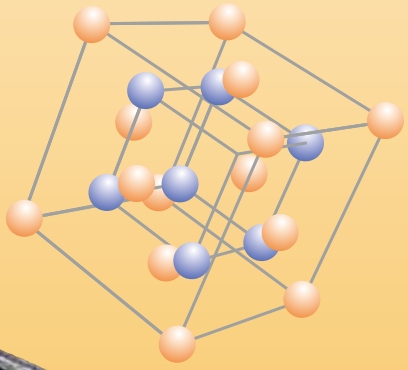
Nikon Calcium Fluoride (CaF_2)

NICF Series



NIKON CORPORATION
Digital Solutions Business Unit

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

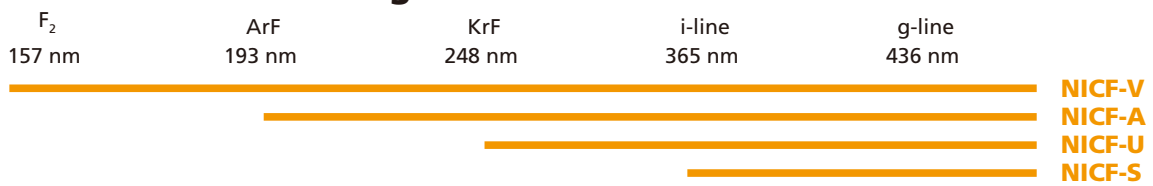
Nikon's proprietary annealing process yields unsurpassed refractive index homogeneity.

Optical grades

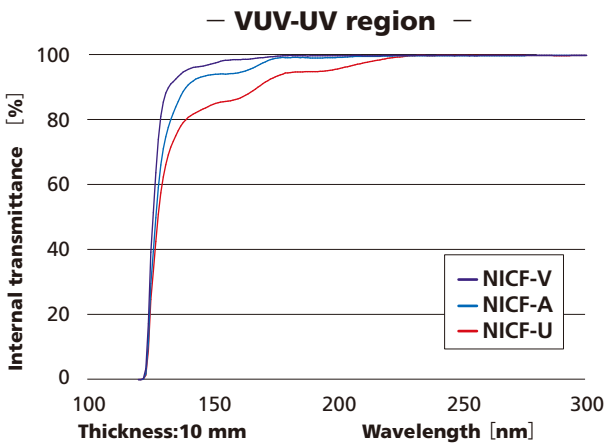
Grade	Internal transmittance [%] Sample thickness:10 mm	Laser durability	Birefringence	Recommended wavelength
NICF-V	≧99.5 (at 157 nm)	A	2 - 20 nm/cm on request	VUV region, ArF excimer laser (193 nm)
NICF-A	≧99.8 (at 193 nm)	B		ArF excimer laser (193 nm)
NICF-U	≧99.8 (at 248 nm)	C		KrF excimer laser (248 nm)
NICF-S	—	—	—	UV region, Visible region, IR region

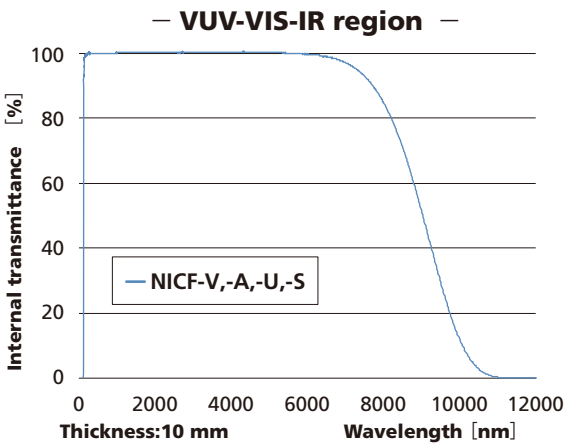
※ Crystal orientation to be specified by the customer, <111>, random and custom orientations are available upon request.
※ Values stated above are valid for material with a diameter of 30 - 260 mm and a thickness of 5 - 35 mm. Material outside this range will be regarded as custom.
※ Laser durability is classified into three groups, A, B and C, with NICF-V represents the highest grade of material available.

