Proton Beam Writing of Erbium Doped Waveguide Amplifiers

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Proton beam writing [1] uses a focused sub-micron beam of high-energy protons to direct-write on a suitable material, such as polymers, phosphate glass, fused silica, quartz, sapphire, etc. Sub-micron beam resolution is extremely critical for proton beam writing as it is important to direct-write the optical pathways accurately in order to realize the optimal design and to minimize optical losses. Proton beam writing can be used to fabricate any arbitrary waveguide pattern (e.g. the mach-zehnder interferometer, directional couplers etc.). This is an asset for the rapid prototyping of optical circuits. Previously, proton beam writing has been used to fabricate passive waveguides in polymers such as buried channel waveguides in PMMA [2] and the ridge-type optical waveguides in SU-8 [3,4]. In this work, we report on the fabrication of active waveguides (i.e. waveguide amplifiers) in Er^{3+}/Yb^{3+} co-doped phosphate glass [5] using proton beam writing.

Erbium doped waveguide amplifier technology has been widely used to compensate for signal loss in telecommunication networks. They are extremely reliable and have a much smaller footprint compared to erbium doped fiber amplifiers. Er^{3+}/Yb^{3+} co-doped phosphate glass is commonly used to fabricate waveguide transmitters, receivers and in-line amplifiers. Conventionally, ion-exchange techniques have been used to fabricate optical waveguides in Er^{3+}/Yb^{3+} co-doped phosphate glass. We present an alternative technique to fabricate buried channel waveguide amplifiers in this material. These waveguides were fabricated using a 2.0 MeV proton beam with ion doses ranging from 10^{14} – 10^{15} ions/cm^2. Fabrication procedures (such as dose normalization) and optical waveguide characterization results (such as the florescence spectra and the net gain) will be discussed.

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