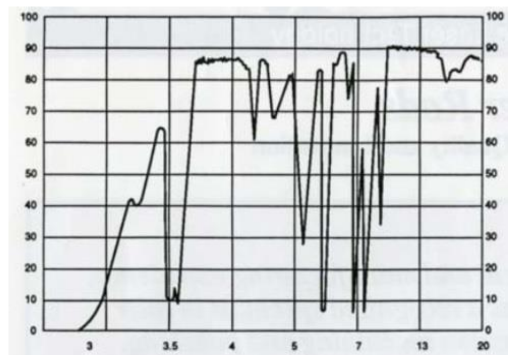
Kigre Laser Glass

With more than 30 years of development and manufacturing experience Kigre, Inc. has earned its reputation as a recognized specialist in laser glass formulation, fabrication, and precision machining and polishing.
In the early 1970s, Kigre acquires the basic patens and let the industry by developing high gain, platinum free phosphate laser glasses with optical and damage resistant properties not thought possible only a few years earlier.
To ensure the highest quality Kigre's specialty glass melt facilities are maintained in a sealed "dry" area capable of humidity levels below 10%. Kigre also utilized proprietary chemical purification techniques to prepare the starting chemicals.

Q-246

A Neodymium-doped silicate laser glass known for its high strength and durability. It is the laser glass of choice for a wide range of applications. In addition to it's excellent optical quality and durability Q-246 salient features include:
1. High Gain- Tests have shown Q-246 is unsurpassed in gain relative to other silicate laser glasses.
2. Non-Solarizing- Protection against solerazation and bleaching by a proprietary anti-solarant.
3. Tough- A modulus of rupture of 1.5 x10^4 psi.

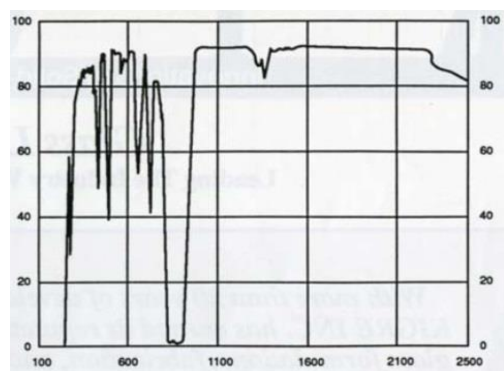


QE-7

Erbium-doped phosphate laser glass is four times more efficient than Erbium silicate laser materials developed in the 1960s. What's more, its unique "eye-safe" operating wavelength of 1.535 microns makes it ideal for specialized medical apparatus as well as field-safe range finder applications.

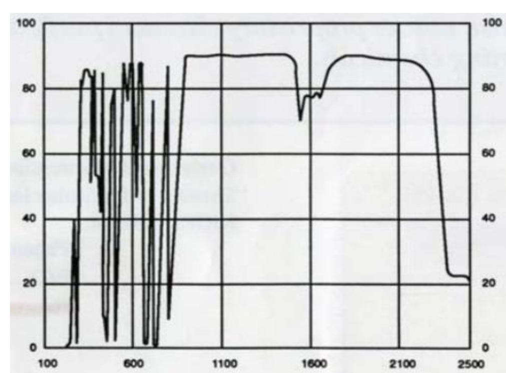
QE-7S

This sensitized version of QE-7 also is available for a wide range of applications.



Q-88

A platinum-free phosphate laser glass renowned for its high gain and exceptional durability in high peak power environments. Used exclusively for a decade in the disk amplifiers of the KMS laser fusion facility, Q-88 performs superbly in range finder applications.



