

## Nd:GdVO<sub>4</sub>

Nd:GdVO<sub>4</sub> crystal is an excellent laser host materials for diode pumped solid state (DPSS) lasers as its good physical, optical and mechanical properties. Like Nd:YVO<sub>4</sub>, the Nd:GdVO<sub>4</sub> exhibits a larger absorption and emission cross section compared to Nd:YAG. In fact, Nd:GdVO<sub>4</sub> has a 7-times higher absorption cross section at 808nm and a 3-times larger emission cross section at 1.06μm than does Nd:YAG. Nd:GdVO<sub>4</sub> has the additional advantage over Nd:YVO<sub>4</sub> of a much higher thermal conductivity.

By compared Nd:GdVO<sub>4</sub> and Nd:YVO<sub>4</sub> in a diode pumped, in each case of cw laser performance at 1.06μm and 1.34μm and intracavity doubling with KTP and LBO, the Nd:GdVO<sub>4</sub> had a higher slope efficiency or optical conversion efficiency than did Nd:GdVO<sub>4</sub>.

AOTK uses the advance Czochralski method technology to grow Nd:GdVO<sub>4</sub> crystal. The crystal is tetragonal which means that 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.

### Nd:GdVO<sub>4</sub> advanced propertles

- Good thermal conductivity
- Large stimulated emission cross-section at lasing wavelength
- High absorption over a wide pumping wavelength bandwidth
- Low lasing threshold and high slope efficiency
- Low threshold and wide absorption peak at pump wavelength
- Strongly-polarized laser output
- Low dependency on pump wavelength

### Basic Properties

Chemical Formula	Gd <sub>0.99</sub> Nd <sub>0.01</sub> VO <sub>4</sub>
Crystal Structure	Tetragonal, Space group I4 <sub>1</sub> /amd
Lattice Parameters	a=b=7.21Å, c=6.35Å
Mohs Hardness	4.6-5
Density	5.47 g/cm <sup>3</sup>
Melting Point	1780°C

### Optical Properties

Lasing Wavelength	1062.9nm, ~1340 nm
Pump Wavelength	808.4nm
Gain Bandwidth	1.3nm
Refractive Indexes	n <sub>o</sub> = 1.98535, n <sub>e</sub> = 2.19813 at 1064 nm
Emission Cross-section (near 1064nm)	7.6×10 <sup>-19</sup> cm <sup>2</sup>
Absorption Cross-section (at 808nm)	5.2×10 <sup>-19</sup> cm <sup>2</sup>
Linewidth	3 nm
Polarization	Parallel to c-axis
Upper-state Lifetime	95μs
Gain Saturation Fluorescence	37.3mJ/ cm <sup>2</sup>
Peak Absorption Coefficient (near 808nm)	57cm <sup>-1</sup> (doped at 1.0%)
Thermal Conductivity <110>	11.7W/m/K



### Demonstrated Performance In Diode Pumped Laser Systems

Laser Operation	Output Wavelength (μm)	Frequency Doubler	Slope Efficiency (%)	Max. Optical Conversion Efficiency (%)
cw	1.06	None	44.6	n/a
cw	1.06	None	42.9	38.1
cw	1.34	None	40.2	n/a
cw	0.53	KTP	n/a	21.0
cw	0.67	LBO	n/a	2.8
Q-switched	1.06	None	31.6	n/a
Q-switched	0.53	KTP	n/a	25.0

### Information Regarding Neodymium Laser Host Crystals

Laser Host Crystals	Nd:GdVO <sub>4</sub>	Nd:YVO <sub>4</sub>	Nd:YAG
Laser Wavelengths	1062.9 nm ~1340 nm	1064.3 nm 1342.0 nm	1064.2 nm 1338.2 nm
Emission Bandwidth (Linewidth at 1064 nm)	3.0 nm	0.8 nm	0.45 nm
Emission Cross Section at 1064 nm	7.6 x 10 <sup>-19</sup> cm <sup>2</sup>	15.6 x 10 <sup>-19</sup> cm <sup>2</sup>	6.5 x 10 <sup>-19</sup> cm <sup>2</sup>
Polarization	Parallel to c-axis	Parallel to c-axis	Unpolarized
Radiative Lifetime at 1% Nd Doping	~ 95 μs	~ 100 μs	230 μs
Pump Wavelength	808.4 nm	808.5 nm	807.5 nm
Peak Pump Absorption at 1% Doping	~ 57 cm <sup>-1</sup>	~ 41 cm <sup>-1</sup>	
Thermal Conductivity	11.7 W/m/K	5.1 W/m/K	14 W/m/K
Doping Concentration Range	0.1 - 3.0%	0.1 - 3.0%	0.1 - 2.0%
Other Possible Dopants	Tm, Ho, Er	Tm, Ho, Er	Cr, Tm, Ho, Er, Yb

### Material Properties: Comparing Nd:GdVO<sub>4</sub> and Nd:YVO<sub>4</sub>

Laser Host Crystals	Nd:GdVO <sub>4</sub>	Nd:YVO <sub>4</sub>
Crystal Structure, Space Group	Tetragonal, I4 <sub>1</sub> /amd	Tetragonal, I4 <sub>1</sub> /amd
Lattice Constants	a=b=7.21Å, c=6.35Å	a=b=7.21Å, c=6.29Å
Melting Temperature	1780°C	1825°C
Thermal Expansion @25°C	α <sub>a</sub> = 1.5 x 10 <sup>-6</sup> /K α <sub>c</sub> = 7.3 x 10 <sup>-6</sup> /K	α <sub>a</sub> = 4.43 x 10 <sup>-6</sup> /K α <sub>c</sub> = 11.4 x 10 <sup>-6</sup> /K
Specific Heat @25°C	32.6 cal/mol K	24.6 cal/mol K
dn/dT	4.7 x10 <sup>-6</sup> /°C	2.7 x10 <sup>-6</sup> /°C

### Standard Specifications

Nd concentrations Range	0.27at%, 0.3at%, 0.5at%, 1.0at%, 2.0at%, 3.0at%
Wavefront Distortion	< λ/8 @633 nm
Scattering Sites	invisible, probed with a He-Ne laser
Orientation	A-axis or C-axis cut, ± 0.2°
Typical End-faces	1) Plano/Plano 2) Plano/Brewster-cut 3) Brewster-cut/Brewster-cut 4) Other angle-wedge
Surface Finish	10/5 scratch/dig as per MIL-O-13830A
Flatness	λ/10 @632.8 nm
Parallelism	< 10 arc seconds
Perpendicularity	< 5 arc minutes
Clear Aperture	> Central 90%

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Coatings

- 1) S1 - HR @1064 nm & HT @808 nm (I\*)  
S2 - AR @ 1064 nm
  - 2) S1 - HR @1064 & 532 nm & HT @808 nm (II\*)  
S2 - AR @ 1064 & 532 nm
  - 3) S1 - AR @1064 nm & HT @808 nm(III\*)  
S2 - AR @ 1064 nm
  - 4) Both ends AR @1064 nm (IV\*)
  - 5) Other kinds of AR, HR coatings upon requests
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\*I)  $R_{1064nm} > 99.8\%$ ,  $T_{808nm} > 95\%$

\*II)  $R_{1064nm} > 99.8\%$ ,  $R_{532nm} > 99.5\%$ ,  $T_{808nm} > 95\%$

\*III)  $R_{1064nm} < 0.2\%$ ,  $R_{808nm} < 0.5\%$

\*IV)  $R_{1064nm} < 0.15\%$ , per surface

**Note**

- Other specifications of Nd:GdVO<sub>4</sub> crystals and coatings are available upon request.

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