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High-Pulse Energy Q-switched Tm^{3+}:YAG Laser for Nonlinear Frequency Conversion to the Mid-IR

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For some medical fields in laser surgery and as a pump source for nonlinear materials to generate mid-IR radiation, e.g. for countermeasure applications, it is very useful to have a solid-state laser with high pulse energy at 2 µm. The rare earth ion Thulium offers a cross relaxation and can thus be directly diode pumped with common laser diodes around 800 nm for an efficient pumping. However, it was not considered for high pulse energy operation due to the high saturation fluence of around 62 J/cm^2 at 2 µm. A limiting factor has always been the damage threshold of the optical elements inside the cavity. One of the reasons is the strong thermal lens of YAG, which affects a change of the beam radius inside the resonator and additionally degrades the beam quality with increasing pump power. Using a new pump geometry of the Tm^{3+}:YAG laser system, it is now possible to reach pulse energies > 13 mJ at a diffraction limited beam quality of M^2 < 1.1. The Q-switched Tm^{3+}:YAG laser system uses an AOM operating at 100 Hz and will be described in detail. Due to the high pulse energy and very good beam quality, this laser is very interesting for nonlinear parametric frequency conversion.