High-Gain Al2O3:Nd3+ Integrated Waveguide Amplifiers

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Resume : Amorphous aluminium oxide is an excellent host material for rare earth ions. Its low loss and large refractive index allow for the realization of compact integrated optical devices. Recently, we demonstrated 170 Gbit/s data amplification at 1.5 μm in Al2O3:Er3+. Here Al2O3 is used as the host material for Nd3+. The layers are reactively co-sputtered onto thermally oxidized 10-cm Si wafers, thus enabling compatibility with standard silicon technology. Single-mode channel waveguides with 600-nm thickness and various widths are fabricated. Under pumping with an 800-nm laser diode, small-signal gain at 880 nm, 1064 nm and 1330 nm of 1.57 dB/cm, 6.30 dB/cm and 1.93 dB/cm, respectively, is demonstrated for individually optimized Nd3+ concentrations. A maximum gain of 3.0 dB, 14.4 dB and 5.1 dB, respectively, is measured. Energy-transfer upconversion of Nd3+ ions in Al2O3 is studied as a loss mechanism. Furthermore, use of the amplifiers in polymer optical backplanes embedded within printed circuit boards is investigated. Pump light at 800 nm and signal light at 880 nm were directly coupled from a polymer waveguide into 3 μm-thick Al2O3:Nd3waveguides, with the width tapered down from 8 μm to 1.5-2.5 μm to increase the pump intensity. Internal net gain of 0.42 dB was demonstrated for an amplifier coupled to a polymer optical backplane, providing a potential solution for compensating loss and achieving loss-less data transmission in optical interconnects.