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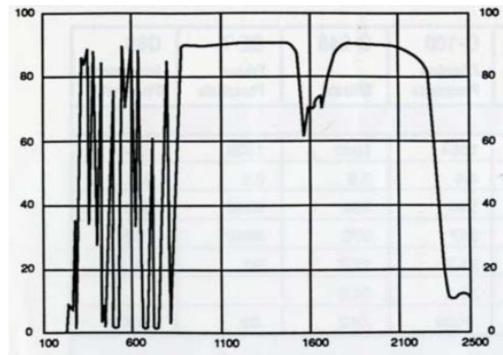
Q-89

A platinum-free athermal phosphate laser glass with improved strength for high power, high repetitive rate laser systems.

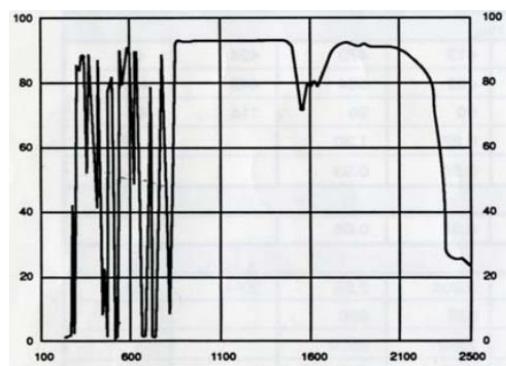
Q-89 combines the high gain and high damage-threshold properties of the phosphate glasses with the high strength and durability characteristics of the silicate glasses. It is ideal for fusion and other scientific applications because of its high gain, constant beam divergence, and liquid-cooling capability.



Q-98

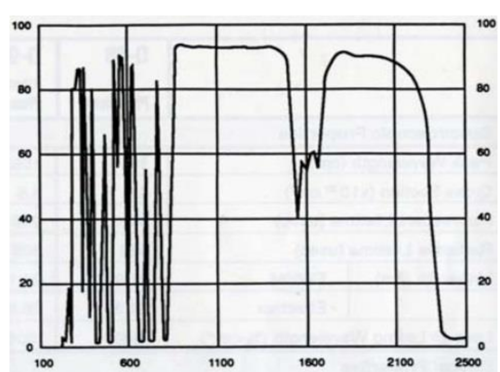
A Neodymium=doped athermal phosphate laser glass of exceptional optical quality offering high gain and athermal behavior. The result- higher repetition rates with minimum beam divergence.

Q-98's high thermal loading and liquid-cooling capabilities make it ideal for fusion and other scientific applications.



Q-100

Used in applications where the highest possible gain is desired, the superior performance of the Neodymium=doped athermal phosphate glass results from its uniquely high Neodymium concentration. Designed for military and industrial applications, Q-100 is the YAG alternative and requires comparable precautions to suppress parasitic lasing and other performance degrading phenomena. For example, Q-100 rods generally should not be polished. In air-cooled systems, samarium cavity filters are recommended.



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Properties	Q-88	Q-98	Q-100	Q-246	QE-7
Laser Wavelength Peak (nm)	1054	1053	1054	1062	1535
Cross Section (x $10^{-20}cm^2$)	4.0	4.5	4.4	2.9	0.8
Fluorescence Lifetime (ns)	330	350	190	330	8000
Radiative Lifetime (µs)	326	308	357	370	8800
Fluorescence Linewidth (nm) FWHM	21.9	21.1	21.2	27.7	30
Fluorescence Linewidth (nm) Effective	26.3	25.5	25.1	34.0	
Loss @ Lasing Wavelength (%cm-1)	0.0008	0.0008	0.0008	0.002	0.02
Index of Refraction (n_D)	1.550	1.555	1.572	1.572	1.542
Index of Refraction @ Lasing wavelength	1.536	1.546	1.562	1.561	1.532
Nonlinear Index N2(10^{-13} esu)	1.1	1.2	1.2	1.4	
Abbe Number	64.8	63.6	62.1	57.8	
dn/dT (20-40°C) (x10^{-6}/C)	-0.5	-4.5	-4.6	2.9	-6.3
Thermal Coefficient of Optical Path (20-40°C) (x10^{-6}/C)	2.7	±0.5	0.5	9.0	
Transition Temperature	336	416	413	470	424
Deformation Temperature	385	440	432	504	443
Coeff. Of Thermal Expansion (20-40°C) (x10^{-7}/°C)	104	99	96	90	114
Thermal conductivity (W/m K)	0.84	0.82	0.82	1.30	
Specific Heat (J/g K)	0.81	0.80	0.80	0.93	
DW (H2O 100 C 1HR) Wt % Loss	0.20	0.08	0.08	0.04	
Density (g/cc)	2.71	3.099	3.204	2.55	2.94
Durability Knoop Hardness (kgf/mm^2)	418	556	558	600	
Young's Modulus (x10^3 N/mm^2)	7123	7210	7150	8570	
Poisson's Ratio	0.24	0.24	0.24	0.24	
Damage Threshold (1ns) J/cm^2	>25	>25	>25	>25	>25

