Design of an Integrated Optical Circuit for Generation of Optical Vortex

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ABSTRACT

We present the results of design studies on an integrated optical circuit able to generate optical vortex by superposition of the two first order modes on the horizontal and vertical direction, respectively. The vertical first order mode has been excited by a discontinuity on the vertical direction, the separation of this mode by the remaining fundamental mode has been obtained via a directional coupler. Another very short directional coupler has been employed to transfer the fundamental mode into a first order mode of a larger waveguide. The vertical and horizontal first order modes has been recombined in order to produce an optical vortex.

LAYOUT

The configuration of the integrated optical circuit illustrated in Fig 1 is generated by the OptiBPM software 3D viewer. There are three distinctive zones. We consider silicon nitride waveguides (n = 2) embedded in silicon dioxide (n= 1.46). In zone A, there is the input waveguide having a rectangular shape 400 nm thick and 400 nm wide such that it allows only three modes to operate at 635 nm wavelength - the fundamental mode, the first order mode on the vertical direction and the first order mode on the horizontal direction. One can notice that the input waveguide presents a a height discontinuity of 220 nm in order to excite the first order mode on the vertical direction.

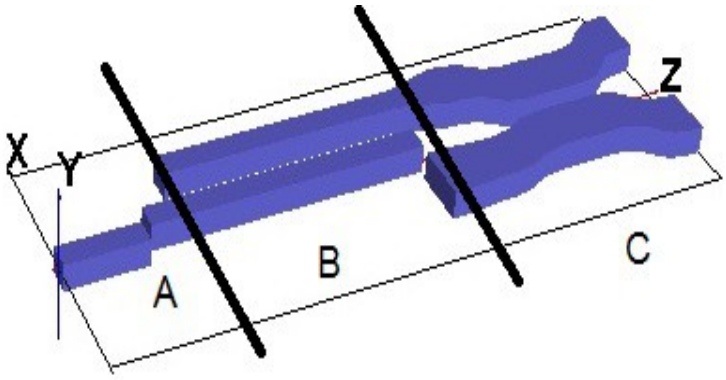

Fig.1

RESULTS

The radiation propagating in the input waveguide as the fundamental mode is equally split into the vertical mode and the fundamental mode by the discontinuity 220 nm. The two modes generated in zone "A" are separated in the zone "B" via a symmetrical directional coupler with its length and separation distance adjusted such the vertical order is completely transferred in the lateral left waveguide, while the fundamental mode remains in the input waveguide. The fundamental mode remained in the input waveguide is laterally coupled in a large waveguide as the horizontal first order using matching of fundamental mode of the input waveguide with horizontal first order mode of the larger waveguide. Once the two first order modes are generated at the end of "B" zone, they are recombined in another directional coupler ("C" zone). At the end of the simulation layout one can notice the generation of the optical vortex. The radiation propagation through the circuit is represented in Fig. 2, and the field configuration at the end of the computational domain showing an optical vortex is represented in Fig. 3.

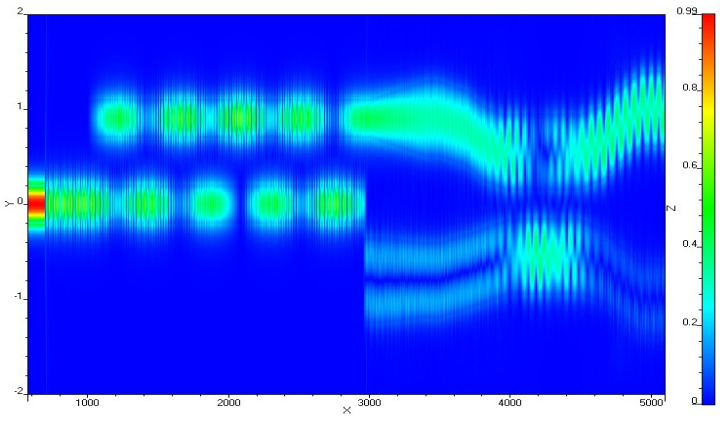

Fig .2

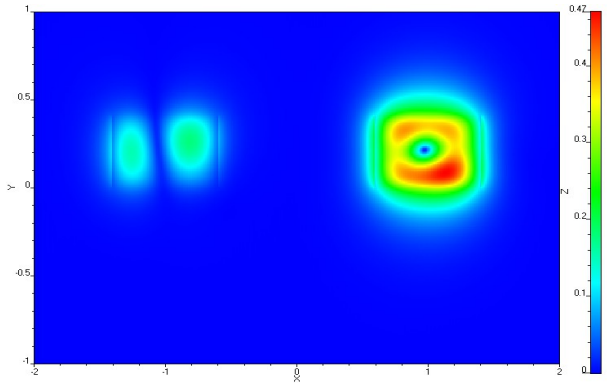

Fig. 3

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