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Electro-optic Long Period Ti:$LiNbO_3$ Waveguide Gratings in Parallel for Broadband Filtering

De-Long Zhang[1,2*], Jia-Qi Xu[1], Wing-Han Wong[1,2], Edwin Yue-Bun Pun[2]

1 School of Precision Instruments and Opto-electronics Engineering, Tianjin University, Tianjin 300072, China, and Key Laboratory of Optoelectronic Information Technology (Ministry of Education), Tianjin University, Tianjin, 300072, China.

2 Department of Electronic Engineering and State Key Laboratory of Millimeter Waves, City University of Hong Kong, Kowloon, Hong Kong SAR, China.

* dlzhang@tju.edu.cn

We report broadband optical filter based on two parallel electro-optic long period Ti:$LiNbO_3$ waveguide gratings with different pitches. By utilizing electro-optic and photorefractive effects of $LiNbO_3$ and by changing driving voltage, one can realize 360 nm broadband linear tunability and 0-30 dB linear adjustment of dip contrast.

Long-period waveguide grating (LPWG) and long-period fiber grating have similar working principle and application background [1, 2]. An LPWG based on electro-optic effect of $LiNbO_3$ (LN) is promising for high-speed application [3,4]. Here, we demonstrate a broadband filter based on a parallel structure of two electro-optic long period gratings in two same Ti:LN strip waveguides. The device was developed on the basis of the electro-optic and photorefractive effects of LN.

The device was fabricated in a following way. First, a special structure of an array of strip waveguides embedded in a planar waveguide was fabricated on an LN substrate surface by successive diffusion of 60 nm thick homogeneous Ti film at 1060 ^oC for 6 h and an array of 6-μm-wide, 105-nm-thick Ti-strips at 1060 ^oC for 11 h. Second, a 320 nm thick SiO_2 buffer layer was coated onto the waveguide surface. Third, two parallel interdigital Al electrodes with pitches 675 and 880 μm were patterned on the top surface. Upper left of Fig. 1 shows the structure of the device.

After the fabrication, the device performances were fully characterized. The lower left part of Fig. 1 shows the morphology of waveguide surface and the mode patterns of the strip waveguide at the 1.5μm wavelength. The upper right of Fig. 1 shows the normalized transmission spectra of the device driven under different voltages for the grating having a pitch of (a) 675 μm and (b) 880 μm. Two features could be identified from these spectra. First, the contrast of the dip increases with a rise in driving voltage. The panel (a) in the lower right of Fig. 1 shows the driving voltage dependence of the dip contrast for the two grating pitches. We note that as the voltage changes from zero to 300 V the contrast increases almost linearly from zero to 30 dB. This feature is associated with the electro-optic effect of LN. Second, the panel (b) in the lower right of Fig. 1 shows the driving voltage dependence of the resonant wavelength for the two grating pitches.

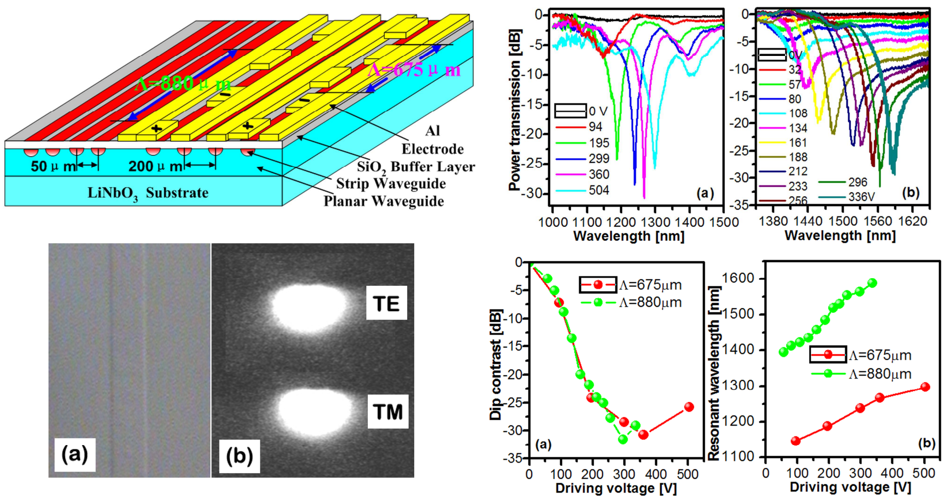

Fig. 1. Upper left: Structural schematic of device; Lower left: (a) Waveguide surface and (b) mode images at 1.5 μm; Upper right: Transmission spectra of the device driven under different voltages for grating pitch of (a) 675 μm and (b) 880 μm; Lower right: Driving voltage dependence of (a) dip contrast and (b) resonant wavelength for two grating pitches.

One can see that the resonant wavelength red-shifts almost linearly with the increase of the driving voltage. The shift is ~160 nm for the shorter period grating and ~200 nm for the longer pitch grating, and hence ~360 nm in total. An overall investigation shows that the shift is due to the photorefractive effect of LN.

In summary, we have demonstrated a broadband filter based on two parallel electro-optic Ti:LN LPWGs with different pitches. By using the electro-optic and photorefractive effects of LN and by changing the driving voltage, one can realize 360 nm broadband linear tunability and 0-30dB linear adjustment of dip contrast. Broader bandwidth is expected by using more parallel LPWGs. The device may find its use in fields of high-speed optical filter, gain flattening and sensing.

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