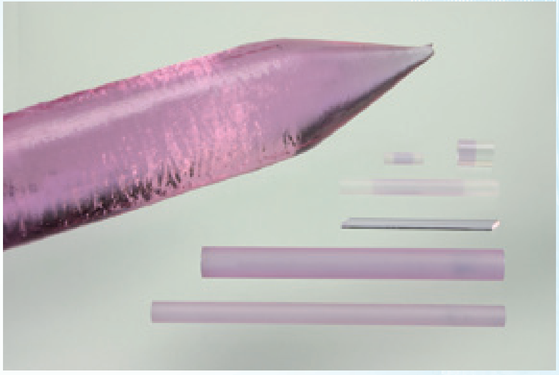
Laser Crystals
Nd:YAG and Nd:YAP

Nd:YAG



CRYTUR grows neodymium doped yttrium aluminium garnet (Nd:YAG) crystals using the Czochralski growth method. A special protective atmosphere applied during crystal growth and post growth annealing result in a very good lasing efficiency of our crystals. Our production line covers crystal growth, machining and coating technologies.

Our standard production of Nd:YAG laser rods includes:

- Nd dopant concentrations from 0.05 % up to 1.3 at. % of Nd/Y
- Rod diameters from 2 mm up to 12 mm
- Rod lengths of up to 160 mm
- Barrel surface fine ground, polished or grooved
- Perpendicular or wedged ends
- Polishing according to DIN and MIL standards
- A wide variety of anti-reflection, partial or high reflection coatings
- AR coatings with R < 0.2 % and damage threshold higher than 15 J/cm^2 for 10 ns pulses

We also offer **composite laser** rods consisting of doped and undoped segments. These composite rods help to decrease thermal lensing and other thermal stress induced effects, particularly when used in axially diode pumped resonators.

Microchip laser design can be used for alignment-free Q-switched resonators. This compact design combines, in one piece, a cooling undoped part, an Nd:YAG active part and a passive saturable absorber segment. Dielectric mirrors are placed directly on the crystal faces. This configuration enables effective heat removal from the Nd:YAG and saturable absorber parts.

Nd:YAP

Our standard production of Nd:YAP laser rods includes Nd dopant concentrations from 0.25 % up to 1.1 at. % of Nd/Y. Nd:YAP laser rods with 0.7 at. % Nd/Y are typically used for CW and 0.9 at. % Nd/Y for pulsed lasers, both with the "b" orientation. The threshold and slope efficiency of Nd:YAP at 1079 nm are comparable to those of Nd:YAG at 1064 nm. Rods cut along the "b" axis are suited for most of applications. Linear polarization, no thermal birefringence and easy generation of 1.3µm are the main advantages of this material.

The 1340 nm emission wavelength of Nd:YAP has higher absorption in water and bodily fluids in comparison with the 1319 nm emission wavelength of Nd:YAG.

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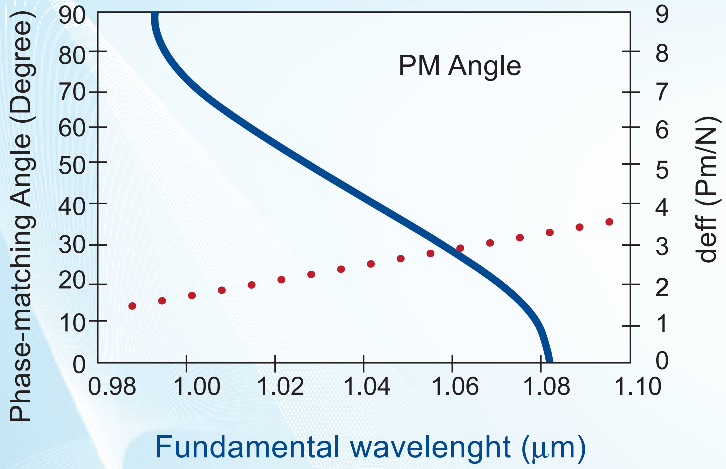

Taking into account the polarized output beam, Nd:YAP can be advantageously utilized in lasers with electro optic cells or harmonic generators. The wavelength of 1079 nm emitted by Nd:YAP can realize type II non-critical phase matching in an α-cut KTP crystal, where the effect of beam walk-off is eliminated and the conversion efficiency is increased compared to angular phase-matching.

