)
NIFS-S	≥99.9 (at 365 nm)	—		3D Free 1D Free	UV region, Visible region
NIFS-I	—	—	—	—	—

※ 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.

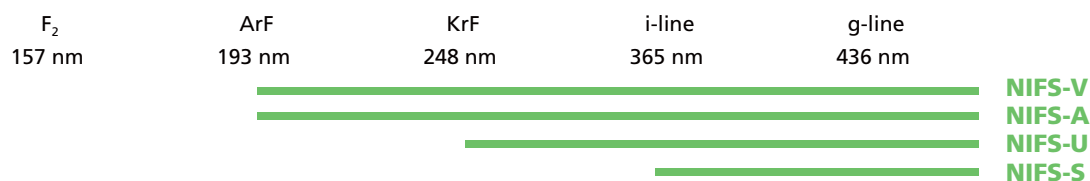
※ Laser durability is classified into three groups, A, B and C, with NIFS-V represents the highest grade of material available.

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

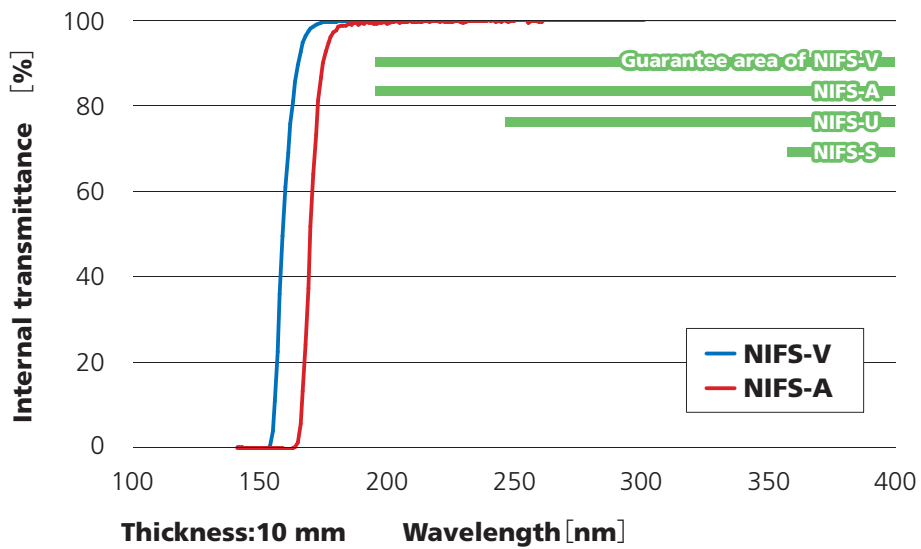
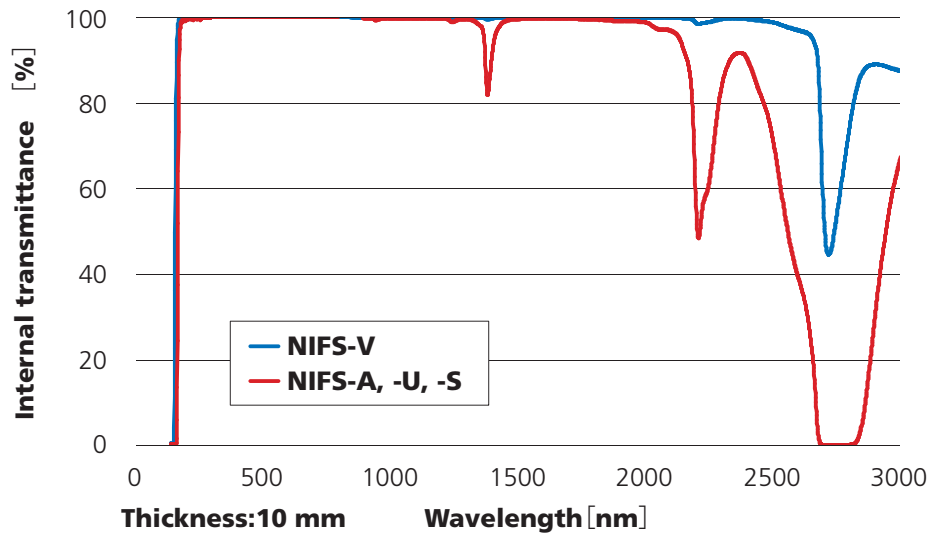
NIFS Available range of homogeneity



