paper GL106-20, *Great Lakes Photonics Symposium, SPIE*, Dayton, USA, *June 2006*

Low-Loss High-Index-Contrast AlGaAs/GaAs S-Bend Waveguide Lasers

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S-bend waveguides are very important for modern photonic integrated circuits to route optical signals on chip and form optical switches, interferometers, couplers and other components. In addition to their use in passive optical devices, single-mode semiconductor lasers incorporating an S-bend waveguide as a spatial mode filter have recently been reported.[1] For such devices utilizing curved waveguide sections, a high-index-contrast (HIC) structure is essential for reducing the bend-loss to improve device performance. Two known methods for forming the required HIC, low bend loss structure, selective-area epitaxial regrowth[1] and impurity-induced-lattice-disordering (IILD) combined with deep-oxidation,[2] and have both found limited application because of their inherent processing complexity. Here, we report low-loss S-bend waveguides realized in an AlGaAs/GaAs heterostructure through a simple dry-etching plus non-selective oxidation technique.[3] S-bend laser diodes with a 100 μm waveguide offset achieved over varying transition distances, l_{tran}, were fabricated and tested. For a waveguide width w=5.5 μm, l_{tran}=200 μm, and total resonator length L=1250 μm, these lasers show a cw, 300 K threshold current of only 40 mA (J_{th}=580 A/cm^2), a differential responsivity of 0.63 W/A, and an external differential quantum efficiency of 41%. For different l_{tran} (140 μm-300 μm), the threshold current density J_{th} lies between 550 A/cm^2 to 600 A/cm^2, only slightly higher than the value for straight devices (460 A/cm^2) fabricated using an identical HIC ridge waveguide structure. Such data reflect the achievement of very low radiation loss of S-bend waveguides fabricated through our new dry-etch + non-selective oxidation process.

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Keywords: high-index-contrast, low loss, S-bend waveguide, single-mode laser