# Neodymium: Yttrium Orthovanadate - $Nd:YVO_4$

Yttrium Vanadate (or orthovanadate) doped with Neodymium, $Nd:YVO_4$, is a promising material for diode pumped lasers. Several advantages over Nd:YAG include a higher gain cross-section, lower threshold, a wider Nd absorption peak and polarized output. The wider absorption peak means that the laser output power is less sensitive to drifting of the diode pump wavelength due to temperature or ageing effects. One optimum pump wavelength is centered at 809 nm with a useful range (at 50% of the peak) of 801 to 821 nm (Ref. 1). Similarly Nd:YAG peaks at 809 nm, but the range is only 805 to 810 nm.

Yttrium Vanadate has been grown from the flux and by the Czochralski method, which is the technique used at SYNOPTICS. The crystal is tetragonal which means there are two equivalent "a" directions and a "c" direction, all mutually orthogonal. A typical laser rod is oriented with the rod axis along an a-axis of the crystal. Maximum absorption of pump light occurs for polarization along the c-axis.

## Comparison of Nd:Yttrium Vanadate with Nd:YAG

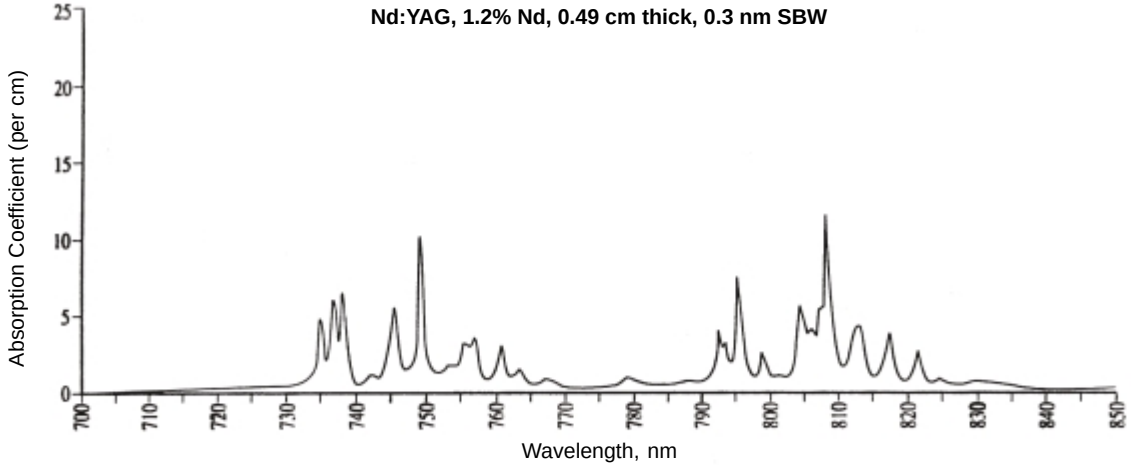
| | **$Nd:YVO_4$** | | **Nd:YAG** | |
|---|---|---|---|---|
| Formulation with 1 atomic % Nd: | $Y_{.99}Nd_{.01}VO_4$ | | $Y_{2.97}Nd_{.03}Al_5O_{12}$ | |
| Nd concentration, atoms / $cm^3$: | $1.54 \times 10^{20}$ | | $1.38 \times 10^{20}$ | |
| Crystal structure: | tetragonal | | cubic | |
| Lattice constant, nm: | a = 0.712, c = 0.629 | (Ref. 2) | a = 1.201 | |
| Melting point, °C: | 1825 | | 1950 | |
| Moh hardness: | 4 to 5 | | 8.5 | |
| Thermal conductivity, W / UK / m: | 5.2 | | 13 | (Ref. 3) |
| Thermal expansion, $10^{-6}$ / °C: | a = 4.43, c = 11.4 | (Ref. 4) | 7.8 | (Ref. 5) |
| Refractive index: | 1.97 | | 1.82 | |
| *Laser wavelength, nm: | 1064 | (Ref. 6) | 1064 | (Ref. 6) |
| *Fluorescence lifetime, microsec: | 98 | (Ref. 1) | 240 | (Ref. 1) |
| *Cross section, $10^{-19}$ $cm^2$ (Ref. 1): | 20 | (Ref. 1) | 7.6 | (Ref. 1) |
| *Polarization: | $\Pi$ | | none | |