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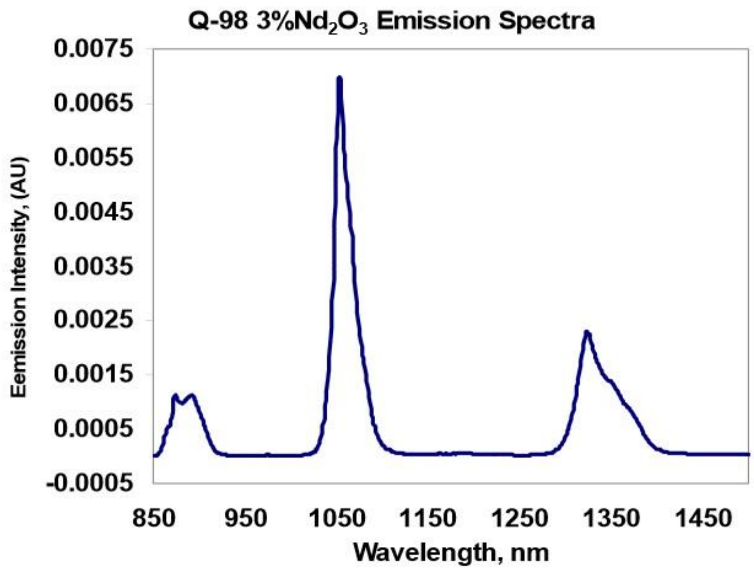
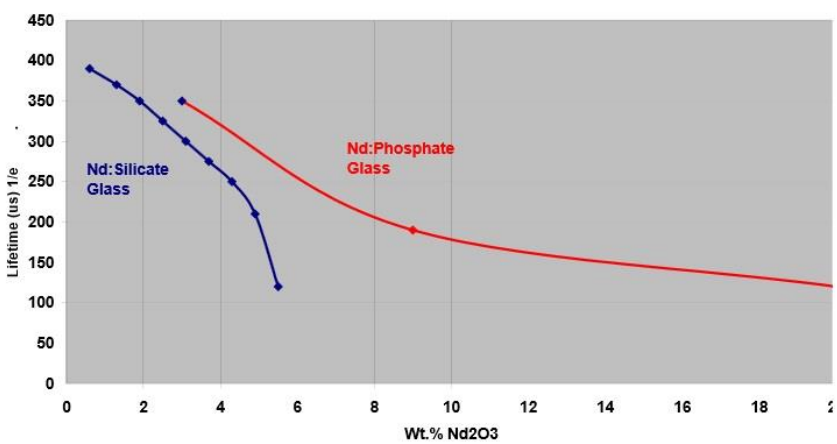