NIFS Transmittance range



Transmittance data — VUV-VIS-IR region —



Nikon NIFS Series Synthetic Silica Glass

Properties of NIFS-V (Nikon Synthetic Silica Glass)

Refractive Indices

	Wavelength [nm]	Refractive Index
He	1082.989	1.44936
t	1013.98	1.45028
s	852.11	1.45259
A'	768.195	1.45402
r	706.519	1.45527
C	656.273	1.45648
C'	643.847	1.45682
He-Ne	632.8	1.45713
D	589.294	1.45851
d	587.562	1.45857
e	546.074	1.46018
F	486.133	1.46322
F'	479.992	1.46360
g	435.835	1.46678
h	404.656	1.46971
i	365.015	1.47464
KrF	248.3	1.50852
ArF	193.4	1.56021

Measured at
 Temperature : 22.5 °C
 Humidity : 50 %
 Atmospheric pressure : 1013 hPa

Impurities

OH	< 100 ppm
Li	< 0.2 ppb
Na	< 0.2 ppb
K	< 0.2 ppb
Mg	< 0.2 ppb
Ca	< 0.2 ppb
Al	< 0.2 ppb
Ti	< 0.2 ppb
Cr	< 0.2 ppb
Fe	< 0.2 ppb
Cu	< 0.2 ppb

Optical Properties

n_d (He, 587.56 nm)	1.45857
n_e (Hg, 546.07 nm)	1.46018
$n_F - n_C$	0.00674
$n_{F'} - n_{C'}$	0.00678
γ_d	68.1
γ_e	67.9

Sellmeier Dispersion Equation Constants

B1	0.151370103
B2	0.610890012
B3	0.341550573
B4	0.048272233
C1	0.005303054
C2	0.005304046
C3	0.014019692
C4	6.438755534

Stress Coefficient *	35 nm/cm MPa
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Mechanical Properties

Density	2.2 g/cm ³
Knoop Hardness (100g load)	590 - 610 kg/mm ²
Abrasion **	50
Young's Modulus	73GPa

Thermal Properties

Linear Thermal Expansion Coefficient	100 - 300 °C	$5.7 \cdot 10^{-7}/K$
Thermal Conductivity	0 °C	1.3 W/m · K
Mean Heat Capacity *	25 °C	730 J/kg · K

* Excerpts from literature

** Measuring method : JOGIS 10

※Each property is shown as a typical value.

Properties of NIFS-A (Nikon Synthetic Silica Glass)

Refractive Indices

	Wavelength [nm]	Refractive Index
He	1082.989	1.44945
t	1013.98	1.45028
s	852.11	1.45251
A'	768.195	1.45393
r	706.519	1.45519
C	656.273	1.45641
C'	643.847	1.45675
He-Ne	632.8	1.45706
D	589.294	1.45844
d	587.562	1.45850
e	546.074	1.46012
F	486.133	1.46317
F'	479.992	1.46354
g	435.835	1.46674
h	404.656	1.46966
i	365.015	1.47458
KrF	248.3	1.50843
ArF	193.4	1.56017

Measured at
 Temperature : 22.5 °C
 Humidity : 50 %
 Atmospheric pressure : 1013 hPa

Impurities

OH	< 1200 ppm
Li	< 0.2 ppb
Na	< 0.2 ppb
K	< 0.2 ppb
Mg	< 0.2 ppb
Ca	< 0.2 ppb
Al	< 0.2 ppb
Ti	< 0.2 ppb
Cr	< 0.2 ppb
Fe	< 0.2 ppb
Cu	< 0.2 ppb

Optical Properties

n_d (He, 587.56 nm)	1.45850		
n_e (Hg, 546.07 nm)	1.46012		
$n_F - n_C$	0.00676		
$n_F - n_C$	0.00680		
v_d	67.8		
v_e	67.7		
Thermal Coefficient $\Delta n/\Delta T$ *	Wavelength	dn/dT (K ⁻¹)	
		0 - 20 °C	20 - 40 °C
	643.8 nm	9.6×10^{-6}	9.8×10^{-6}
	587.6 nm	9.8×10^{-6}	10.0×10^{-6}
	546.1 nm	9.9×10^{-6}	10.1×10^{-6}
	365 nm	11.0×10^{-6}	11.2×10^{-6}
	237.8 nm	14.6×10^{-6}	14.9×10^{-6}
Stress Coefficient *	35 nm/cm MPa		