NICF Transmittance range



Transmittance data





NICF Available range of homogeneity

NICF Series

Properties of NICF-V, A, U (Nikon Calcium Fluoride)

n_d	1.43384	ν_d	95.26
n_e	1.43492	ν_e	94.72

Optical Properties

Wavelength[μm]		Refractive Indicies
-	2.32542	1.42211
-	1.97002	1.42401
-	1.52958	1.42613
-	1.0603	1.42850
t	1.01398	1.42879
s	0.85211	1.43002
r	0.70652	1.43166
C	0.65627	1.43245
C'	0.64385	1.43267
He-Ne	0.63280	1.43288
D	0.58929	1.43380
d	0.58756	1.43384
e	0.54608	1.43492
F	0.48613	1.43700
F'	0.47999	1.43726
g	0.43584	1.43946
h	0.40466	1.44148
i	0.36502	1.44488
-	0.33415	1.44848
-	0.31270	1.45170
-	0.29673	1.45463
-	0.2804	1.45823
KrF	0.2484	1.46786
-	0.19416	1.50059
ArF	0.1934	1.50133
-	0.18489	1.51052

Conditions:
temperature:22.5 ℃
humidity:50 %
atmospheric pressure:1013.25 hPa

Dispersion Coefficients *7	
P_1	5.81797965E-01
P_2	3.73232342E-01
P_3	8.36771960E-02
P_4	2.36293749E+00
Q_1	2.47744200E-03
Q_2	1.03202600E-02
Q_3	1.03234730E-02
Q_4	7.38225998E+02

Partial Dispersions	
F - C	0.004554
F'- C'	0.004592

Abnormal Dispersions	
$\Delta P_{C,t}$	-0.1940
$\Delta P_{C,s}$	-0.0918
$\Delta P_{F,e}$	0.0183
$\Delta P_{g,F}$	0.0553
$\Delta P_{i,g}$	0.2642

Relative Partial Dispersions	
$P_{s,t}$	0.2697
$P_{C,s}$	0.5332
$P_{d,C}$	0.3046
$P_{e,d}$	0.2388
$P_{g,F}$	0.5389
$P_{i,h}$	0.7465
$P'_{s,t}$	0.2675
$P'_{C',s}$	0.5769
$P'_{d,C'}$	0.2540
$P'_{e,d}$	0.2368
$P'_{g,F'}$	0.4783
$P'_{i,h}$	0.7404

Constants for Absolute Δn/ΔT *8			
D_0	-3.16E-05	E_0	4.32E-07
D_1	-2.05E-08	E_1	2.04E-10
D_2	9.02E-13	λ/μm	1.15E-01

Effect of Temperature on Refractive Index			
℃	Absolute Δn/ΔT [10^{-6}/℃]		
	1060.0 nm	546.23 nm	365.12 nm
-40 ~ -20	-10.6	-10.3	-9.8
+20 ~ +40	-11.5	-11.2	-10.6
+60 ~ +80	-12.1	-11.8	-11.2

Chemical/Electrical Properties

Crystal Structure	Cubic, Fluorite type	
Cleavage Plane		(111)
Molecular Weight		78.08
Climatic Resistance CR(S) [Class] *4		1
Acid Resistance by Surface Method AR(S) [Class]		3
Acid Resistance by Powder Method AR(P) [Class] *5		1
Phosphate Resistance PR(S) [Class] *6		1
Solubility in Water (20℃) [g/l] *1		0.016
Dielectric Constants (27℃) *1	εr	6.81

Thermal Properties

Expansion Coefficient	α	
(-30 ~ +70℃) [10^{-6}/℃]		18.4
(0 ~ +25℃) [10^{-6}/℃]		18.4
(+20 ~ +300℃) [10^{-6}/℃]		20.8
Thermal Conductivity(20℃) [W/m•K]	λ	9.70
Melting Point [℃]	-	1360
Specific Heat Capacity [J/g•K]	c	0.893
Thermal Diffusivity [$10^{-7}m^2$/sec]	κ	35.60

Mechanical Properties

Young's Modulus [GPa]	E	146<100> 101<110> 91<111>
Poisson's Ratio	μ	0.21
Knoop Hardness [kgf/mm^2]*2	HK	164
Abrasion Hardness *3	A	301
Shear Modulus [GPa]	G	34.6
Compressive Modulus [GPa]	-	83.8
Mohs Hardness *1	-	4
Stress Optical Coefficient (q11-q12) @193nm [10^{-12}/Pa]	-	1.77

Specific Gravity	3.18

※Each property is shown as a typical value.

Note

＊1	Excerpts from literature
＊2	JOGIS09-1975
＊3	JOGIS10-1994
＊4	JOGIS07-2006
＊5	JOGIS06-1999
＊6	ISO 9689:1990
＊7	$n^2-1=\frac{P_1\lambda^2}{\lambda^2-Q_1}+\frac{P_2\lambda^2}{\lambda^2-Q_2}+\frac{P_3\lambda^2}{\lambda^2-Q_3}+\frac{P_4\lambda^2}{\lambda^2-Q_4}$
＊8	$\Delta n_{abs}=\frac{n^2-1}{2n}\left[D_0\Delta T+D_1\Delta T^2+D_2\Delta T^3+\frac{E_0\Delta T+E_1\Delta T^2}{\lambda^2-\lambda_{tk}^2}\right]$

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)

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