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A Photonic Integrated Circuit based Erbium-Doped Amplifier

Erbium-doped fiber amplifiers revolutionized long-haul optical communications and laser technology [1-2]. Erbium ions could equally provide a basis for efficient optical amplification in photonic integrated circuits [3], but has remained impractical due to insufficient output power. Here, we demonstrate a photonic integrated circuit-based erbium amplifier reaching 145 mW output power and more than 30 dB small-signal gain - on par with commercial fiber amplifiers and beyond state-of-the-art III-V heterogeneously integrated semiconductor amplifiers. We apply ion implantation [4] to ultralow-loss Si_3N_4 photonic integrated circuits [5] and can increase the soliton microcomb output power by 100-fold, achieving power requirements for low-noise photonic microwave generation and wavelength-division multiplexed optical communications. Endowing Si_3N_4 photonic integrated circuits with gain enables the miniaturization of various fiber-based devices such as high-pulse-energy femtosecond mode-locked lasers.

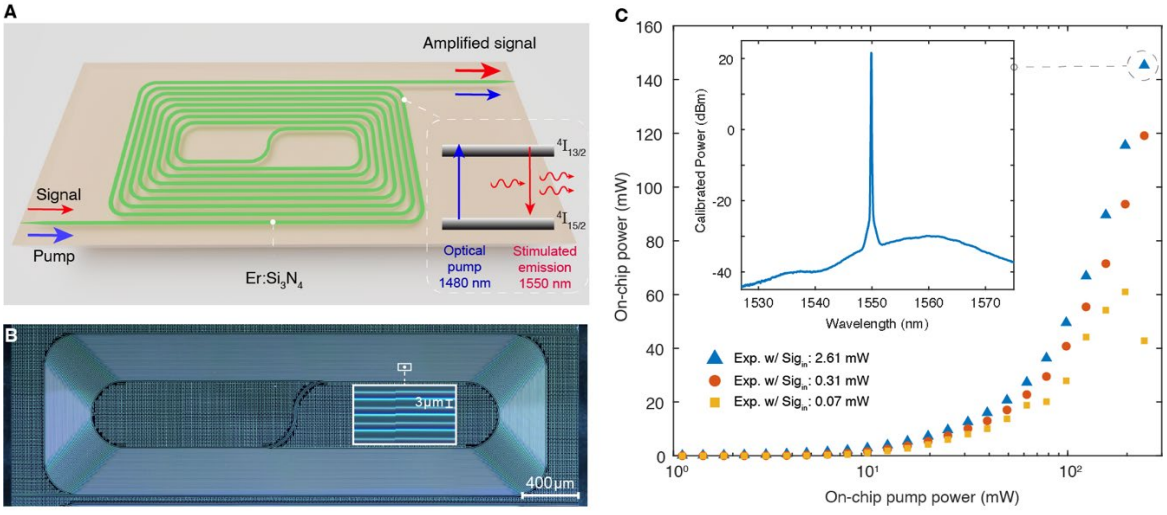

Figure 1: Integrated erbium-implanted Si_3N_4 waveguide amplifier. (**A**) Si_3N_4 waveguide amplifier using erbium ions optically excited by 1480 nm pump. (**B**) Optical image of a 0.5-m-long Er:Si_3N_4 waveguide coil. (**C**) Measured output powers at 1550 nm. The inset shows the calibrated optical spectrum at 145 mW signal output.

References

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