Gain bandwidth of 80 nm and 2 dB/cm peak gain in $Al_2O_3:Er^{3+}$ optical amplifiers on silicon

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Erbium-doped aluminum oxide integrated optical amplifiers were fabricated on silicon substrates, and their characteristics were investigated for Er concentrations ranging from 0.27 to 4.2×10^{20} cm^{-3}. Background losses below 0.3 dB/cm at 1320 nm were measured. For optimum Er concentrations in the range of 1 to 2 $\times10^{20}$ cm^{-3}, an internal net gain was obtained over a wavelength range of 80 nm (1500–1580 nm), and a peak gain of 2.0 dB/cm was measured at 1533 nm. The broadband and high peak gain are attributed to an optimized fabrication process, improved waveguide design, and pumping at 977 nm as opposed to 1480 nm. In a 5.4-cm-long amplifier, a total internal net gain of up to 9.3 dB was measured. By use of a rate-equation model, an internal net gain of 33 dB at the 1533 nm gain peak and more than 20 dB for all wavelengths within the telecom C-band (1525–1565 nm) are predicted for a launched signal power of 1 μW when launching 100 mW of pump power into a 24-cm-long amplifier. The high optical gain demonstrates that $Al_2O_3:Er^{3+}$ is a competitive technology for active integrated optics.

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