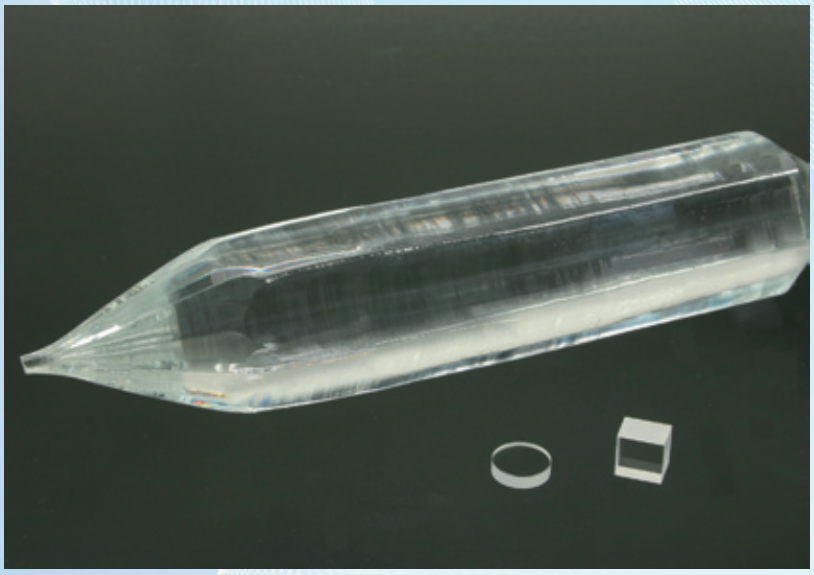
Laser Crystals Yb:YAG and Yb:LuAG

The Yb^{3+} ion exhibits a small quantum defect and a quasi-three level system with a long upper laser level lifetime (around 1 ms for Yb:YAG), which is important for energy accumulation in Q-switched lasers. The wide luminescence band of Yb^{3+} is advantageous for the generation of sub-picosecond pulses. Yb^{3+} doped crystals do not suffer from luminescence concentration quenching. Their long energy storage lifetime, broad absorption band at 940 nm and very low quantum defect make Yb:YAG and Yb:LuAG crystals superior candidates for diode-pumped high-energy lasers.

PHYSICAL PROPERTIES	Yb:YAG	Yb:LuAG
Pump wavelength	941 nm	938 nm
Absorption cross section	8.2×10^{-21} cm^2	7.2×10^{-21} cm^2
Emission wavelength	1030 nm	1031 nm
Emission cross section	2.1×10^{-20} cm^2	2.6×10^{-20} cm^2
Laser transition	$^2F_{5/2} \rightarrow {}^2F_{7/2}$	$^2F_{5/2} \rightarrow {}^2F_{7/2}$
Refractive index at 1030 nm	1.82	1.84
Crystal structure	cubic	cubic

Yb:YAG



Our standard offer of Yb doped YAG crystals includes:

- Yb dopant concentrations from 1 at. % up to 10 at. % of Yb/Y
- Rod diameters from 2 up to 10 mm
- Rod lengths of up to 100 mm
- Variety of anti-reflection, partial or high reflection coatings

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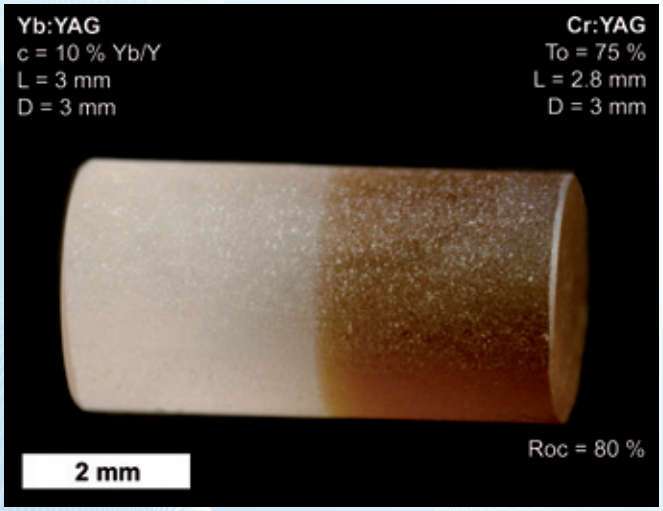
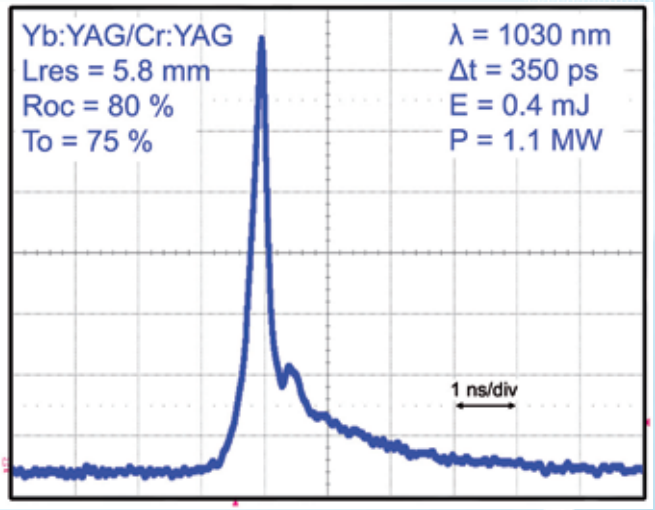
Application example: **Q-switched Yb:YAG-Cr:YAG microchip laser**

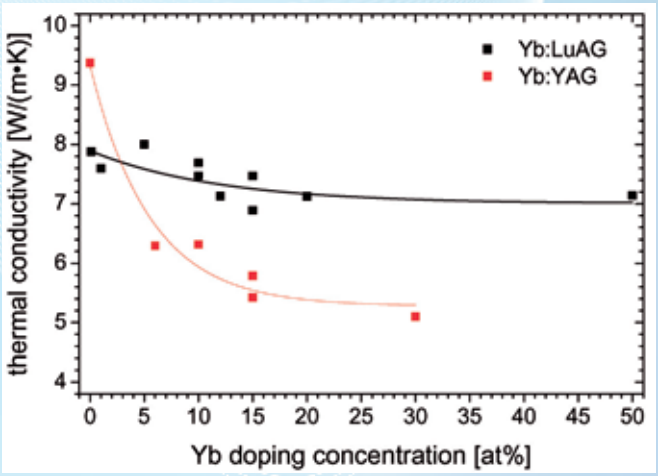
Gain medium: Yb:YAG 3 x 3 mm, Q-switch Cr^{4+}:YAG T_0 = 75 %

Coating: Yb:YAG side – HR@1030 nm + HT@968 nm
Cr4⁺:YAG side – R_{OC} = 80 % @1030 nm





Yb:LuAG



Undoped YAG has higher thermal conductivity compared to undoped LuAG. Increasing Yb^{3+} doping leads to a drop of in thermal conductivity. In Yb:YAG thermal conductivity decreases to almost half of its initial value, while Yb:LuAG displays a drop of only 10%. Heavily doped Yb:LuAG can be advantageously used in thin disc lasers.

References:

K. Beil, S. T. Fredrich-Thornton, R. Peters, K. Petermann, and G. Huber, "Yb-doped thin-disk laser materials: A comparison between Yb:LuAG and Yb:YAG," in Advanced Solid-State Photonics 2009 Technical Digest on CD-ROM, WB28, OSA, 2009.

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