H-7 A PLANAR ELECTRO-OPTIC BEAM SPLITTER WITH A SAWTOOTH ELECTRODE

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Summary

A planar electro-optic beam splitter with a sawtooth electrode is presented. The realized device on $LiNbO_3$ showed that this device had a deflection power two times higher than the beam splitter with conventional prism electrodes. It is easier to be fabricated and gives a higher operating speed.

Planar electro-optic devices based on electrodes of simulated prism structure to be a beam deflecor or a beam splitter had been studied extensively.[1-6] In this paper, a new type of electrode which acts as a beam splitter, while at the same time, gives better performance than existing devices, is presented. The device was also demonstrated on a $LiNbO_3$ Ti in-diffused planar wavequide at 6328Å.

The electrode pattern is shown in Fig.1a. With the voltage V applied on electrodes as shown, the device can be, in effect, considered to be an array with coventional prism electrodes, while for which, two voltages, V and V/2, are applied alternatingly on each seperated electrode as shown in Fig.1b. When an optical beam propagates through the device, each individual simulated prism region of the device will give an alternating linear phase shift to the wavefront of the optical beam. The device acts effectively as two sets of triangular phase grating arranged alternatingly. Hence it is a beam splitter.

For a single simulated prism electrode, it can be derived that the deflection angle, θ, is[5]

$$\theta = \frac{4n_e\gamma_{33}VB}{\pi A^2} \qquad (1)$$

where n_e and γ_{33} are the extraordinary refractive index and the appropriate electro-optic coefficient of $LiNbO_3$, respectively, and A and B are the aperture and length of the electrode respectively. For the sawtooth electrode, for each "virtual" single prism electrode, V becomes V/2 and A becomes A/2 in equation (1). The overall deflection angle is doubled. That is: the sawtooth electrode has a deflection power two times larger than the beam splitter constructed with the conventional prism electrodes.

Another advantage with the sawtooth electrode is the following: When prism electrode are arranged in an array structure to be a deflector or beam splitter, because of the finite width of electrodes and the required spacing between electrodes (these are due to the intrinsic photo-lithography limitation), the performance of the device can not approach those as predicted by the theory which assumes zero width and spacings. Sidelobes are usually seen on the deflected or splitted beams. For the sawtooth electrode, horizontal electrodes are eliminated. For one pair of tilt electrodes, this saves one unit of the electrodes. This makes the deflected or splitted beam be better quality.

Finally, due to less number of electrodes used, this device is easier to be fabricated and is expected to be able to operate at a higher speed.

An experimental device was fabricated and tested. The device was realized on a Ti indiffused Y-cut X-propagation $LiNbO_3$ wavequide. The aperture A was chosen to be 110μm, and the length B was chosen to be 3300μm. The width of the electrode and the spacings between electrodes were chosen to be 10μm. A 6328Å He-Ne laser optical beam was coupled into the device. Fig.2 shows the output spots of the device with the applied voltage to be 15, 30, 45 and 60V respectively. With an applied voltage of 15V, two splitted beams appeared while with the central beam still observable. With the applied voltage increased to 30V, the beam splitted to six spots and the central beam disappeared. With the applied voltage increased further, the intensities of beams near the central region decreased while those for beams near outside region increased. The measured deflected angles, when compared with those of a similar device which was fabricated with conventional prism electrodes with comparable dimensions as the sawtooth electrode, they were two times larger.

It can then be concluded that when electrodes are arranged in a sawtooth fashion, a beam splitter is obtained. This beam splitter has a deflection power two times higher than the beam splitter formed with conventional

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prism electrodes. It will give better quality for the deflected beam. It is easier to be fabricated and it should give a higher operating speed.

References

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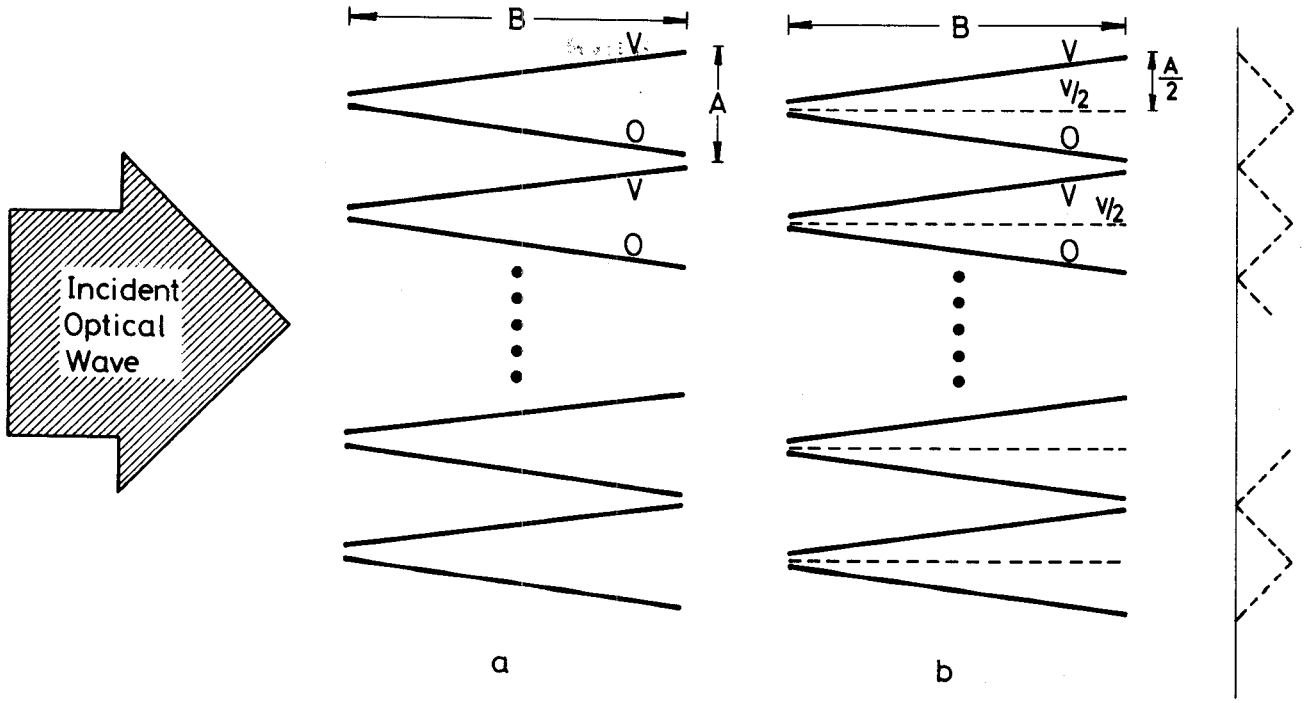

Fig.1 The sawtooth electrode and the corresponding "virtual" prism electrode array. The phase front shift on the passing optical beam is also shown.

Fig.2 Pictures of the output beam spots of the experimental device for the applied voltage of 0, 15, 30, 45 and 60V, respectively.