Mechanical Properties

Density	2.2 g/cm ³
Knoop Hardness (100 g load)	590 - 620 kg/mm ²
Abrasion **	58
Young's Modulus	73 GPa
Shear Modulus	31 GPa
Poisson's Ratio	0.16
Bending Strength	67 MPa

Thermal Properties

Softening Point *	$\log \eta = 7.6$	1600 °C
Annealing Point *	$\log \eta = 13.0$	1100 °C
Strain Point *	$\log \eta = 14.5$	1000 °C
Linear Thermal Expansion Coefficient	100 - 300 °C	$5.1 - 5.9 \cdot 10^{-7}/K$
Thermal Conductivity	0 °C	1.4 W/m · K
Mean Heat Capacity *	0 - 100 °C	770 J/kg · K
	0 - 500 °C	960 J/kg · K
	0 - 900 °C	1050 J/kg · K

Dielectric Constant ϵ_r (0 - 1×10^6 Hz) *	20 °C	3.7
$\tan \delta$ *	1 MHz	1.0×10^{-4}
Electrical Resistivity *	20 °C	$1.0 \times 10^{16} \Omega \cdot m$

* Excerpts from literature

** Measuring method : JOGIS 10

※Each property is shown as a typical value.

Nikon NIFS Series Synthetic Silica Glass

Properties of NIFS-U (Nikon Synthetic Silica Glass)

Refractive Indices

	Wavelength [nm]	Refractive Index
He	1082.989	1.44945
t	1013.98	1.45028
s	852.11	1.45251
A'	768.195	1.45393
r	706.519	1.45519
C	656.273	1.45641
C'	643.847	1.45675
He-Ne	632.8	1.45706
D	589.294	1.45844
d	587.562	1.45850
e	546.074	1.46012
F	486.133	1.46317
F'	479.992	1.46354
g	435.835	1.46674
h	404.656	1.46966
i	365.015	1.47458
KrF	248.3	1.50843
ArF	193.4	1.56017

Measured at
 Temperature : 22.5 °C
 Humidity : 50 %
 Atmospheric pressure : 1013 hPa

Impurities

OH	< 1200 ppm
Li	< 50 ppb
Na	< 50 ppb
K	< 50 ppb
Mg	< 50 ppb
Ca	< 50 ppb
Al	< 50 ppb
Ti	< 50 ppb
Cr	< 50 ppb
Fe	< 50 ppb
Cu	< 50 ppb

Optical Properties

n_d (He, 587.56 nm)	1.45850		
n_e (Hg, 546.07 nm)	1.46012		
$n_F - n_C$	0.00676		
$n_F - n_C'$	0.00680		
V_d	67.8		
V_e	67.7		
Thermal Coefficient $\Delta n/\Delta T$ *	Wavelength	dn/dT (K ⁻¹)	
			0 - 20 °C
	643.8 nm	9.6×10^{-6}	9.8×10^{-6}
	587.6 nm	9.8×10^{-6}	10.0×10^{-6}
	546.1 nm	9.9×10^{-6}	10.1×10^{-6}
	365 nm	11.0×10^{-6}	11.2×10^{-6}
237.8 nm	14.6×10^{-6}	14.9×10^{-6}	
Stress Coefficient *	35 nm/cm MPa		

Mechanical Properties

Density	2.2 g/cm ³
Knoop Hardness (100 g load)	590 - 620 kg/mm ²
Abrasion **	58
Young's Modulus	73 GPa
Shear Modulus	31 GPa
Poisson's Ratio	0.16
Bending Strength	67 MPa

