Explanation of pulse shape in quasi-continuous wave diode pumped Er: LiYF4 lasers

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There exists a strong interest in obtaining and optimizing lasers in the 3μm region because of the strong absorption due to the OH vibration of water vapor, liquid water and consequently, biological tissue. This wavelength may be used for LIDAR measurements of atmospheric humidity and laser surgery. For laser surgery a small laser system is desirable with high rep rate and pulses of hundreds of microseconds. In this work we investigate the pulse shape of an Er:$LiYF_4$ laser as a function of the upper laser level energy transfer upconversion. By spectroscopic measurements and numerical simulations we obtain a value for the upconversion of 9x10-17 cm^3/s. Experimentally, an output power increase at the beginning of the pulse of the qcw 2.8 μm laser is observed. The laser generates higher average output power when operated at 250μs pulse duration than for longer pulses. The observed decay at the beginning of the pulse is indicative for a process that does not depend linearly on the upper laser level population. This could be verified in our simulations, which demonstrated clearly that no other process than the upper laser upconversion is capable of reproducing the experimentally obtained pulse decay. In this regime, 60% more efficiency is obtained than with pulses of several millisecond duration when the laser is diode pumped at 970nm.