Constant-Loss Taper: Design, Simulation, and Fabrication

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Silicon-on-insulator (SOI) is a platform that possesses a large index of refraction layer of silicon (n~3.5) on top of an optically insulating buried oxide layer (n~1.46); strong light confinement can be achieved via the large index of refraction contrast offered by the SOI platform and it enables high-density optical circuitry. The modal area of a typical SOI waveguide is approximately 0.1 μm^2 (500x220 nm) which, for comparison, is orders of magnitude smaller than a typical SMF-28 fiber, ~100 μm^2 (10.4 µm in mode-field diameter); this large mismatch prohibits efficient light coupling from an external fiber to an integrated waveguide and requires the implementation of mode converters. This paper presents a novel approach to the design of inverse taper for mode conversion, shown is a comparative study between three types of tapers: linear, parabolic, and a novel constant-loss taper (CLT). The CLT is firstly derived using 3D coupled-mode theory and then simulated using 3D finite-difference time-domain simulations. It is demonstrated that a gain in efficiency of 5-20% can be achieved by using a CLT over a linear or parabolic taper for taper lengths ranging from 2 to 40 µm. Furthermore the CLT is shown to be more resilient to both fabrication errors and sidewall roughness than its linear or parabolic counterparts. In addition, our latest results from fabrication and testing will be presented.