Conference or Workshop Item:
Dunn, A orcid.org/0000-0002-7369-1469, Zhang, Z, Horbury, M et al. (12 more authors) Liquid-Crystal-Based Optics for THz-Frequency Variable Attenuators. In: UK National Earth Observation Conference 2022, 06-08 Sep 2022, Leicester, UK. (Unpublished)

Liquid-Crystal-Based Optics for THz-Frequency Variable Attenuators

Numerous important gas-phase species in the upper atmosphere (e.g., O, OH, NO) have distinctive spectral features in the terahertz-frequency (THz) band of the electromagnetic spectrum. This has raised considerable interest in the development of THz radiometry from satellite or airborne platforms. However, there are limited optical components in this band. Adaptive optical devices have been proposed to modulate THz radiation dynamically, although none are yet compatible with high bandwidth or high-frequency (>2.5 THz), narrowband sources, such as quantum-cascade lasers.

Here we present the first liquid-crystal (LC) controllable attenuators operating in the 2–4-THz band. A commercially available nematic LC mixture, E7, was selected for this study and was enclosed within a planar cell of fused quartz windows. A long-chain polyimide (SE-3510) layer and a conductive polymer (PEDOT:PSS) electrode layer were used to achieve monodomain alignment of the LC molecules and bias the LC layer respectively.

THz time-domain spectroscopy was used to characterize the materials over a 0.3–4 THz bandwidth, and a birefringence of 0.14–0.18 was determined. Using a linearly polarized, collimated beam from a 3.4-THz QCL, the THz power transmitted through a LC device (100 µm LC layer thickness) was modulated by up to 40% dependent on the bias voltage applied to the device. This modulation was caused by a combination of effects, namely the linear dichroism between the two optical axes of the LC material, and etalon interference between the LC/electrode/quartz interfaces, with the former effect being dominant.