Highly efficient channel waveguide lasers at 1 µm and 2 µm in refractive-index-engineered potassium double tungstates

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Epitaxial growth of rare-earth-ion-activated $KY_{1-x-y}Gd_xLu_y(WO_4)_2$ co-doped thin layers onto $KY(WO_4)_2$ substrates has enabled lattice-matched waveguides with high refractive-index contract and large variation of the active rare-earth-ion concentration. In Yb^{3+}-activated micro-structured channel waveguides, we demonstrated lasers with 418 mW of continuous-wave output power at 1023 nm and a slope efficiency of 71% versus launched pump power at 981 nm. Channel waveguide lasers operating on the 981-nm zero-phonon line were demonstrated under pumping at 934 nm with an output power of 650 mW and a slope efficiency of 76% versus absorbed pump power. Lasing with a record-low quantum defect of 0.7% was achieved. In a feasibility study, a device comprising a tapered active channel waveguide and a passive planar pump waveguide, fabricated by multi-layer growth of lattice-matched layers, was demonstrated as a laser by diode-side pumping with a high-power, multi-mode diode bar. This approach offers the potential for significantly increased output powers from channel waveguide lasers. Tm^{3+}-activated channel waveguide lasers demonstrated a maximum output power of 300 mW and slope efficiency of 70%, when pumping near 800 nm. Lasing was obtained at various wavelengths between 1810 nm and 2037 nm. These lasers were operated with resonators exploiting either butt-coupled mirrors, providing only a non-permanent solution, or based on Fresnel reflection at the waveguide end-facets, resulting in laser emission from both waveguide ends and without control of the laser wavelength. Currently we are inscribing Bragg gratings into the top cladding to provide a stable resonator configuration that allows for effective wavelength selection.