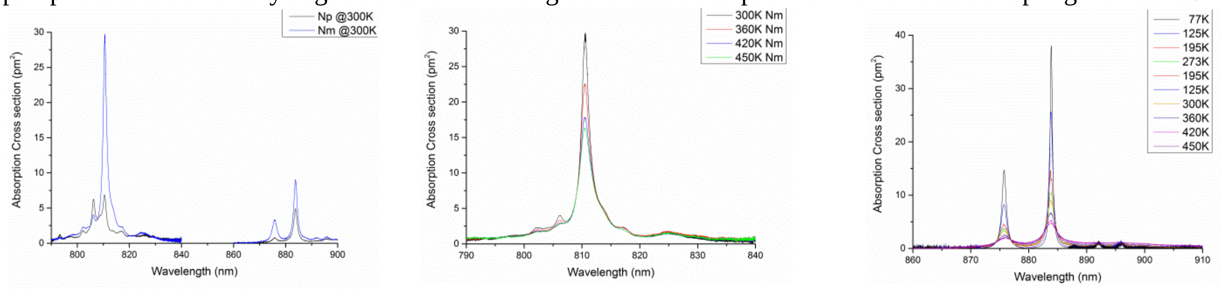
Temperature Dependent Nd:KGW Spectroscopy Study.

S.J. Yoon, S.J. Beecher, J.I. Mackenzie

Optoelectronics Research Centre, University of Southampton, Highfield, Southampton SO171BJ, UK

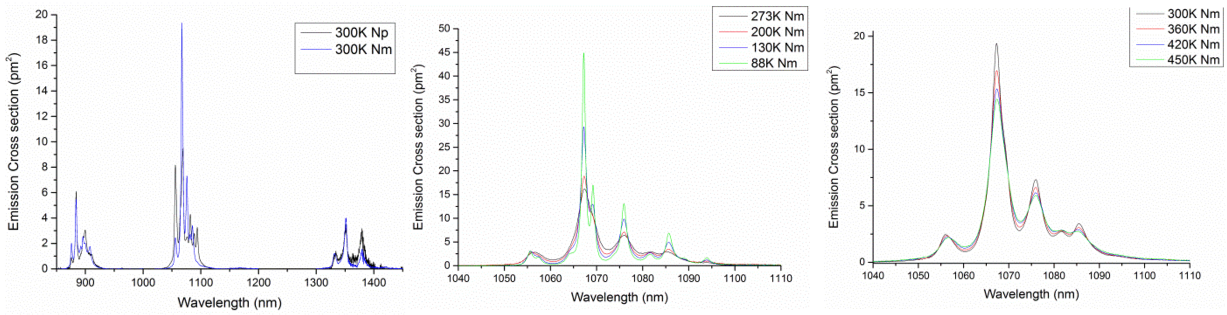
We report a high resolution spectroscopic characterisation of Nd:KGW as a function of temperature, over the range 80 K - 450 K. Measurements were made for the two dominant polarizations, with respect to the principal optical axes for the double tungstate crystal, namely $E//N_m$ and $E//N_p$ for an N_g – cut crystal. Knowledge of the critical spectroscopic characteristics at various temperatures enables more accurate prediction of laser performance over a large range of possible operating conditions.

We investigated the absorbance of a 1 mm thick 3 at.% Nd:KGW using broadband Amplified Spontaneous Emission (ASE) sources for wavelengths around 800 nm and 880 nm, a polarizer, and an optical spectrum analyser (OSA) with 0.1 nm resolution. The setups are very similar to those described in more detail in [1], where an additional cube polarizer is placed before the collection fibre of the OSA. In measuring the fluorescence we arranged the crystal to be at ~45° to the incident beam, from a re-imaged fibre-coupled 810 nm diode laser providing low irradiance (<1.5 $kWcm^{-2}$) at the sample to prevent ground state depletion, and with the pump focussed at the very edge to ensure minimal ground state absorption or ASE effects corrupting the results.



(a) (b) (c)

Fig. 1 Absorption spectra: (a) N_m and N_p at 300 K, and (300 K) 80 K – 450 K (b) N_m $^4I_{9/2} \rightarrow {}^4F_{5/2}$, and (c) N_m $^4I_{9/2} \rightarrow {}^4F_{3/2}$



(d) (e) (f)

Fig. 2 $^4F_{3/2}$ emission spectra: (a) N_m and N_p at 300 K, (b) N_m (80 K – 300 K), and (c) N_m (300 K – 450 K), excluding the terminal level $^4I_{15/2}$.

In the absorption measurements (Fig. 1) we were limited by the absorbance of the 1mm thick crystal at low temperatures, therefore Fig.1 (b) is for above 300K only. Fig 2 shows the calculated emission cross sections, we find distinct differences in the value for the $^4F_{3/2} \rightarrow {}^4I_{9/2}$ transition with respect to that reported by Chen et al [2], but comparable to that of Moncorgé et al [3], thus apparently avoiding reabsorption losses for this wavelength band. It is evident that the bandwidth of the 1μm emission does not expand significantly with increasing temperature, whilst it does resolve into respect Stark level transitions at lower temperatures. Notwithstanding, a $\Delta\lambda$=0.9 nm spectral bandwidth at 80K will support few-picosecond pulse durations with dramatically improved thermo-optic properties at cryogenic temperatures, where the very short absorption lengths with in-band pumping offers very good efficiency and high optical gains.

References

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