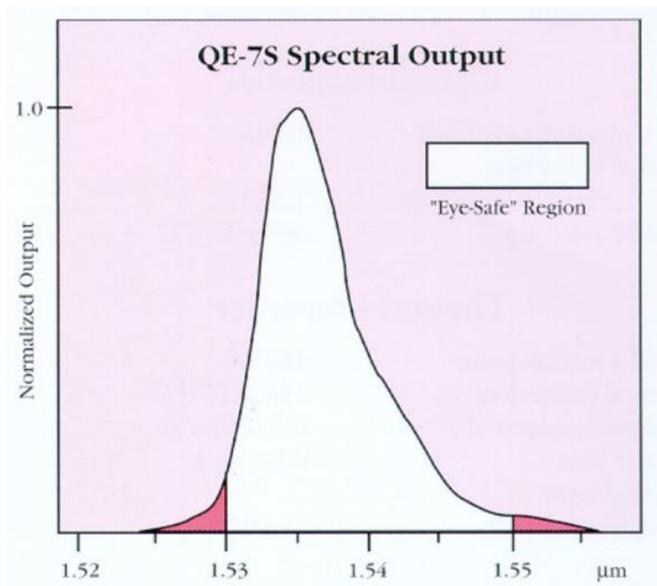
Fluorescence lifetime vs. Nd2O3 Concentration
ND: Silicate & Nd: Phosphate



QE-7S Erbium-Doped Phosphate Laser Glass

Technical specification:

Properties	**QE-7S**
Laser Wavelength Peak	1535 nm
Cross Section	$0.8x\ 10^{-20}cm^2$
Fluorescence Lifetime	8 ms
Radiative Lifetime	8 ms
Linewidth	30 nm FWHM
Loss at lasing wavelength	0.02%/cm
Index of Refraction (nD)	1.542
Index of Refraction at 1.54µm	1.531
dn/dT (20-40°C)	$-63x10^{-7}$/°C
Transformation point	462°C
Thermal expansion	$114\ x10^{-7}$/°C
Thermal conductivity	0.82 W/m°K
Specific heat	0.80 J/g°K
Thermal-optic coefficient (W)	$-3x10^{-7}$/°C
Density	2.94 g/cc
Knoop's hardness	556
Young's modulus	7210 kg/mm^2
Poisson's ratio	0.24
Damage threshold	>25 J/cm^2



QX Laser Glasses

Properties	QX/Nd	QX/Er	QX/Yb
Laser Wavelength Peak (nm)	1054	1535	1032
Emission Cross Section (x 10-20cm^2)	3.8	0.8	0.4
Absorption Cross Section (x 10-20cm^2)	0.7	1.7@977nm	1.4
Fluorescence Lifetime (ns)	353	7900	2000
Fluorescence Linewidth (nm) FWHM	27.6	55.0	56.5
Index of Refraction (nD)	1.538	1.532	1.535
(nF)	1.543		
(nC)	1.536		
(nF)-(nC) (x10^{-5})	815	848	834
Abbe Number	66.0	63.7	61.1
Index of Refraction (laser line)	1.53	1.521	1.52
dn/dT (20-40°C) (x10^{-7}/C)	-4	-21	-21
Thermo-stress Birefr. Coeff. Q=[E/2(1-μ)](C1-C2)(x10^{-7}/°C)	9.0	9.1	9.1
Thermo-optical Coeff. W=[dn/dT + (n-1)](x10-7/C) @ 70°C	59	41	41
Thermo-optical Coeff. W=[dn/dT + (n-1)](x10-7/C) @ 30°C	51	33	33
Transformation Temperature (°C)	506	470	450
Deformation Temperature (°C)	535	502	485
Coeff. Of Thermal Expansion (20-40°C) (x10-7/°C)	72	76	83
Coeff. Of Thermal Expansion (20-100°C) (x10-7/°C)	84	88	95
Coeff. Of Thermal Expansion (20-300°C) (x10-7/°C)		99	1.22
Nonlinear Index n2 (x10^{-13} esu)	1.17	1.22	2.81
Density (g/cc)	2.66	2.93	0.85
Thermal conductivity (W/mK)	0.85	0.85	67
Young's Modulus (x10+3 N/mm^2)	71	67	0.24
Poisson's Ratio	0.24	0.24	2.3
Stress Optical Coeff. B=[C1-C2] (x10-6 mm^2/N)	2.1	2.3	5.1
Stress Thermal –Optical Coeff. P=dn/dT-[E/2(1-μ)](C1+3C2)	-3.6	5.1	5.2
Durability Knoop Hardness (kgf/mm^2)	503	435	435

