

Shin-Etsu's Synthetic Quartz Photomask Substrate



Shin-Etsu's Synthetic Quartz Photomask Substrate

“*KNFS6025*”

for Polarized ArF Lithography

~ Optimum Substrate for High-NA and Immersion Lithography ~

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[Summarized typical data]

Laser source	Wavelength	Optics		Substrate grade	Transmission at 193nm (Distribution in a surface: T)	Durability to ArF (10mJ/cm ² · pulse, 2 × 10 ⁶ pulses)	Birefringence (nm / 6.35mm at 193nm)	Flatness
ArF	193.4nm	Non-polarized system	Dry	KNFS6025	90.7% (T=0.20%)	-0.2% (Transmission loss)	> 2nm	0.5μm
		Polarized system					Immersion	2nm, 1nm
			1nm or less					
		Special use	XNFS6025				90.7% (T=0.05%)	-0.05%

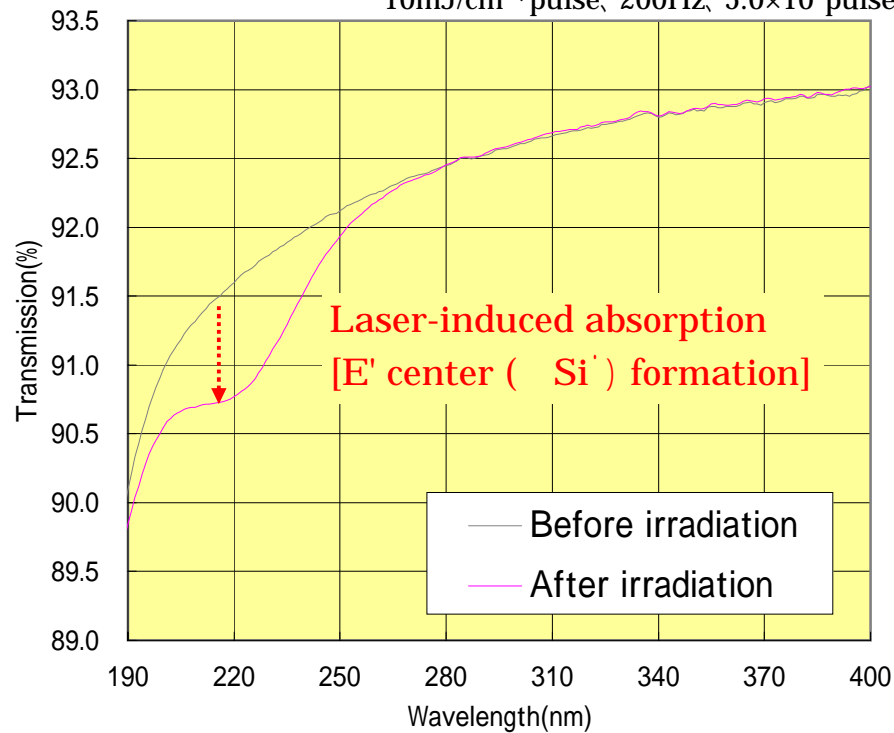
Laser Durability against ArF Excimer Laser (1)

Shin-Etsu's photomask substrate for ArF lithography keeps high transmission property even after practically high level dose of ArF excimer laser.

