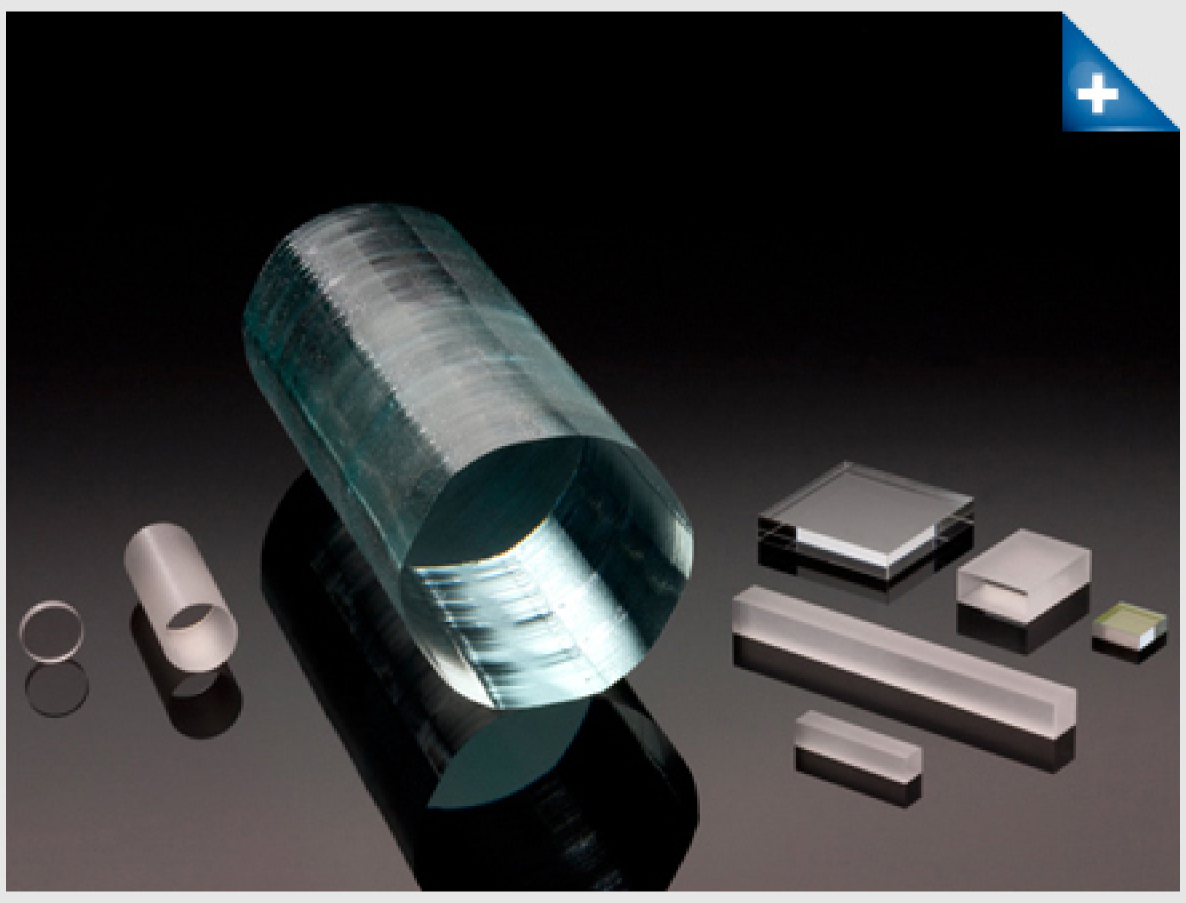
Laser Materials Yb:YAG



General Information

Crystals doped with trivalent ytterbium (Yb^{3+}) have demonstrated significant potential for application in compact, efficient, diode-pumped laser systems.[1-4] The Yb_{3+} ion has only two manifolds, the ground $^2F_{7/2}$ and the excited $^2F_{5/2}$ which are separated by approximately 10,000 cm-1. As a result, Yb^{3+}doped materials have spectroscopic and laser properties that are advantageous for high energy 1 μm laser systems. In particular, Yb^{3+} doped materials should not suffer from concentration quenching, upconversion, or excited state absorption. The Yb^{3+} ion also has a long energy storage lifetime (typically three to four times that of Nd_{3+} in the same host) and a very small quantum defect which reduces heat generation during lasing.

In the specific case of the host material YAG, Yb^{3+} has a storage lifetime of 950 μs and a quantum defect of only 8.6%. Yb^{3+}:YAG also has a broad pump line at 940 nm that is 10 times broader than the 808 nm pump line in Nd^{3+}YAG making the system less sensitive to thermal drift of the pump diodes wavelength. These material properties combined with the development of robust long-lifetime InGaAs pump diodes at 940 nm have made this material a superior candidate for diode-pumped high-energy lasers.

Laser systems based on SMC's UP-grade Yb^{3+}:YAG have been reported with cw output powers exceeding 430 W,[1] quasi-cw output powers of 600 W,[4] and optical to optical efficiencies of 60%.[2] Such systems have been reported to be scaleable with output powers at the kW level.

Crystals of Yb^{3+} doped YAG are available in a variety of dopant concentrations from 1% - 100% (e.g. Ytterbium aluminum garnet - YbAG).

Please contact us with your specific requirements or for availability and pricing of currently stocked compositions.

