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Pulsed stimulated random emission at 1064.12 nm using a powder of $NdYVO_4$

Light diffusion with gain in highly scattering gain media, well known random lasers (RLs), has received considerable attention for several years due to its unique properties and its potential applications. Random lasers have has been demonstrated in a wide variety of media, including powdered of rare-earth crystals, reporting pulsed and continuous-wave lasing emission.

In this work, gain competition and linewidth narrowing is experimentally analyzed in an optical pumped random media, observing a sharp threshold and pulsed emission on only one transition, namely, the $^4F_{3/2} \rightarrow {}^4I_{11/2}$.

The powder was obtained by grinding 1.4mol% Nd^{3+}:YVO_4 laser crystal using an agate mortar and a pestle. The disc sample with flat surfaces had dimension of $\Phi 5x1$ mm^3, prepared by compressing the powder with a manual punch tablet.

For experiment, at room temperature, a QCW laser diode bar was used as the pump source, tuned to the maximum of the Nd^{3+} absorption for this sample at 809 nm, with 100 µs pulse width and 3 Hz of repetition rate. The excitation beam was focused to a square shape with area of 5.33 mm^2. The sample backscattered luminescence, caused by the normally incident beam from the diode bar, was separated from pump excitation by using a beam splitter, then collected and analyzed using an oscilloscope and a spectrometer in a several incident powers.

For low pump intensity (0.81 mW/mm^2), several fluorescent emissions from $^4G_{7/2} \rightarrow {}^4I_{9/2}$, $^4G_{5/2} \rightarrow {}^4I_{9/2}$, $^4F_{3/2} \rightarrow {}^4I_{9/2}$, and $^4F_{3/2} \rightarrow {}^4I_{11/2}$ Nd^{3+} transitions were visible. However, increasing the pump intensity to 5.7 mW/mm^2 we observed a sharp threshold on the $^4F_{3/2} \rightarrow {}^4I_{11/2}$ transition (1064.12 nm). Also, the spectral width (from 1.30 nm to 0.48 nm) and decay time (from 141 µs to 71 µs) of this transition decreased as a function of pump power, demonstrating that we obtained stimulated random emission for this sample. Others fluorescent emissions suffered a spectral quenching.