Rare-earth activated potassium double tungstate waveguide amplifiers and lasers

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(100 word abstract)

Recent advances on high-performance channel waveguide amplifiers and lasers in rare-earth-ion-doped potassium double tungstates are reviewed. When activated with Yb\textsuperscript{3+}, lasers with low threshold of a few mW, high slope efficiency of 76\%, high output power of ~650 mW, tunability between 980-1045 nm, and record-low quantum defect of 0.7\% were demonstrated. In Tm\textsuperscript{3+}-doped waveguides, 31\% slope efficiency and 149 mW output power at 1.9 μm were obtained. In a channel waveguide amplifier, a high gain of 935 dB/cm was demonstrated, which represents a two-order-of-magnitude improvement for rare-earth ions. The potential utilization of this material in nanophotonics will be highlighted.

(250 words summary)

Several fields, including optical communications, bio-sensing, health, and safety, will greatly benefit from on-chip high-gain amplifiers and high-power, compact, efficient, tunable or short-pulse lasers in channel waveguide geometry. The rare-earth (RE) doped potassium double tungstates KY(WO\textsubscript{4})\textsubscript{2}, KGd(WO\textsubscript{4})\textsubscript{2}, and KLu(WO\textsubscript{4})\textsubscript{2} are very promising candidates for such applications. RE ions exhibit a long excited-state lifetime, typically ranging from hundreds of microseconds to milliseconds, thus permitting large excitation densities and distortion-free amplification of high-bit-rate signals in the small-signal-gain regime. The large interionic separation of ~0.5 nm of RE ions in double tungstates allows to exploit increased RE dopant concentrations without significant fluorescence quenching, which, together with the large absorption and emission cross-sections of RE ions in these host materials and the good overlap between pump and signal light provided by the optimization of the channel waveguide structure, leads to very high modal gain.

In this paper, our recent achievements in integrated waveguide amplifiers and lasers will be presented. When activated with Yb\textsuperscript{3+}, lasers with low threshold of a few mW, high slope efficiency of 76\%, high output power of ~650 mW, tunability between 980-1045 nm, and low quantum defect of 0.7\% were demonstrated. A high-gain waveguide amplifiers presenting a modal gain of ~935 dB/cm was achieved. In Tm\textsuperscript{3+}-doped waveguides, 31\% slope efficiency and 149 mW output power at 1.9 μm were obtained. Finally, potential applications of this material in nanophotonic devices will be highlighted.