利用 PEDOT 電極之液晶太赫茲空間光調制器之研究

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摘要

Poly(3,4-ethylenedioxythiophene)/poly(4-styrenesulfonate) (PEDOT/PSS) 此種有機電極材料在兆赫(太赫茲)頻域下有很高的穿透率，穿透率可高達約 90%。在本工作中，我們使用以簡單的旋塗(spin-coating)製程製作之 PEDOT/PSS 薄膜作為以液晶為基底的兆赫(太赫茲)光電元件之透明電極。

我們設計了一種易於製作、低成本、符合經濟效益的空間光調制器(SLM)，並在 PEDOT/PSS 上製作空間光調制器的像素圖案，空間光調制器的每一個像素均為扭曲向列型液晶盒。

在本論文中，我們使用兆赫時域光譜技術(THz-TDS)進行量測分析，比較三種不同光學異向性(雙折射率)的液晶，分別為 MDA-00-3461，TD101-146 以及 mixture-W1825 所製作不同厚度的相位調制器的相位移程度，使用高雙折射率液晶 mixture-W1825 (其在 0.2 到 1.2THz 頻寬間所量測出的 n_e~2.03，n_o ~1.65，△n~0.37)，只需要 250μm 厚度即可達到在 1.2THz 的 95.2^o 的相位移。

此外，我們引入了一種聚合物薄膜置於厚的兆赫液晶盒中間，作為中間層的均勻配向層，以提升響應速度和達到更高的相位以及振幅調製。在本工作中，我們實驗發現一 500μm 厚的 MDA-00-3461 液晶相位調制器，相位移從 94^o 增加到 111°，此外振幅調制頻寬從 0.2-0.6 THz 擴展到 0.2-0.9 THz，響應速度之上升時間由 1.63 秒縮短至 1.06 秒，下降時間由 >100 秒縮短至 40 秒。

Liquid-Crystal-Based Terahertz Spatial Light Modulator Using PEDOT as Electrodes

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Abstract

An organic electrode material, poly(3,4-ethylenedioxythiophene)/poly(4-styrenesulfonate) (PEDOT/PSS) exhibits as high as transmittance 90% in the range 0.2 - 1.2 THz. In this work, spin coated PEDOT/PSS thin films use as transparent electrodes for various liquid crystal (LCs) based Terahertz (THz) devices.

We design a 3 × 3 pixels PEDOT/PSS pattern for spatial light modulator (SLM), which is simple device fabrication step and low cost for economic effective, each pixel of the SLM is a twisted nematic (TN) LC cell.

In this thesis included, evaluation of optical anisotropy properties of three different kinds of LCs, such as MDA-00-3461, TD101-146 and mixture-W1825 using THz time-domain spectroscopy (THz-TDS). In addition, we investigated the phase shift phenomena of these three types of LCs cell at different thickness. We observed that mixture-W1825 LCs be excellent candidate for THz devices application (measured values of ne, no and △n are 2.03, 1.65 and 0.37, respectively at 0.2 - 1.2 THz). The highest phase shift achieved 95.2° at 1.2 THz with injected mixture-W1825 LCs into 250 μm thick cell only.

Besides that, we introduced a polymeric thin film as an intermediate layer in between a thick THz LCs cells to improve the alignment properties for faster response and higher phase as well as amplitude modulation. The phase shift increased from 94° to 111°, amplitude modulation range increased from 0.2-0.6 THz to 0.2-0.9 THz with intermediate based LCs cell (injected LCs MDA-00-3461, 500μm thickness). Also, improve the response time properties of the bi-layers as compare single layer LCs cell. The rise time and fall time is shortened from 1.63 sec to 1.06 sec, and 100 sec to 40 sec, respectively.