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Tunable and Rotatable Birefringence Controller Based on Electrical Control of Liquid Crystal Filled Photonic Bandgap Fibers

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Continuously tunable birefringence controllers by using Liquid Crystal Photonic BandGap (LCPBG) fibers have been proposed [1,2]. Here, we demonstrate the first compact electrically tunable and rotatable birefringence controller based on LCPBG fibers. The cross section of the device is shown in Fig. 1(a). A LCPBG fiber is mounted between two v-grooves fabricated in a silicon substrate by standard UV lithography and KOH wet etching. 200nm gold electrodes are deposited on the side walls of the grooves, forming a set of electrodes, which fix the fiber at four orthogonal corners relative to the core. The device electrodes are connected in different electrode configurations (ECs) corresponding to three directions of the electric field (0°, 45°, and 90°):

EC1 (0°): electrode 1=Vs, electrode 4=-Vs, electrode 2=electrode 3=ground.

EC2 (45°): electrode 1=electrode 2=0.707Vs, electrode 3=electrode 4=-0.707Vs.

EC3 (90°): electrode 2=Vs, electrode 3=-Vs, electrode 1=electrode 4=ground.

At 25°C, a birefringence change of 7.37×10^{-5} is obtained by applying 210Vrms with EC1 connection at 1520nm. More birefringence changes shown in Fig. 1(b) are observed when an input signal with a longer wavelength is launched, e.g. a change in birefringence of 8.13×10^{-5} , 8.55×10^{-5} and 8.94×10^{-5} are obtained for 1550nm, 1580nm and 1600nm, respectively. With the rotatable electric field, the absolute changes in birefringence in the wavelength range 1520nm-1600nm are shown in Fig. 1(c) for EC2 and Fig. 1(d) for EC3. The changes in birefringence are less than that of EC1, since the electric field to the fiber breaks the cylindrical symmetry of the LC alignment and subsequently induces a polarization dependence of the transmission.

Fig. 1 (a). The cross section of the LCPBG fiber device. Electrically induced absolute change in birefringence of this LCPBG device in the wavelength range 1520nm-1600nm for EC1 (b), EC2 (c) and EC3 (d). The insets show the phase shift on the Poincaré sphere with a driving voltage of 120Vrms and 210Vrms at 1550nm for EC1 (b), EC2 (c) and EC3 (d).

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