*Laser property measurements along the a-axis

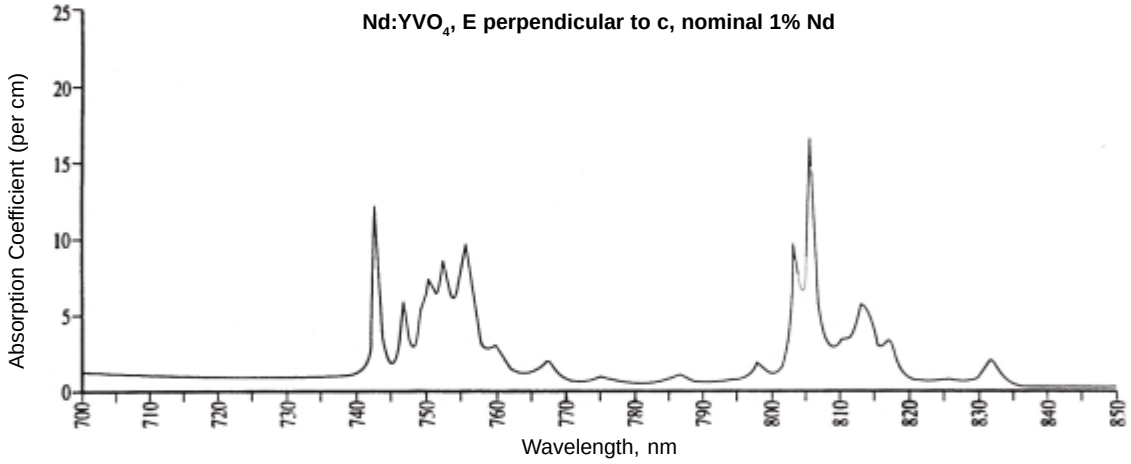
***References***


1. R.A. Fields, M. Birnbaum and C.L. Fincher, Appl. Phys. Lett. 51 (23), 1885 (1987).
2. K. Robinson, G.V. Gibbs and P.H. Ribbe, Amer. Mineral 56, 782 (1971).
3. P.H. Klein and W.J. Croft, J. Appl. Phys. 38 ,1603 (1967).
4. H.C. Schopper, W. Urban and H. Ebel, Solid State Comm. 11, 955 (1972).
5. J.D. Foster and L.M. Osterink, Appl. Optics 7, 2428 (1968).
6. M. Bass, L.G. DeShazer and U. Ranon, Report No. ECOM 74-0104-1 (1974).

**Nd:YAG, 1.2% Nd, 0.49 cm thick, 0.3 nm SBW**




**Nd:$YVO_4$, E perpendicular to c, nominal 1% Nd**

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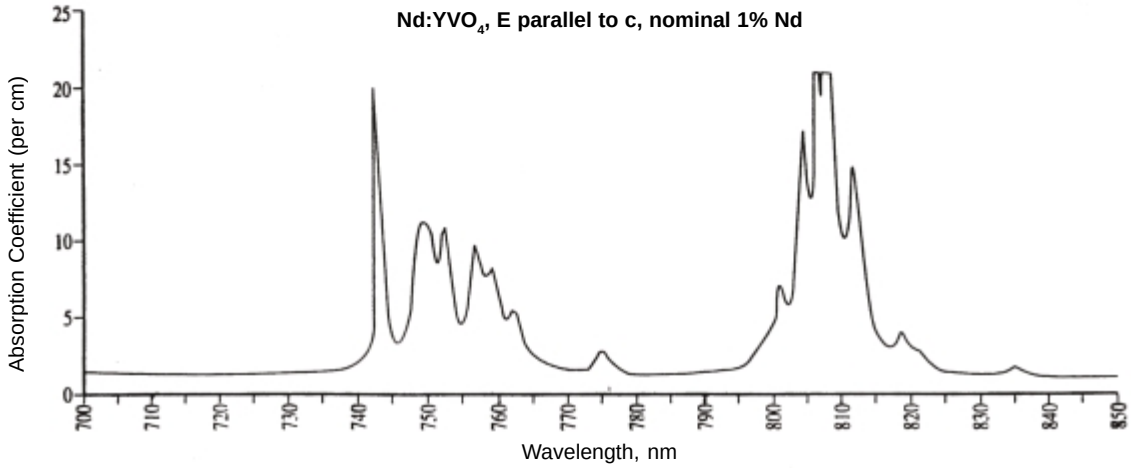




NORTHROP GRUMMAN
Space Technology

**704-588-2340 • FAX 704-588-2516**
**1201 Continental Blvd., Charlotte, NC 28273**
**email: st.synoptics.sales@ngc.com**

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