Result of accelerated test

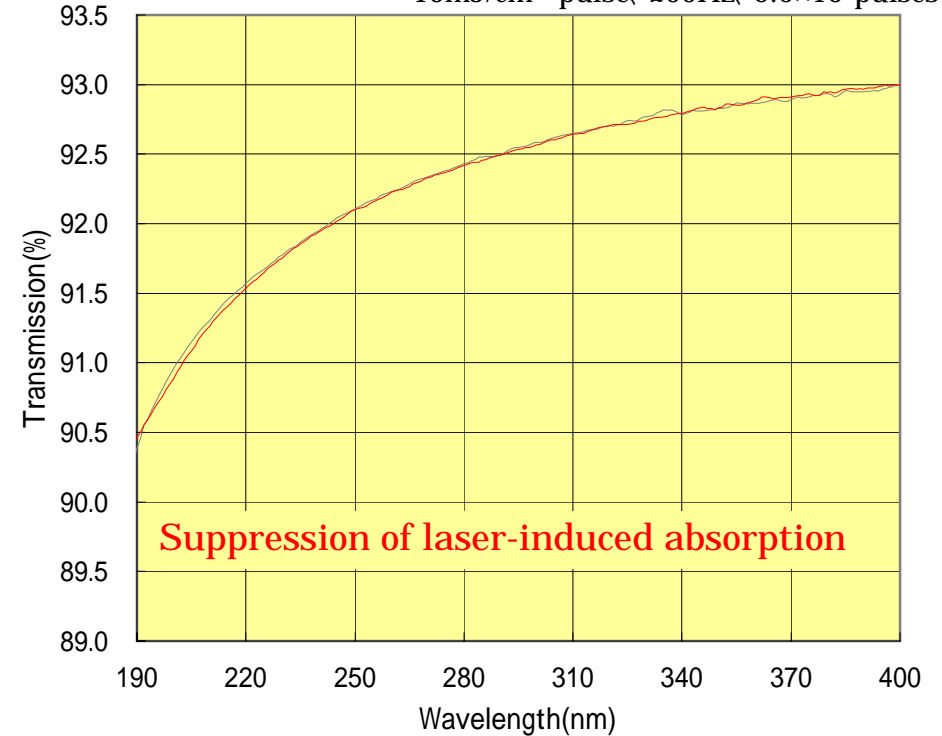
[SZS6025 ~ conventional grade for KrF]

10mJ/cm²·pulse, 200Hz, 5.0×10⁴pulses



[KNFS6025 ~ ArF grade]