Thermal Properties

Softening Point *	$\log \eta = 7.6$	1600 °C
Annealing Point *	$\log \eta = 13.0$	1100 °C
Strain Point *	$\log \eta = 14.5$	1000 °C
Linear Thermal Expansion Coefficient	100 - 300 °C	$5.1 - 5.9 \cdot 10^{-7}/K$
Thermal Conductivity	0 °C	1.4 W/m · K
Mean Heat Capacity *	0 - 100 °C	770 J/kg · K
	0 - 500 °C	960 J/kg · K
	0 - 900 °C	1050 J/kg · K

Dielectric Constant ϵ_r (0 - 1×10^6 Hz) *	20 °C	3.7
$\tan \delta$ *	1 MHz	1.0×10^{-4}
Electrical Resistivity *	20 °C	$1.0 \times 10^{16} \Omega \cdot m$

* Excerpts from literature

** Measuring method : JOGIS 10

※Each property is shown as a typical value.

Properties of NIFS-S (Nikon Synthetic Silica Glass)

Refractive Indices

	Wavelength [nm]	Refractive Index
He	1082.989	1.44945
t	1013.98	1.45028
s	852.11	1.45251
A'	768.195	1.45393
r	706.519	1.45519
C	656.273	1.45641
C'	643.847	1.45675
He-Ne	632.8	1.45706
D	589.294	1.45844
d	587.562	1.45850
e	546.074	1.46012
F	486.133	1.46317
F'	479.992	1.46354
g	435.835	1.46674
h	404.656	1.46966
i	365.015	1.47458
KrF	248.3	1.50843
ArF	193.4	1.56017

Measured at
 Temperature : 22.5 °C
 Humidity : 50 %
 Atmospheric pressure : 1013 hPa

Impurities

OH	< 1200 ppm
Li	< 100 ppb
Na	< 100 ppb
K	< 100 ppb
Mg	< 100 ppb
Ca	< 100 ppb
Al	< 100 ppb
Ti	< 100 ppb
Cr	< 100 ppb
Fe	< 100 ppb
Cu	< 100 ppb

Optical Properties

n_d (He, 587.56 nm)	1.45850		
n_e (Hg, 546.07 nm)	1.46012		
$n_F - n_C$	0.00676		
$n_F - n_C'$	0.00680		
V_d	67.8		
V_e	67.7		
Thermal Coefficient $\Delta n/\Delta T$ *	Wavelength	dn/dT (K ⁻¹)	
		0 - 20 °C	20 - 40 °C
	643.8 nm	9.6×10^{-6}	9.8×10^{-6}
	587.6 nm	9.8×10^{-6}	10.0×10^{-6}
	546.1 nm	9.9×10^{-6}	10.1×10^{-6}
	365 nm	11.0×10^{-6}	11.2×10^{-6}
	237.8 nm	14.6×10^{-6}	14.9×10^{-6}
Stress Coefficient *	35 nm/cm MPa		

Mechanical Properties

Density	2.2 g/cm ³
Knoop Hardness (100 g load)	590 - 620 kg/mm ²
Abrasion **	58
Young's Modulus	73 GPa
Shear Modulus	31 GPa
Poisson's Ratio	0.16
Bending Strength	67 MPa

Thermal Properties

Softening Point *	$\log \eta = 7.6$	1600 °C
Annealing Point *	$\log \eta = 13.0$	1100 °C
Strain Point *	$\log \eta = 14.5$	1000 °C
Linear Thermal Expansion Coefficient	100 - 300 °C	$5.1 - 5.9 \cdot 10^{-7}/K$
Thermal Conductivity	0 °C	1.4 W/m · K
Mean Heat Capacity *	0 - 100 °C	770 J/kg · K
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	0 - 900 °C	1050 J/kg · K

Dielectric Constant ϵ_r (0 - 1×10^6 Hz) *	20 °C	3.7
$\tan \delta$ *	1 MHz	1.0×10^{-4}
Electrical Resistivity *	20 °C	$1.0 \times 10^{16} \Omega \cdot m$

* Excerpts from literature

** Measuring method : JOGIS 10

※Each property is shown as a typical value.



NIKON CORPORATION Glass Business Unit
Sagamihara Plant
10-1, Asamizodai 1-chome, Minami-ku, Sagamihara,
Kanagawa 252-0328 Tel: +81-42-740-6746
<http://www.nikon.co.jp/glass/>
Mail: Glass.Sales@nikon.com

