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COMMENT

OPTIMISED IMPLEMENTATION OF REAL-TIME DISCRETE WIGNER DISTRIBUTION

Owing to the Hermitian symmetry of the Wigner kernel, the above Letter[1] proposed a fast algorithm to compute the discrete Wigner distribution (DWD) by an $N/2$-point FFT

$$wk(n) = x_a^1(n) \,.\, x_a^{l*}(-n) = \text{even}\,(n) + j\,\text{odd}\,(n) \qquad n = 0, 1, 2, \ldots, N-1 \quad (1)$$

$$y(n) = wk(2n) + [wk(2n+1) - wk(2n-1)] \qquad n = 0, 1, 2, \ldots, \frac{N}{2} - 1 \quad (2)$$

$$\text{DWD}\,(l, k) = \text{Re}\,[Y(k)] + \frac{\text{Im}\,[Y(k)]}{2\sin 2\,.\,\pi k/N} \qquad k = 1, 2, \ldots, \frac{N}{2} - 1 \quad (3)$$

However, the last half part of the DWD is not equal to zero as the author claims; it needs to be added and computed as follows:

$$\text{DWD}\,(l, N-k) = \text{Re}\left[Y\left(\frac{N}{2} - k\right)\right] - \frac{\text{Im}\left[Y\left(\frac{N}{2} - k\right)\right]}{2\sin 2\pi k/N} \qquad k = 1, 2, \ldots, \frac{N}{2} - 1 \quad (4)$$

$$\text{DWD}\,(1, 0) = \sum_{n=0}^{N-1} \text{Re}\,[wk(n)] \qquad k = 0 \quad (5)$$

$$\text{DWD}\left(1, \frac{N}{2}\right) = \sum_{n=0}^{N-1} (-1)^n\, \text{Re}\,[wk(n)] \qquad k = \frac{N}{2} \quad (6)$$

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INTEGRATED ACOUSTO-OPTIC COLLINEAR *TE–TM* MODE CONVERTORS FOR 0·8 μm OPTICAL WAVELENGTH RANGE

Indexing terms: Acousto-optics, Surface-acoustic-wave devices, Convertors, Integrated optics

Low power, narrowband integrated acousto-optic *TE–TM* mode convertors for the 0·8 μm optical wavelength range have been developed. Acoustic drive power of less then 10 mW was required for 96% conversion efficiency. The 0·32 nm optical bandwidth corresponding to the acoustic bandwidth of 138 kHz achieved is the narrowest reported to date for a *TE–TM* mode convertor.

Introduction: Surface acoustic wave (SAW) controlled integrated optical *TE–TM* mode convertors are used for several applications, e.g. as tunable optical filters in wavelength division multiplexed fibre optic communication systems,[1,2] in narrow-linewidth extended cavity semiconductor lasers as intracavity wavelength filters[4] or in the optical spectroscopy,[3] or as acousto-optic frequency shifters[5] etc. Recently, an unconventional X–Y (X cut, Y propagation) interaction geometry on $LiNbO_3$ was proposed, which results in a significant reduction of the power requirement.[1] All *TE–TM* mode convertors known up to now have been developed for the wavelength range 1·3–1·55 μm[1,2] or earlier with the conventional Y–X geometry for the He–Ne wavelength of 0·633 μm,[5] for experimental convenience. The wavelength range in the vicinity of 0·8 μm, for which a large choice of cheap semiconductor lasers, LEDs and optical fibres exists has not yet been considered. In this wavelength range, besides the above mentioned general application areas of the *TE–TM* mode convertors, several sensor applications can be envisaged; one example is the recently proposed acousto-optic gas sensor.[6]

In the 0·8 μm optical range, the phase matching is achieved with shorter acoustic waves (as compared to the 1·3–1·55 μm).[4] The smaller penetration depth of the SAWs leads to higher power densities and better overlap with the optical fields and, consequently, significantly lower acoustic power requirements can be expected. Additionally, the bandwidth of the mode conversion, which is directly proportional to the SAW wavelength, will also be narrowed.

We report on the development and investigation of collinear acousto-optic *TE–TM* mode convertors for the 0·8 μm wavelength range. Using X–Y $LiNbO_3$ samples, we were able to construct efficient devices with low acoustic power requirements and with very narrow bandwidth, especially suitable for filter applications.

Fabrication of devices: An integrated optical *TE–TM* mode convertor essentially consists of an optical waveguide and a suitably designed interdigital transducer (IDT) for exciting the SAWs necessary to achieve phase matching. The optical channel waveguides were produced with Ti diffusion on $10 \times 30\,mm^2$ $LiNbO_3$ samples. On the surface of the samples 68 nm thick and 2·5 and 3 μm wide, vacuum evaporated Ti stripes were photolithographically formed. The diffusion was performed for 7 h at 1050°C in O_2 atmosphere using a closed platinum box. After polishing the endfaces of the samples, the near-field patterns of the two fundamental modes were investigated (at 0·84 μm wavelength) showing a pure monomode behaviour and a good overlap of the modal fields.

In a further technological step, the IDT was photolithographically patterned on the surface of the samples. It consisted of four pairs of 150 nm thick Al fingers with 2·6 μm width, and spacing between the fingers. The aperture of the transducer (~1 mm) was equal to 100 SAW wavelengths to mini-