

## Continuous-wave laser operation of disordered double tungstate and molybdate crystals doped with ytterbium

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Double tungstate and molybdate compounds with the general formulae  $MT(WO_4)_2$  and  $MT(MoO_4)_2$  where M is a monovalent alkali cation (Li-Cs) and T is a trivalent cation (Y, La or rare earth Ln) exhibit ordered phases with separate sites for M and T cations and disordered phases where M and T cations are randomly distributed over the same cationic sublattice. Some of the optically passive ordered phases like the monoclinic  $KGd(WO_4)_2$  and  $KY(WO_4)_2$  are established rare-earth ion laser hosts with very large absorption and emission cross sections of the active dopant. The disordered phases are, however, interesting because the inhomogeneous broadening extends their potential for tunable laser operation and generation of ultrashort optical pulses. Here we present initial laser results obtained in the continuous-wave regime at room temperature with Yb-doped disordered crystals of  $NaGd(WO_4)_2$ ,  $NaLa(WO_4)_2$ ,  $NaLa(MoO_4)_2$ , and  $LiGd(MoO_4)_2$ , all of them exhibiting tetragonal structure and congruent melting character. The latter allowed their growth by the Czochralski method.

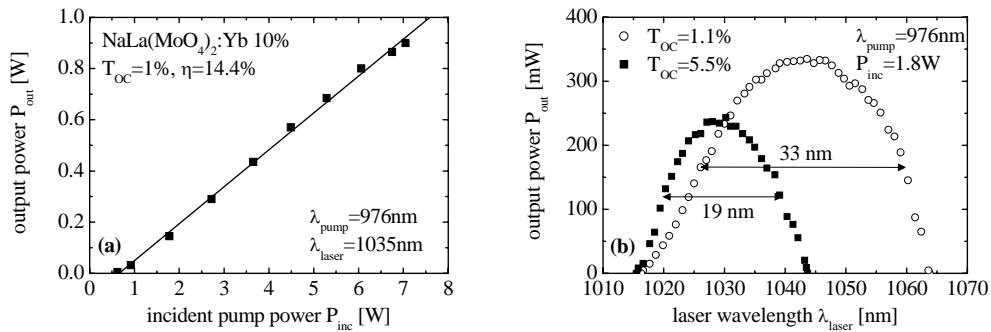


Fig. 1: Laser performance of the diode-pumped  $NaLa(MoO_4)_2:Yb$  (a) and tuning obtained with the same sample and two different output couplers under Ti:sapphire laser pumping (b).

Astigmatically compensated three and four mirror cavities with Brewster angle geometry were applied to study the optimum pump wavelength and polarization configuration using a tunable Ti:sapphire pump laser or a tapered laser diode. Tuning was achieved with an additional Lyot filter. High-power laser operation was studied with an 8 W unpolarized fiber coupled diode module in a short hemispherical cavity. All samples used were uncoated.

Some results obtained with  $NaLa(MoO_4)_2:Yb$  in the continuous-wave regime are shown in Fig.1. Output powers of the order of 1 W could be obtained with diode pumping in the hemispherical cavity. Pumping by the Ti:sapphire laser resulted in general in stronger depletion of the absorption and much higher (5 times) slope efficiencies. We will compare the performance of the different Yb-hosts belonging to the  $MT(WO_4)_2$  and  $MT(MoO_4)_2$  families. The achieved tunability indicates that these new materials are very promising for the generation of sub-100-fs laser pulses in the mode-locked regime with high pump efficiency.

Keywords: disordered crystals, ytterbium lasers, double tungstates, double molybdates