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LOW-LOSS PLANAR OPTICAL POLARISATION SPLITTER WITH SMALL DIMENSIONS

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A novel planar polarisation splitter with the smallest dimensions thus far reported (0.6 x 2.5 mm²) is presented. The component, which is based on an optical phased array, was designed and fabricated using conventional (high-quality) optical lithography. Insertion losses as low as 0.5 dB and crosstalk values of 17-21 dB have been achieved.

Introduction: Polarisation splitters play an important role in coherent optical receivers based on polarisation-diversity detection schemes. Planar splitters based on intersecting waveguides, focusing gratings, directional couplers and two-mode interference couplers have been reported recently.1-3 The best results obtained are 1.7 dB insertion loss and 20 dB far-end crosstalk. The smallest device length so far reported is 5 mm. In this letter a new planar polarisation splitter with comparable performance but considerably smaller device size will be presented.

Basic principle: Recently we reported a planar optical phased array, consisting of a number of concentrically bent waveguides with both focusing and dispersive properties.6 The component had considerable loss, however, as evidenced by guides with both focusing and dispersive properties6 The array, consisting of a number of concentrically bent waveguides, was used as the source field for the computation of the field in the focal plane. Finally, the focal field was overlapped with the modal fields in the receiver waveguides to obtain insertion loss and crosstalk figures.

The theoretically predicted insertion loss is 0.5 dB for both channels, if positioned symmetrically relative to the optical axis. Channel crosstalk is predicted to be better than -45 dB.

Experimental results: The devices were measured by selectively coupling TE- or TM-polarised light into the splitter with a coupling prism, and observing the light intensity in the output channels at the cleaved endface, indicated in Fig. 1. The light distribution is imaged onto a CCD camera with a microscope objective. Signal levels are measured by digitising the video image. Fig. 3 shows a photograph of the light distribution for TE- and TM-polarised light, and Fig. 4 an intensity scan across the TM distribution. The two channels furthest to the

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Fig. 1 Polarisation splitter geometry, including two reference channels

ELECTRONICS LETTERS 20th July 1989 Vol. 25 No. 15
left and the four furthest to the right are reference channels. Channels 3 and 4 from the left are the TE and TM channels, respectively. By making a comparison of the simultaneously excited reference channels with the splitter output channels, loss and crosstalk values can be determined.

Fig. 2 Micrograph of realised polarisation splitter

Six reference channels are included, two bent channels on both sides of splitter, and two straight ones. Array contains 26 waveguides.

Fig. 3 Light distribution at cleaved endface for TE and TM polarisations

Channels 3 and 4 from left are TE and TM channel, respectively. Other channels are reference channels.

Fig. 4 Intensity scan across TM-polarised light distribution, shown in Fig. 3

The measured insertion loss for the TM channel is equal to the theoretically predicted 0.5 dB within the accuracy of the measurement method, which is estimated to be ±0.5 dB. The TE channel has 1 dB additional loss, for reasons not yet understood. Channel crosstalk is 20 dB for the TM channel and 17 dB for the TE channel, which is close to the best results reported, but with a considerably smaller device size.

Conclusions: A new polarisation splitter based on an optical phased array is reported. A number of experimental devices were realised using conventional (high-quality) optical lithography, with 0.5–1.5 dB insertion loss and 17–20 dB crosstalk. These results are comparable with the best results reported so far, but with a considerably smaller device size (0.6 x 2.5 mm²).

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References

LOSSES IN SMALL-RADIUS BENDS IN SINGLE-MODE FIBRES

Introduction: Single-mode fibres with smaller mode field radii and, therefore, tighter confinement of the mode field should exhibit lower bending losses. However, bending tests conducted on six different types of single-mode fibres showed that a smaller mode field radius does not necessarily ensure lower losses for bending radii between 1.25 mm and 8 mm. For a given bending radius the measured losses depend on both the refractive index depression in the core centre reduces the bending-loss sensitivity.

Test results: Fig. 1 shows the index profiles (measured at 0.63 μm) for the six fibres investigated. Depressions at the core centre due to GeO₂ burn-off can be observed in fibres 1, 3 and 6. Reduced cladding and outer diameters in fibres 1, 2 and 3 allowed smaller bends than the conventional 125/250 μm diameters in fibres 4, 5 and 6. The cutoff wavelength λc, the maximum relative index difference Δ and the radial distance of the maximum core index from the axis rmax, are shown in Table 1.

The fibres were bent into semicircles with radii ranging from 1.25 mm to 8 mm and losses per unit length in the bend were measured over the spectral region from 1300 to 1600 nm. Fig. 2 shows the losses in dB/mm at 1550 nm. The fibres exhibited strong spectral resonances which required the loss at 1550 nm to be interpolated between resonant peaks. To investigate further the bending sensitivity, far-field intensities were measured by launching a 1550 nm laser beam into the fibres and rotating a GaInAs p-i-n diode in an arc in the output