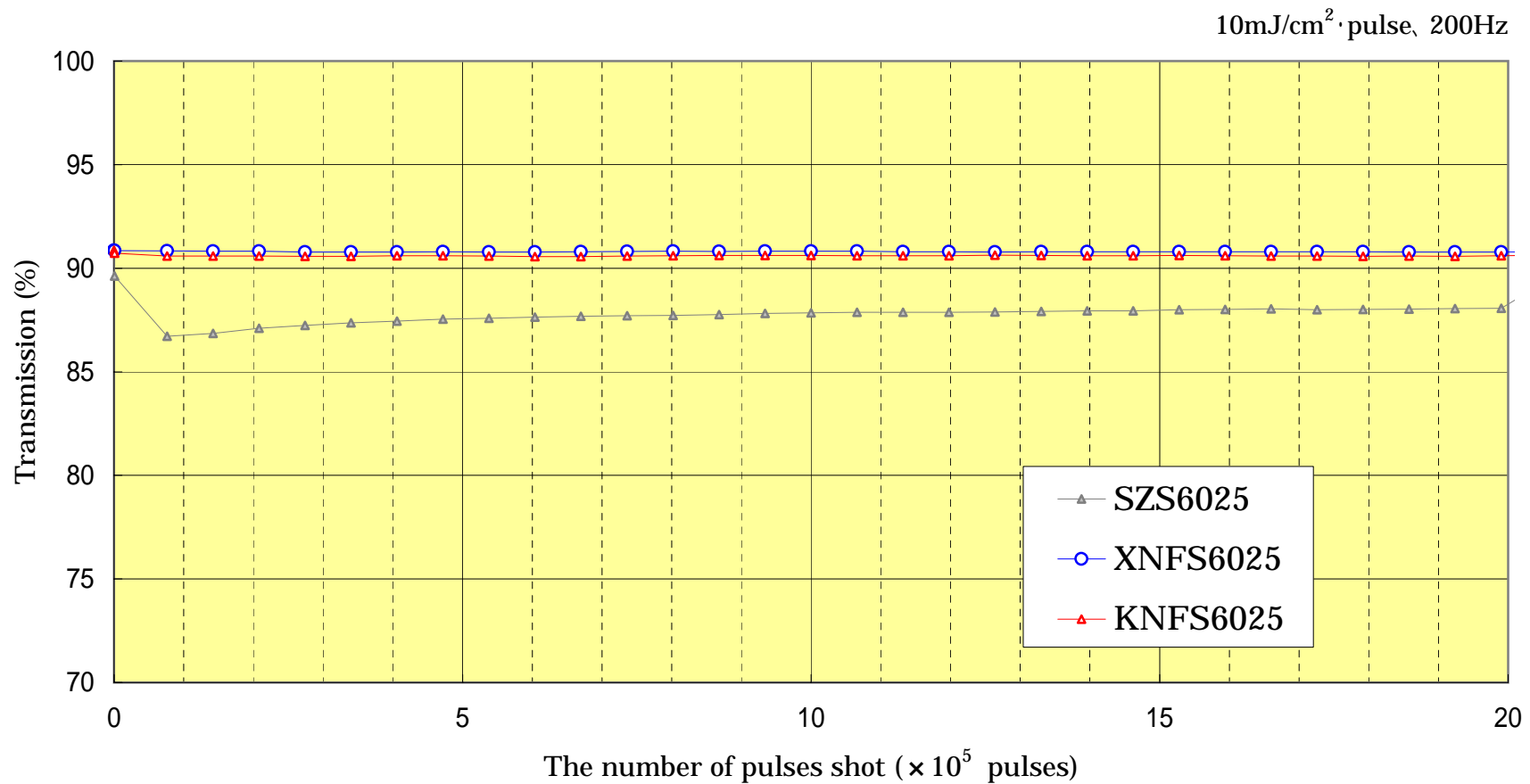
10mJ/cm²·pulse, 200Hz, 5.0×10⁴pulses



Laser Durability against ArF Excimer Laser (2)

Shin-Etsu's photomask substrate for ArF lithography keeps high transmission property even after practically high level dose of ArF excimer laser.

Result of accelerated test



Miscellaneous Properties

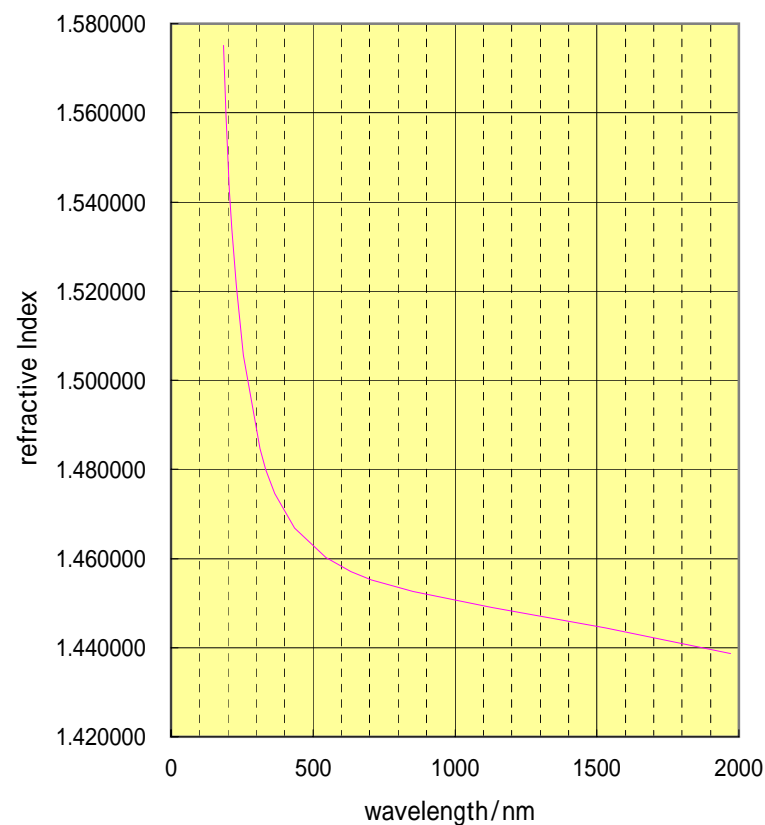
Optical properties, mechanical properties and thermal properties of Shin-Etsu's photomask substrate for ArF lithography are shown below. Reflective index will be important for Levenson masks, CPL masks, etc.

[Optical Properties]		Substrates for ArF		for KrF
		KNFS6025	XNFS6025	SZS6025
Refractive Index	248.3nm	1.508552	1.508543	1.508528
	193.4nm	1.560350	1.560338	1.560331

[Mechanical Properties]		Substrates for ArF		for KrF
		KNFS6025	XNFS6025	SZS6025
Young's modulus	kg/mm ²	7450	7450	7450
Shear modulus	kg/mm ²	3160	3160	3160
Poisson's ratio		0.17	0.17	0.17
Specific gravity	g/cm ³	2.20	2.20	2.20

[Thermal Properties]		Substrates for ArF		for KrF
		KNFS6025	XNFS6025	SZS6025
Coefficient of thermal expansion	K ⁻¹	5 × 10 ⁻⁷ (0 ~ 200)	5 × 10 ⁻⁷ (0 ~ 200)	5 × 10 ⁻⁷ (0 ~ 200)
Strain point		985	1095	985
Annealing point		1090	1190	1090

