다중 모드 간섭 도파로에서의 스위칭 특성에 관한 연구

Study on Switching Characteristics in the Multimode Interference Waveguide

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Abstract

A novel 2×2 switching characteristics are investigated. This switching characteristics are obtained in the multimode interference waveguide structure. For analysis, beam propagation method (BPM) based on mode propagation theory is used. As a result, the extinction ratio of higher than 11.74dB is achieved.

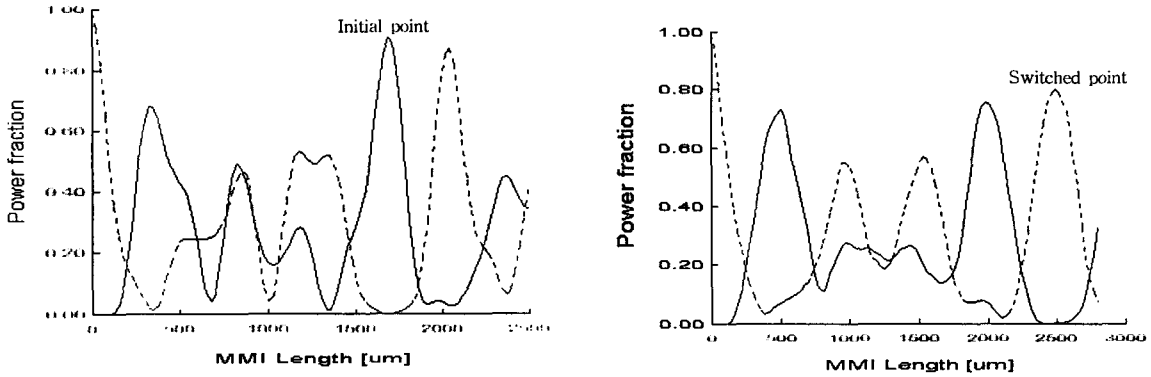
In recent years, there has been a growing interest in the application of multimode interference effects in integrated optics. The multimode interference waveguide is a good candidate because MMI waveguide has wide bandwidth insensitive properties as well as various tolerance of fabrication[1]. Furthermore, the size of the MMI device is very compact[1] comparing with other device using directional coupler of Mach-Zehnder interferometer. Because of the advantages of multimode interference structure, the multimode interference waveguide devices are more useful than another types of devices and it is applicable various optical telecommunication system.

In this study, a novel 2×2 switching characteristics obtained from the multimode interference patterns in a thick waveguide structure are presented. The interference patterns vary according to the length as well as the width of the thick waveguide structure which may be in turn virtually controlled by change of refractive index. Adjusting the index, therefore, the outlet point of field signal can be moved. This result is applied to the bar- and cross-states of 2×2 optical switches.

Multimode interference waveguide design is based on self-imaging effect caused by the interference principle in the thick waveguide. Mode propagation theory based beam propagation method (BPM) is used in the analysis of designed structure. In general, the output of the MMI waveguide can be expected from mode propagation analysis[2] (MPA). However, because of some approximations of MPA[3], when BPM analysis is produced in the multimode waveguide with small index difference between core and cladding layer, another bar-(cross-)state output can be found around the expected cross-(bar-)state output. These states are very important to obtain the switching characteristics in the multimode interference waveguide structure.

The MMI waveguide is designed with the parameters that the core refractive index is 1.5000 and cladding refractive index is 1.5100. In the structure with MMI width of 17.5m, MMI length of

2045m, at the initial bar-state output, insertion loss of 0.542 dB and crosstalk of 14.939 dB is achieved. Switching is occurred when the core refractive index is changed to the value of 1.5047. When switching is occurred insertion loss of 1.118 dB and crosstalk of 12.281 dB is achieved. The extinction ratio of higher than 11.74dB is also achieved.



(a) (b)

Figurel. Change of output powers as changing MMI length (a) before switching and (b) after switching with solid line represents cross-state and dashed line represents bar-state

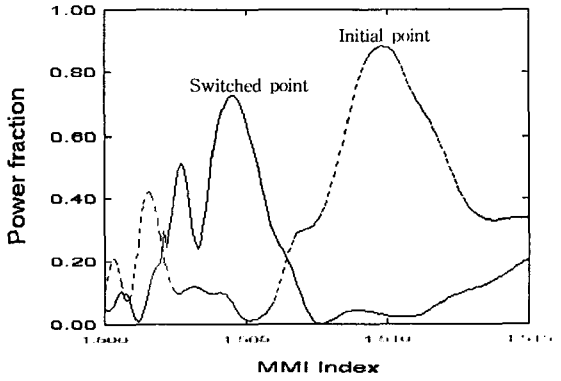


Figure 2. Change of output powers as changing MMI core index with solid line represents cross-state and dashed line represents bar-state

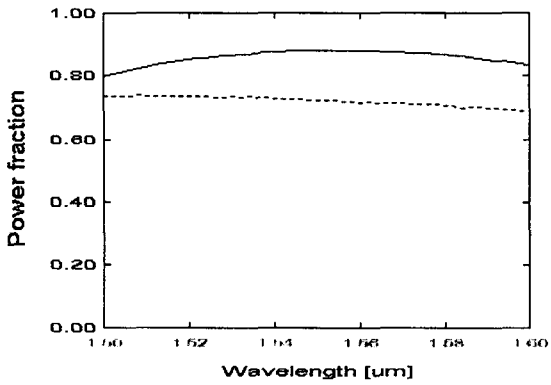


Figure 3. Characteristics for wavelength dependency with solid line represents initial bar-state and dashed line represents switched cross-state

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