High Speed Polarization Independent THz Phase Shifter

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In recent years, Terahertz (THz) photonics have attracted plenty of attraction due to its remarkable progress.[1] For tunable phase shifting application, several groups have demonstrated 2π THz phase shifter by nematic liquid crystal.[2] However, these devices need polarizer or other polarization control system to achieve polarization independency. Meanwhile, few hundred second modulation speed also limits its application potential. Therefore, a high speed polarization independent device for THz is desirable. Using chiral nematic liquid crystals, polarization independent THz 2π phase shifter was proposed and demonstrated.[3] In this work, voltage-controlled 2π THz phase shifter with sub-second modulation speed was demonstrated. The device was constructed by stacking three CLC layers. Each CLC layer with thickness of 1.5mm was sandwiched by two fused silica glasses coated with ITO. The CLC was made by chiral dopant mixed in a NLC host BL006 and pitch length is around 20um. The structure of CLCs becomes visible homeotropic texture from invisible focal conic texture when the driving voltage increases from zero till over 360V. However, the device all behaves with high transmittance for THz with or without driving voltage due to small Bragg diffraction. Figure one shows the THz temporal profiles under various driving voltage. Clearly, the profile almost maintains unchanged and has 1psec time shift as voltage is larger than 360V. This indicates the 2π phase shift for 1THz. In addition, the rising time which is defined as the THz signal increasing from 10% to 90% is investigated by turning on the voltage suddenly. Same, we can also have falling time as turning off the voltage. Figure two shows the rising and falling time under various driving voltage. The increasing modulation speed as driving voltage is observed. The speed of modulation as short as 0.5sec can be obtained as driving voltage of 1500V. One should be noted that this is the first time the modulation speed of liquid crystal based 2π THz phase shifter can be shorter than one second. Besides, the device is still polarization independent. Meanwhile, we also discuss the feasibility of 100msec modulation speed device with few tens V driving voltage.

Fig. 1 THz temporal profiles under various driving voltage

Fig. 2 The rising and falling time under various driving voltage

References