Dopant Ion

Yb3+ Concentration Range	1.0 - 100 atomic %
Dopant Ion Density @ 1 atomic %	
Y3+ Site	1.38×10^{20} cm^{-3}
Al3+Site (IV)	1.38×10^{20} cm^{-3}
Al3+Site (VI)	0.92×10^{20} cm^{-3}

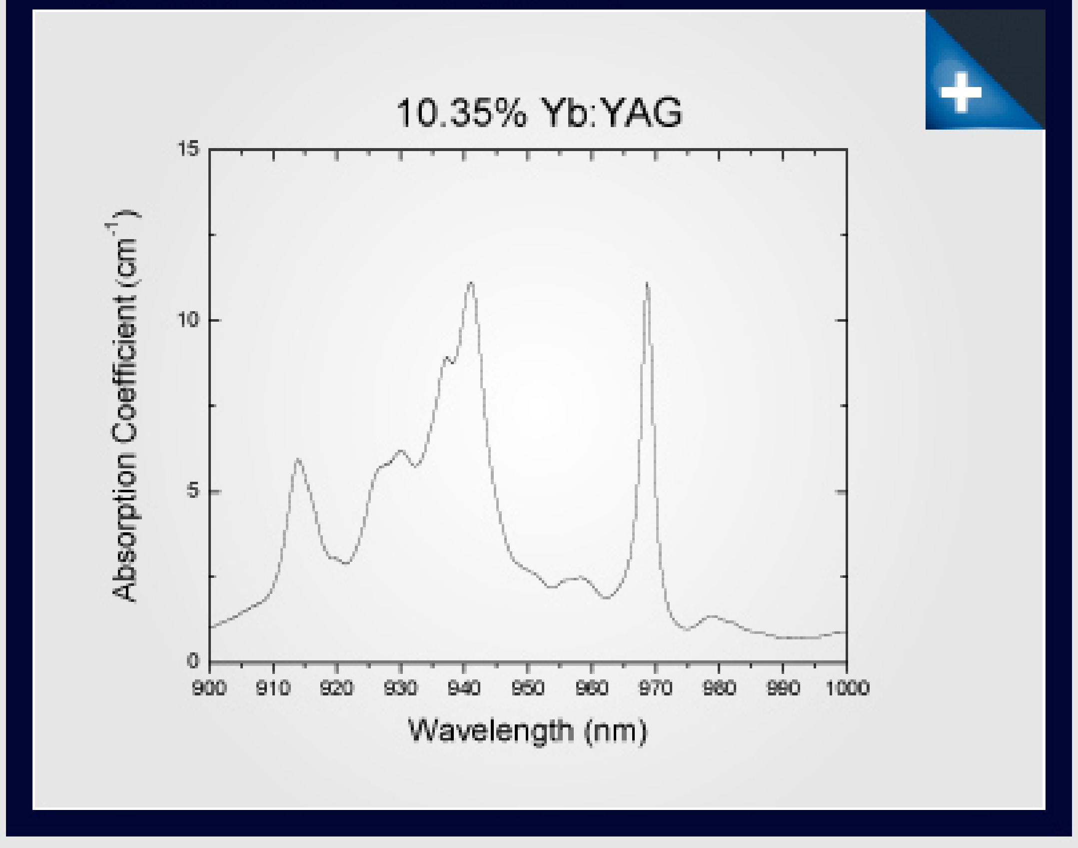
Common Operating Specs

Emission Wavelength	1.064 µm
Laser Transition	$^2F_{5/2} \rightarrow {}^4F_{7/2}$
Intrinsic Flouresence Lifetime (≤ 15 atomic % Yb doping)	967 µs
Pump Wavelength	941 nm

Physical Properties

Coefficient of Thermal Expansion	6.14×10^{-6} K^{-1}
Thermal Diffusivity	0.041 cm^2 s^{-2}
Thermal Conductivity	11.2 W m^{-1} K^{-1}
Specific Heat (Cp)	0.59 J g^{-1} K^{-1}
Thermal Shock Resistant	800 W m^{-1}
Refractive Index @ 632.8 nm	1.83
dn/dT (Thermal Coefficient of Refractive Index) @ 1064nm	7.8 10^{-6} K^{-1}
Molecular Weight	593.7 g mol^{-1}
Melting Point	1965°C
Density	4.56 g cm^{-3}
MOHS Hardness	8.25
Young's Modulus	335 Gpa
Tensile Strength	2 Gpa
Crystal Structure	8Cubic
Standard Orientation	<111>
Y3+ Site Symmetry	D_2
Lattice Constant	a=12.013 Å

Absorption Coefficient Chart



References

1) Camille Bibeau and Ray Beach, "CW and Q-switched performance of a diode end-pumped Yb:YAG laser," Advanced Solid-State Lasers, January 27-29, 1997 Orlando, FL.

2) M. Karszewski, U. Brauch, A. Giesen, I. Johannsen, U. Schiegg, C. Stewen, A. Voss, "Advanced Tunability and High-Power TEM00-Operation of the Yb:YAG Thin Disc Laser," Advanced Solid-State Lasers, January 27-29, 1997 Orlando, FL.

3) H. Bruesselbach and D. Sumida, "69-W-average power Yb:YAG laser," Opt. Lett. 21, 480 (1996).

4) H. Bruesselback, D. S. Sumida, R. Reeder, and R. W. Byren, "High-Power Side-Diode-Pumped Yb:YAG Laser," Advanced Solid-State Lasers, January 27-29, 1997 Orlando, FL.

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