<Refractive index of KNFS6025>



Low Birefringence Grade for ArF High-NA Lithography

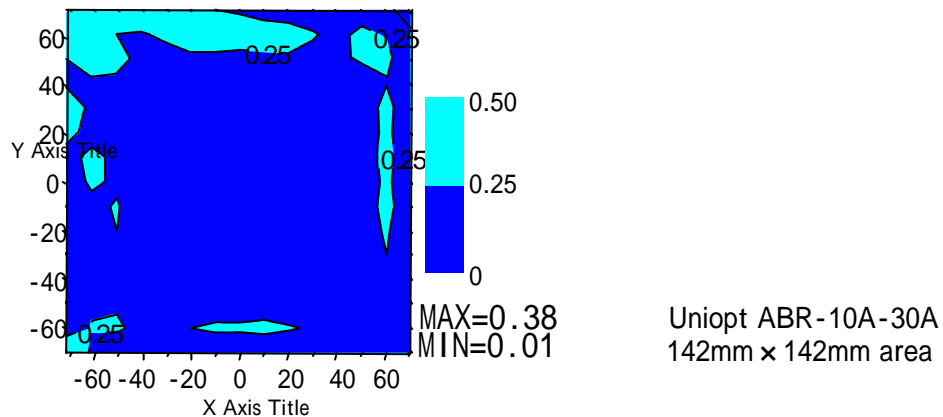
Shin-Etsu can add the property of low birefringence to the next generation photomask substrate for ArF High-NA and immersion lithography.

[Tentative specification]

Birefringence 1nm/6.35mm at wavelength of 193.4nm

Birefringence 2nm/6.35mm at wavelength of 193.4nm

[An example map of low birefringence KNFS6025]

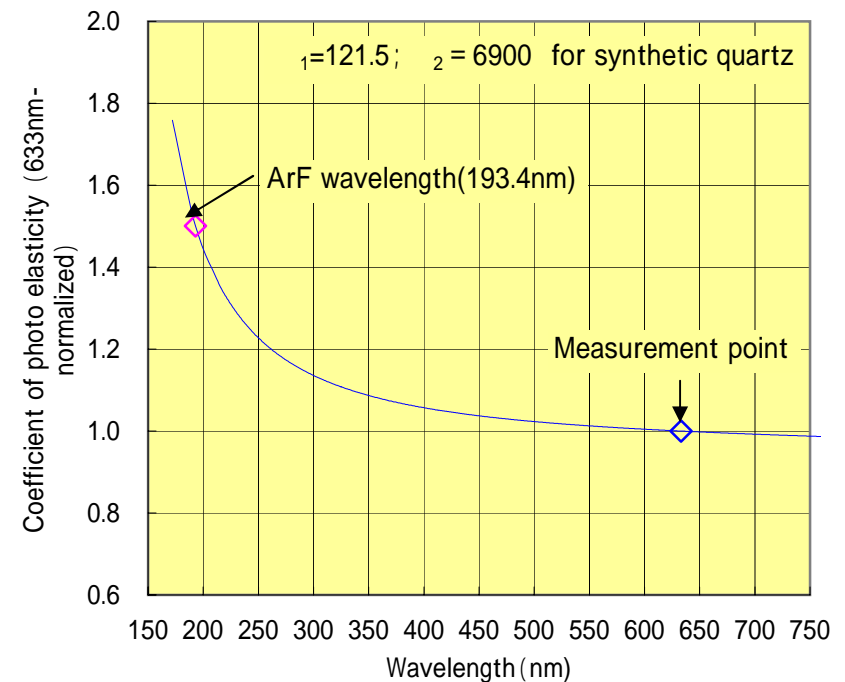


6.35mm-thick-Birefringence 0.38nm at wavelength of 633nm
corresponds to 0.57nm at 193.4nm