Important Material Properties of Nd:YAP and Nd:YAG

	Nd:YAP	Nd:YAG
Host	Yttrium Aluminium Perovskite ($YAlO_3$)	Yttrium Aluminium Garnet ($Y_3Al_5O_{12}$)
Dopant	Nd^{3+}	Nd^{3+}
Crystal structure	orthorhombic	cubic
Unit cell dimensions	a_0= 0.518 nm b_0= 0.531 nm c_0= 0.736 nm	a_k= 1.201 nm
Refractive index (1,06 μm)	a: 1.914 b: 1.925 c: 1.940	1.816
Thermal expansion coefficient	‖a: 9.5 x 10^{-6} / K ‖b: 4.3 x 10^{-6} / K ‖c: 10.8 x 10^{-6}/ K	7.8 x 10^{-6}/ K
Thermal Conductivity	0.11 W/cm K	0.11 W/cm K
Density	5.35 g/cm^3	4.56 g/cm^3
Mohs Hardness	8.5	8.25
Fluorescent lifetime (1% Nd)	170 μs	235 μs
Linear dispersion δn/δT [$10^{-6}K^{-1}$]	9.7 (n_a)	9.86
Laser wavelengths	$^4F_{3/2}\rightarrow{}^4I_{9/2}$ 930 nm $^4F_{3/2}\rightarrow{}^4I_{11/2}$ 1079 nm $^4F_{3/2}\rightarrow{}^4I_{13/2}$ 1340 nm	$^4F_{3/2}\rightarrow{}^4I_{9/2}$ 946 nm $^4F_{3/2}\rightarrow{}^4I_{11/2}$ 1064 nm $^4F_{3/2}\rightarrow{}^4I_{13/2}$ 1319 nm

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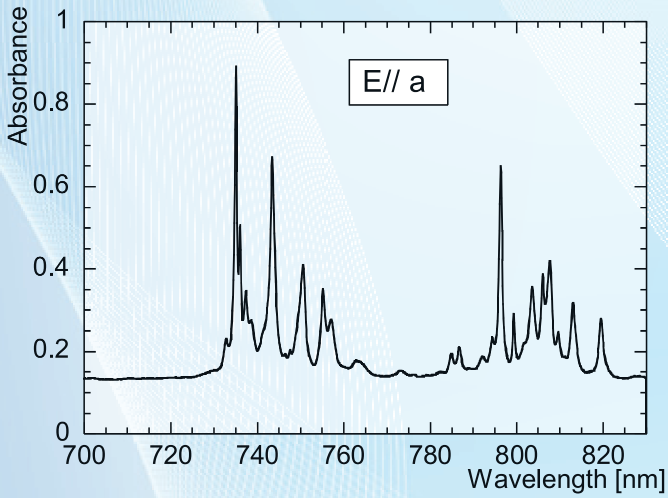
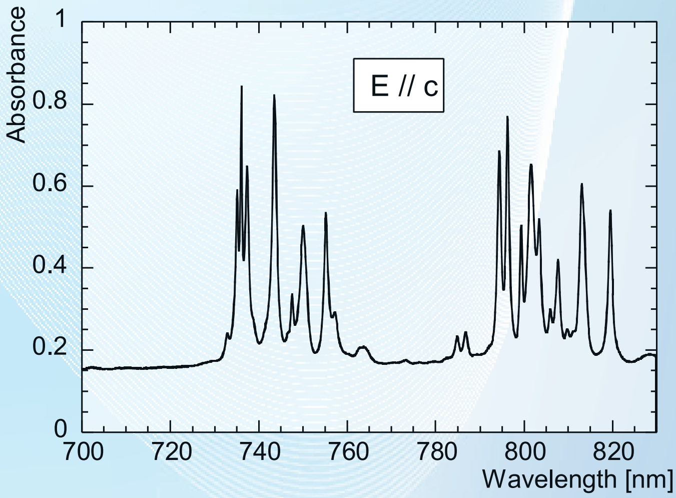
Comparison of emission cross sections of Nd:YAG and Nd:YAP in dependence on its crystallographic orientation.

(Ref. A. A. Kaminskii, Laser Crystals, New York: Springer Verlag 1981).

	Wavelength [nm]	Emission cross section [10^{-19} cm^2]		
Nd:YAG	1064.1	3.3		
	1318.7	0.95		
	1341.9	0.36		
		"a" cut	"b" cut	"c" cut
Nd:YAP	1064.4	1.1	1.09	1.38
	1079.6	2.05	1.76	1.2
	1399.3	0.69	0.94	0.78
	1341.3	1.13	0.97	0.47

The main absorption line of the Nd:YAG crystal occurs at 808 nm. In case of the "b" cut Nd:YAP crystal, the peak of the absorption band is centred at 803 nm for polarization parallel to the "c" crystallographic direction and 807 nm for polarization parallel to the "a" crystallographic direction.





Absorption spectra of Nd:YAP (1 mm thick plate)

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