

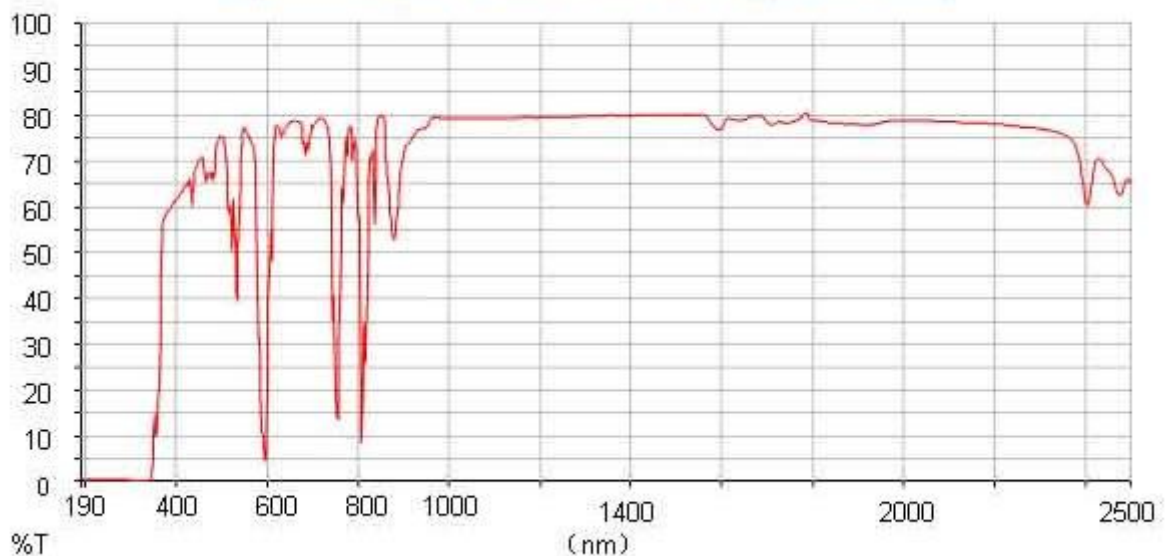
### Nd:YVO4 Crystal Basic Properties:

Atomic Density	$1.26 \times 10^{20}$ atoms/cm <sup>3</sup> (Nd1.0%)
Crystal Structure	Zircon Tetragonal, space group $D_{4h}-I4/amda=b=7.1193A,c=6.2892A$
Density	4.22g/cm <sup>3</sup>
Mohs Hardness	4-5(Glass-like)
ThermalExpansion Coefficient(300K)	$\alpha_a=4.43 \times 10^{-6}/K$ $\alpha_c=11.37 \times 10^{-6}/K$
Thermal Conductivity Coefficient(300K)	//C:0.0523W/cm/K, $\perp$ C:0.0510W/cm/K

### Nd:YVO4 Crystal Optical Properties:

Lasing wavelength	1064nm,1342nm
Thermal optical coefficient (300K)	$dn_o/dT=8.5 \times 10^{-6}/K$ $dn_e/dT=2.9 \times 10^{-6}/K$
Stimulated emission cross-section	$25 \times 10^{-19} \text{cm}^2$ @ 1064nm
Fluorescent lifetime	90 $\mu$ s(1% Nd doping)
Absorption coefficient	$31.4 \text{cm}^{-1}$ @810nm
Intrinsic loss	$0.02 \text{cm}^{-1}$ @1064nm
Gain bandwidth	0.96nm@1064nm
Polarized laser emission	n polarization; parallel to optic axis(c-axis)
Diode pumped optical to optical efficiency	>60%
Sellemeier equations ( $\lambda$ in $\mu$ m)	$n_o^2=3.77834+0.069736/(\lambda^2-0.04724)-0.010813\lambda^2$ $n_e^2=4.59905+0.110534/(\lambda^2-0.04813)-0.012676\lambda^2$

Figure 1. Absorption Curve of 0.5% Nd:YVO<sub>4</sub>(thickness 4mm)



## Nd:YVO4 Crystal Laser Properties:

1. One of the most attractive character of Nd:YVO4 is, compared with Nd:YAG, it has 5 times larger absorption coefficient in a broader absorption bandwidth around the 808 nm peak pump wavelength, which just matches the standard of high power laser diodes currently available. This means a smaller Nd:YVO4 crystal that could be used for the laser, leading to a more compact laser system. For a given output power, this also means a lower power level at which the laser diode operates, thus extending the lifetime of the expensive laser diode. The broader absorption bandwidth of Nd:YVO4 which may reaches 2.4 to 6.3 times that of Nd:YAG, is also valuable. Besides more efficient pumping, Nd:YVO4 also means a broader range of selection of diode specifications. This will be helpful to laser system makers for wider tolerance and lower cost choice.

2. Nd:YVO4 crystal has larger stimulated emission cross-sections, both at 1064nm and 1342nm. When a-axis cut Nd:YVO4 crystal lasing at 1064m, it is about 4 times higher than that of Nd:YAG, while at 1340nm the stimulated cross-section is 18 times larger, which leads to a CW operation completely outperforming Nd:YAG at 1320nm. These make Nd:YVO4 laser be easy to maintain a strong single line emission at the two wavelengths.

3. Another important character of Nd:YVO4 lasers is, because it is an uniaxial rather than a high symmetry of cubic as Nd:YAG, what it emits is only a linearly polarized, thus avoiding undesired birefringent effects on the frequency conversion. Although the lifetime of Nd:YVO4 is about 2.7 times shorter than that of Nd:YAG, its slope efficiency can be still quite high for a proper design of laser cavity, because of its high pump quantum efficiency.

The major laser properties of Nd:YVO4 vs Nd:YAG are listed in Table below, including stimulated emission cross-sections ( $\sigma$ ), Absorption Coefficient ( $\alpha$ ) Fluorescent lifetime ( $\tau$ ), Absorption Length ( $L_a$ ), threshold Power ( $P_{th}$ ) and Pump Quantum Efficiency ( $\eta_s$ ).

Laser Crystal	Doping (atm%)	$\sigma$ ( $10^{-19}cm^2$ )	$\alpha$ ( $cm^{-1}$ )	$\tau$ ( $\mu s$ )	$L_a$ (mm)	$P_{th}$ (mW)	$\eta_s$ (%)
Nd:YVO <sub>4</sub> (a-cut)	1.0	25	31.2	90	0.32	30	52
	2.0	25	72.4	50	0.14	78	48.6
Nd:YVO <sub>4</sub> (c-cut)	1.1	7	9.2	90		231	45.5
Nd:YAG	0.85	6	7.1	230	1.41	115	38.6

## Diode pumped Nd:YVO4 laser output comparing with diode pumped Nd:YAG laser:

Crystals	Size(mm <sup>3</sup> )	Pump Power	Output (at 1064nm)
Nd:YVO <sub>4</sub>	3x3x1	850mW	350mW
Nd:YVO <sub>4</sub>	3x3x5	15W	6W
Nd:YAG	3x3x2	850mW	34mW

Diode pumped Nd:YVO<sub>4</sub>+KTP green laser:

8W green laser was generated from a 15W LD pumped 0.5% Nd:YVO<sub>4</sub> with intracavity KTP.

200mW green outputs are generated from 1W LD pumped 2% Nd:YVO<sub>4</sub> lasers by using the 2x2x5mm KTP and 3x3x1mm Nd:YVO<sub>4</sub>.