[Conversion of birefringence, $Re(\lambda)$: wavelength; $n(\lambda)$: index

$$\frac{Re(193.4nm)}{Re(633nm)} = \frac{C(193.4nm)}{C(633nm)} = 1.50$$

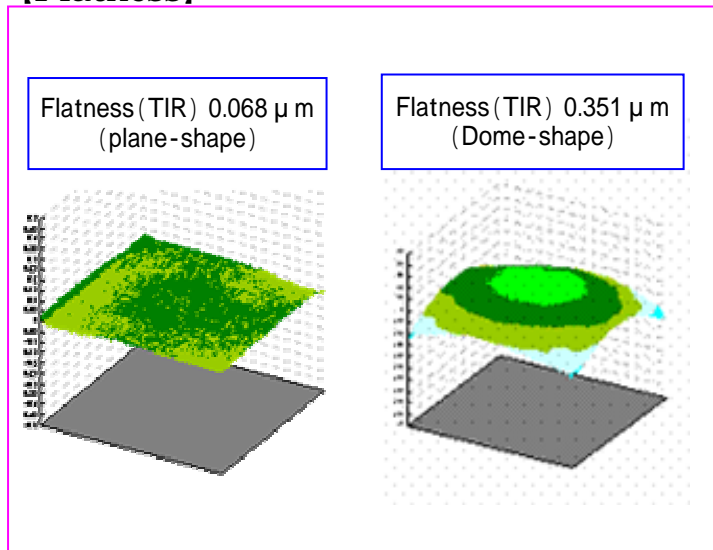
$$C(\lambda) = C(\lambda_0) \cdot \frac{n(\lambda_0)^2 - n_0^2}{n(\lambda)^2 - n_0^2} = C(\lambda_0) \cdot \frac{n_0^2 - n_1^2}{n_0^2 - n_2^2}$$



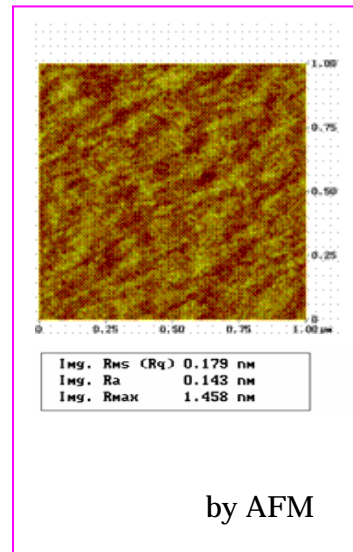
Shin-Etsu's Surface Technologies

Shin-Etsu supplies smooth, low-defect-density and highly flat surface for the photomask substrate for ArF lithography. Shin-Etsu manufactures a 0.5 μm-flatness substrate as a standard flatness grade for the photomask substrate for ArF lithography.

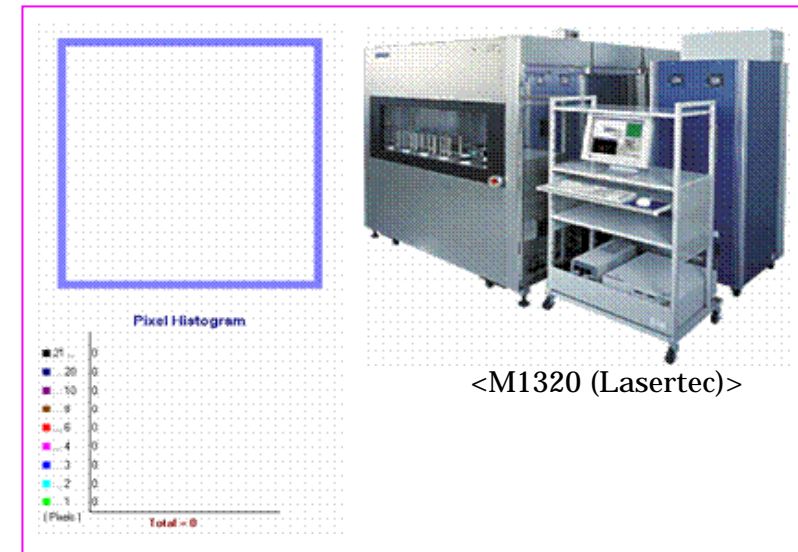
[Flatness]



[Roughness]



[Defect]



Flatness grades

Grade	Flatness	Comments
E05	0.5 μm	
E05S	0.5 μm	A certain shape to your option
E025	0.25 μm	Special use
E01	0.1 μm	

Low Surface Roughness

· Rms(1μm) 0.2nm

Low-Defect-Density Surface (called LD-SZS)

· The number of 0.5μm-defects counts 20

(Standard grade with sampling inspection by MAGICS)