TECHNOLOGY

A Method for Fabrication of Vertically Coupled Integrated Optical Waveguide Resonator, Coupler and Interferometer Devices

OVERVIEW

Integrated photonics are a very useful technology for the transmitting, receiving, routing and processing of information in optical form, as is widely documented in extensive literature. Many integrated photonic devices require the controlled coupling of light from one waveguide to another in an integrated chip. It has long been known that a useful method for performing this coupling is to position two waveguides in a parallel fashion with a controlled separation allowing light to couple between waveguides across the gap. The properties of this coupling are determined by the material, shape and dimensions of the waveguides and their cladding, and the dimension of the coupling gap. The dimension of the coupling gap is particularly important in determining the coupling strength.

In a conventional integrated coupler in which two waveguides are separated in a lateral direction, a relatively small variation in the waveguide separation due to lithographic nonuniformity or misalignment may cause a considerable change in the coupling strength. The strength of coupling between two waveguides is a strong function of the waveguide separation; in many cases it is an exponential dependence. In a conventional integrated coupler in which two waveguides are separated in a lateral direction, a relatively small variation in the waveguide separation due to lithographic nonuniformity or misalignment may cause a considerable change in the coupling strength. The present invention provides a way to implement coupling by applying the advantages of projection photolithography, substrate removal and low temperature polymer bonding to achieve coupled, tightly confined single transverse mode couplers, interferometers and ring resonators with very high quality. It makes possible the fabrication of such single transverse mode, highly confined components using widely available semiconductor processing equipment, such as i-line steppers and reactive ion etching, high density plasma (ECR or ICP) etching or chemically assisted ion beam etching (CAIBE) tools. It removes the requirement for direct write electron beam lithography or deep-UV photolithography, which have previously been used for laterally coupled, highly confined components due to the very small dimension of the lithographically defined lateral coupling gap. It avoids the limitations of resolution and alignment presented by infrared backside-aligned contact photolithography which has made single transverse mode highly confined waveguide couplers difficult to realize. Although the procedure could also be used with a wafer fusion bonding technique, a method using a polymer bonding technique is shown to achieve very high quality results without the high temperatures typically used to fuse wafers, and providing the possible use of the bonding polymer as a low index cladding material. The use of a bonding and substrate removal process for vertically coupled structures provides complete patterning access to both waveguiding layers without incurring the planarization difficulties encountered with a single side patterning and redeposition approach. The invention described here further extends the fabrication technique to allow the use of conventional projection lithography tools useful for low cost mass production.

For additional technical information Office of Technology Commercialization at the Office of Technology Commercialization, University of Maryland, 301 405-3947 or otc@umd.edu.

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CATEGORIES

- Sensors/Monitors

EXTERNAL RESOURCES

- US Patent 6,859,603

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