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NOVEL YTTERBIUM AND THULIUM LASERS BASED ON THE MONOCLINIC $KLu(WO_4)_2$ CRYSTALLINE HOST

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The monoclinic crystals $KGd(WO_4)_2$ and $KY(WO_4)_2$ are well known host materials for highly efficient diode-pumped Nd-lasers. The main advantages of these strongly anisotropic biaxial crystals are related to the very high values of the absorption and emission cross sections and the possibility to dope them with high concentration of the active ions without substantial fluorescence quenching. Recently, the iso-structural host $KLu(WO_4)_2$ was developed and its thermo-mechanical and optical properties were characterized. Substantial progress was achieved in the field of spectroscopy and laser operation with trivalent ytterbium (Yb) and thulium (Tm).

We will review the properties of $KLu(WO_4)_2$ grown by the flux method with focus on the spectroscopic studies and present laser results obtained in several operational regimes both with Ti:sapphire and direct diode laser pumping using AlGaAs and InGaAs diodes near 800 and 980 nm, respectively. These include efficient and tunable operation of Yb- and Tm-lasers in the continuous-wave (cw) regime, Q-switched and Raman lasers based on $Yb:KLu(WO_4)_2$, efficient cw operation of epitaxial lasers based on Yb- or Tm-doped layers deposited on undoped $KLu(WO_4)_2$ substrates, and mode-locked (femtosecond) operation of lasers based on Yb-doped bulk or epitaxial $KLu(WO_4)_2$ crystals.

The slope efficiencies achieved with bulk and epitaxial $Yb:KLu(WO_4)_2$ lasers under Ti:sapphire laser pumping were 57 and 66%, respectively. Passively Q-switched laser operation was obtained with a Cr:YAG saturable absorber resulting in oscillation at 1030 nm with a repetition rate of 28 kHz and simultaneous Raman conversion to 1137.6 nm with maximum energies of 32.4 and 14.4 μJ, respectively. The corresponding pulse durations were 1.41 and 0.71 ns. Passive mode-locking by a semiconductor saturable absorber resulted in bandwidth-limited pulses with duration of 81 fs (1046 nm, 95 MHz) and 114 fs (1030nm, 101 MHz) for bulk and epitaxial $Yb:KLu(WO_4)_2$ lasers, respectively. Slope efficiency as high as 69% with respect to the absorbed power and an output power of 4 W at 1950 nm were achieved with a diode-pumped $Tm:KLu(WO_4)_2$ laser. The tunability of this laser, under Ti:sapphire laser pumping, extended between 1800 and 1987 nm revealing an interesting potential for mode-locking.

The $KLu(WO_4)_2$ laser host seems predestined for Yb-doping because the close ionic radii of Lu and Yb allow high doping levels with low defect formation probability and epitaxial growth of highly absorbing films with best quality of the interface while the dopant affects only weakly the thermal conductivity of the host.