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Properties	QX/Nd	QX/Er	QX/Yb
Thermal Loading Limit, TLL (W/inch) (unstrengthened)	> 300	> 150	> 300
Lamp Pumped (strengthened) 5x80 mm rod	> 900	> 450	>900
Lamp Pumped (strengthened) 10x150 mm rod	> 500	> 250	> 500

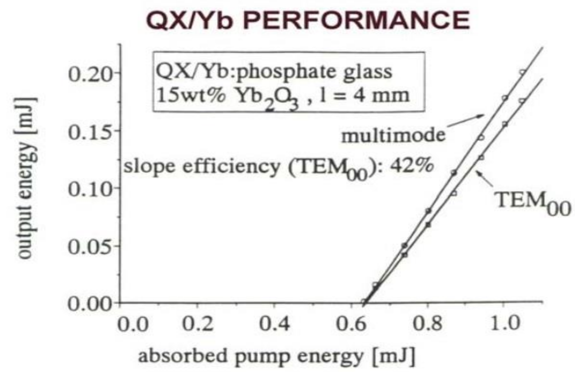
Conditions in both ion-exchanged strengthened and un-strengthened configurations.

Note: TLL= Rupture strength. Unstrengthened QX glasses exhibit a Rupture Strength of ~10,000 psi. Strengthened QX glasses exhibit a Rupture Strength of ~40,000 psi. The TLL is strongly dependent upon rod barrel surface conditions.
ET% to ions/cc: WT%(g)/100g x 2.9g/cc x 2 Er3+/382.52g/mole x 6.02 x 1023 ions/mole = ions/cc Er3+

These phosphate glass laser materials exhibit a chemical durability that is comparable to silicate glasses. EX glasses are designed to withstand high thermal loading and shock.

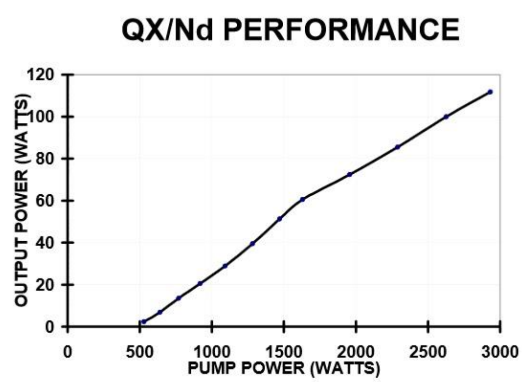
QX/Yb

Tunable 1025-1060 nm output
975nm pump



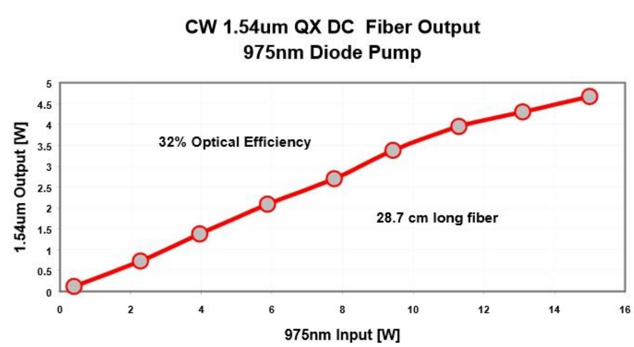
QX/Nd

Lamp pump 10mm x 6" rod,
60%R OC, 2ms PW,
5.4% Slope Efficiency



QX/Er

1.54 microns DC LMA
Fiber Laser



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