

Broadly tunable operation of Tm^{3+} in locally disordered $\text{NaGd}(\text{WO}_4)_2$ near 2 μm

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A single crystal of $\text{NaGd}(\text{WO}_4)_2$ with disordered structure was grown by the Czochralski method with 5 mol % of Tm^{3+} -doping in the melt. This crystal host belongs to the $I\bar{4}$ tetragonal space group. The Tm^{3+} optical absorption and emission spectroscopy revealed strong polarization dependence in accordance with the S_4 local site symmetry of the uniaxial host. The Stark energy levels of Tm^{3+} in this host were determined from 5 K optical absorption and photoluminescence measurements. The 300 K lifetime of the upper laser level for the ${}^3\text{F}_4 \rightarrow {}^3\text{H}_6$ transition amounts to 1.35 ± 0.20 ms. The maximum ground state absorption cross sections for the ${}^3\text{H}_4$ level of interest for diode pumping near 795 nm are 2.9×10^{-20} and 1.18×10^{-20} cm^2 for the σ and π polarization, respectively. The maximum emission cross sections amount to 10.6×10^{-21} cm^2 at 1796 nm and 9.5×10^{-21} cm^2 at 1847 nm, for the σ and π polarization, respectively. Laser operation in the continuous-wave (cw) regime has been achieved at room temperature under Ti:sapphire and diode laser pumping using an uncoated a -cut sample with a thickness of 3 mm. A maximum output power of ≈ 300 mW was obtained at 1925 nm for the σ polarization under Ti:sapphire laser pumping. Slightly higher powers were obtained with diode pumping but the threshold pump power also increased. In this case the laser naturally selected the σ polarization. The optical bands of Tm^{3+} in this crystal have inhomogeneous contribution and their FWHM reaches, e.g. for the ${}^3\text{H}_6 \rightarrow {}^3\text{F}_4$ transition at 5 K, ≈ 60 cm^{-1} . This is related to Na and Gd (or Tm) local disorder between the two non-equivalent lattice sites of the host [1]. The full cw laser tunability range (see Fig. 1) at 300 K, from 1813 to 2025 nm, corresponds to ≈ 17 THz, and is one of the broadest achieved with a Tm^{3+} -doped crystalline material, despite the relatively low efficiency obtained with this first sample of $\text{Tm}:\text{NaGd}(\text{WO}_4)_2$. Further improvement in the laser performance can be expected after elimination of the internal gradients observed in this first grown crystal.

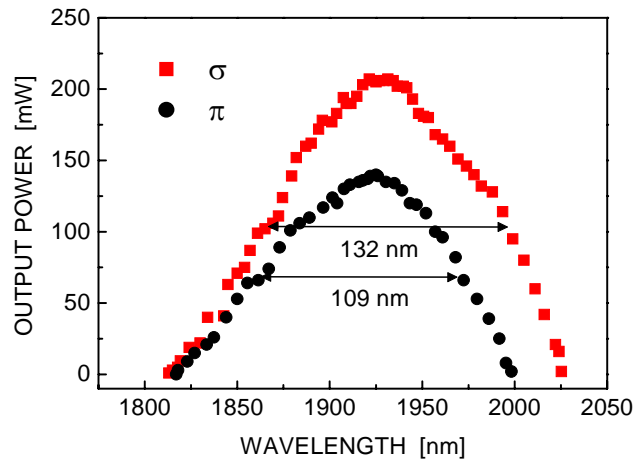


Fig.1: Output power of the Tm-laser versus wavelength for an incident power of 1.54 W of the Ti:sapphire pump laser and $T_{OC}=3$ %. Tuning is realized by a Lyot filter in an astigmatically compensated X-type cavity with the $\text{Tm}:\text{NaGd}(\text{WO}_4)_2$ sample positioned under Brewster angle between two $\text{RC}=-10$ cm folding mirrors.

1. J. M. Cano-Torres, M. D. Serrano, C. Zaldo, M. Rico, X. Mateos, J. Liu, U. Griebner, V. Petrov, F. J. Valle, M. Galán, G. Viera, *J. Opt. Soc. Am. B* (2006), submitted for publication.