반파장판을 이용한 편광에 무관한 광섬유-평면도파로 결합기

Polarization insensitive fibre-to-planar waveguide coupler incorporating a half-wave plate

이규효, 김효겸, 황보승, 김광택
호남대학교 광전자공학과
ktkim@honam.ac.kr

Fibre-to-planar waveguide (PWG) couplers comprising a side-polished single-mode (SM) fibre covered with a high index multimode PWG, have drawn a great deal of attention due to the strong wavelength selectivity. However the couplers suffer from large polarization dependence mainly caused by structural and material birefringence of PWG. It has been reported that the coincidence of resonance wavelengths of TE and TM polarizations can be achieved through compensating the birefringence of PWG with the birefringence of a polarization maintain fiber(birefringent fibre)[1] But those method is no longer available if the birefringence of PWG is sufficiently lager than that of the birefringent fibre.

In this letter, we present a method to achieve the polarization insensitive properties of the coupler incorporating a thin film half-wave plate. The PDL of planar waveguide circuits[2] can eliminated without considerable excess loss by inserting a thin film half-waveplate at a centre of device. The schematic structure of the proposed fibre-to-planar waveguide coupler is shown in Fig. 1. TE (TM) polarisation mode is evolved into TM(TE) polarization mode during travelling the half-waveplate passing a strong birefringence, Since fibre and PWG have different dispersion characteristics, the phase matching condition for effective coupling between fibre and PWG is satisfied at a certain wavelengths called as resonance wavelengths, which can be determined from the eigen value equation of fiber and PWG[1]. At a resonance wavelength, one of two orthogonal polarisation components is removed at the first section, the remained other polarisation component is coupled out at second section through polarisation conversion by the half-waveplate. It means that optical coupling occurs resonance wavelengths of both TE and TM polrisations when a half-wave plate is used in the coupler. we have prepared two side-polished SM fibre blocks. One includes a half- waveplate while the other does not. To insert a half-waveplate(NTT-AT) with 15 mm thickness made of polyimide, a groove with about 20 mm width and 0.5 mm depth was engraved across the fibre direction at longitudinal centre. After inserting the half-waveplate into the groove, it was fixed using an index matching epoxy.

The magnified picture of the around inserted half-waveplate after final polishing is shown in Fig. 2. The measured additional loss after inserting the half-waveplate was typically 0.1~0.3 dB at 1550nm. A silicon nitride film deposited on fused silica block by PECVD method was adopted as multimode PWG. The measured refractive index of the silicon nitride film for TE and TM polarizations were1.7404 and 1.7534, respectively at1550 nm. Its thickness was measured to be about 6.0 mm. A fibre-to-PWG coupler was prepared by physical contact of side-polished fiber and silicon nitride film. The wavelength response of the devices for unpolarization, TE and TM polarization were shown in Fig. 3 an d Fig. 4 As we expected. the wavelength responses of two orthogonal polarization are entirely different when the side-polished block without a half waveplate

as shown in Fig. 3. Due to a birefringence in PWG, about 20nm of resonance wavelength difference between the two orthogonal polarizations was observed. The extinction ratio did not exceed 3 dB at resonance positions for unpolarized light input. But the wavelength responses of the device with a half-waveplate for three different polarizations were almost equal. The optical resonance coupling occurred at both two adjacent positions regardless of polarization state of input light. Relatively higher extinction ratio exceeding 9 dB at resonance wavelengths for unpolarized light input was observed as shown in Fig. 4. From the experimental results, PDLs at resonance wavelengths expected to be reduced regardless of magnitude of birefringence of PWG. Note that PWG layer does not involve a half-waveplate film, so it still continuous. This feature may facilitate forming a electrode on the PWG when the couplers are applied to active device as fiber optic switches and modulators.

T
D

References

1. K. T. Kim, D. S. Yoon, and G. I. Kwoen, "Optical properties of side-polished polarization maintaining fiber coupledwith a high index planar waveguide," Opt. Commun., 230, pp.137-144, 2004

2.Y. Inouse et. al "Elimination of polarization sensitivity in silica-based wavelength division multiplexer using a polyimide half waveplate," IEEE J. of Lightwave Technology, 15, (10), pp. 1947-1957, 1997,

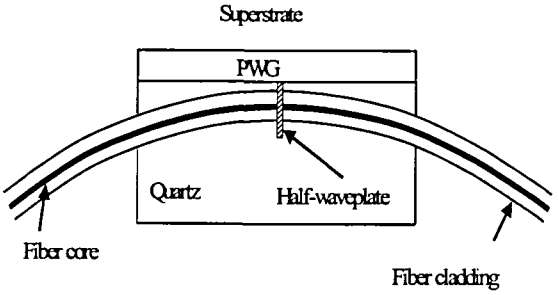

Fig. 1 structure of proposed device

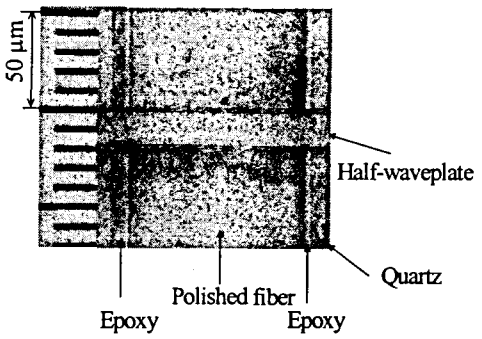

Fig. 2 Picture of polished surface including half-waveplate

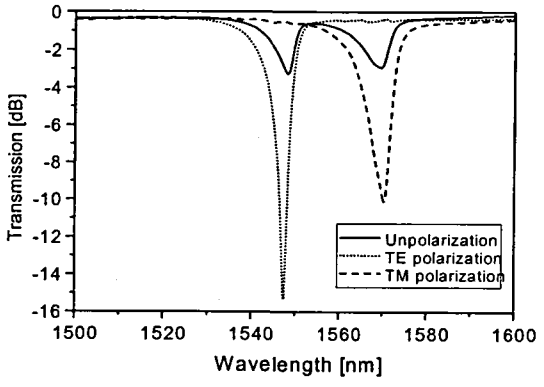

Fig. 3 Wavelength reponse of device without a half-wavplate

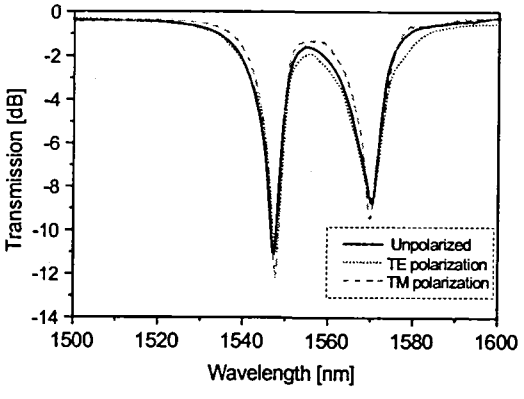

Fig. 4 Wavelength reponse of device with a half-wavplate