Optically Driven Broadband Mid-infrared Polarization Rotator Based on TNLCs

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Abstract— Mid-infrared (mid-IR) photonics have been paid a lot attention for the past few years, because of their many strong fundamental vibrational molecular bonds of various molecules. Recently, several mid-IR light sources technologies have been progressed rapidly, so the development of other mid-IR optical devices has become urgent. In particular, most optical systems require a polarization controller, but the most mid-IR polarization controllers are based on resonance structures and thus exhibit only narrowband operation. Therefore, we propose a mid-IR polarization rotator using a TNLC cell with a photo-controllable alignment layer. The TNLC device can act as an achromic polarization rotation device over a wide wavelengths range and thus can rotate the polarization of a mid-IR laser beam. The photo-alignment technique enables TNLCs with arbitrary twisting angles to be generated by the use of visible polarized addressing light to control the directors of the photo-alignment layer.

Figure 1(a) shows the device configuration of a TNLC cell where the inner surface of the top substrate was coated with a PI layer and rubbed along the x-axis, while that of the bottom substrate was coated with a photo-alignment layer (PAAD-72, Beam Co.). To verify the rotation of polarization in the mid-IR spectrum, the 30°, 60°, and 90° TNLC cell is addressed *in situ* using a linearly polarized 405 nm photo-aligned laser. Figure 1(b) plot polar graphs of the transmittance of the linearly polarized 3 μm mid-IR laser following the photo addressing. The passing of the linearly polarized mid-IR laser light through the photo addressed TNLC cells rotated its polarization axis from 0° (parallel to the rubbing direction) to 30°, 60°, and 90°, respectively. The measurements reveal that the output linear polarization axis of the mid-IR laser follows the alignment of the LC directors on the photo-alignment film. Such a TNLC-based polarization rotator has many advantages, such as an arbitrary rotation angle, an extremely large bandwidth, and rewritability. It therefore has great potential for use in mid-IR photonics.