High slope efficiency in epitaxially grown $KY(WO_4)_2$:Yb^{3+} waveguide laser

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One way of increasing the slope efficiency and decreasing the laser threshold is the use of a waveguiding structure. One of the active materials that can be efficiently exploated in the waveguide geometry is $KY(WO_4)_2$ doped with Yb^{3+} (KYW:Yb). Thin layers of KYW:Yb can be grown by liquid-phase epitaxy (LPE) on undoped KYW crystals. Recently, their continuous-wave (CW) laser operation under longitudinal pumping normal to the layer has been demonstrated [1]. Next step is the realization of a waveguide laser with end-face pump coupling and pump absorption along the whole waveguide length, which we report in the present work.

Epitaxial surface and buried layers with thicknesses d = 10 to 100 μm and Yb^{3+} concentrations ranging from 1.2 to 2.4 at% were produced by LPE. The planar waveguides were positioned at Brewster's angle in a Z-shaped laser cavity and pumped with a tunable CW Ti:Sapphire laser. Independent of the chosen output coupler transmission, stable CW oscillation near $\lambda = 1025$ nm could be achieved for all waveguides investigated. The best laser performance was achieved with the 17-μm thin surface waveguide doped with 1.2 at% Yb^{3+}. Its laser threshold was reached at an absorbed pump power of 80 mW. Using a 3.7%-transmission output coupler the maximum output power amounted to 290 mW, resulting in a slope efficiency of $\eta = 67.4\%$. For the output coupler transmission of T = 6.2% corresponding to a pump efficiency of 58.9%, the maximum slope efficiency of 80.4% was obtained, which is the highest value ever reported for a KYW:Yb laser.

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[1] A. Aznar, R. Sole, M. Aguilo, F. Diaz, U. Griebner, R. Grunwald and V. Petrov, *Appl. Phys. Lett.* **85**, 4313 (2004).

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