Polymer-dispersed Liquid Crystal Devices with Graphene Electrodes

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The quest for transparent conducting electrode materials has been an important issue since they are widely used in the flat panel display, OLED, and photovoltaic industry. Due to the high processing cost of the conventional ITO electrode, many alternative processes using CNT, graphene, metal mesh, nanoparticles, and nanowires has been studied recently. In this work, we fabricated smart window devices using polymer-dispersed liquid crystal (PDLC) film [1] with graphene electrodes and studied the effect of the electrodes on the electro-optical properties of the devices.

We fabricated the PDLC film from a mixture of a liquid crystal (E7, 5CB) with a pre-polymer (NOA65) by 5:5 and 8:2 wt% ratios. The PDLC cells were fabricated by polymerization induced by phase separation (PIPS) method (365nm-UV, 3min) after injecting the mixture into the 20μm wide cell gap between two electrodes. We prepared the graphene electrode on transparent substrates by a standard transfer process using a PMMA stamp on the graphene grown on Cu.[2] The sheet resistance of the transferred graphene on a glass substrate was 1.1 kΩ/□.

Figure 1 shows the optical transmittance of the PDLC devices with different combinations of the top and bottom electrodes. The performance of the PDLC devices with one graphene electrode was comparable to the devices with ITO electrodes. The device showed higher transmission, lower operating voltage and lower haze compared to the ITO devices. The graphene devices were also robust under the standard operating condition of $100V_{rms}$ at 1kHz. In addition, as shown in Fig. 2, the UV dose for the optimal device performance was less than 80% of the optimal dose for the devices with ITO electrodes, which suggests a cost-effective device processing. We believe that the graphene electrode affected the LC-polymer phase separation during UV-polymerization, which resulted in the changes in the morphology and interface properties and the light scattering efficiency of the PDLC film.

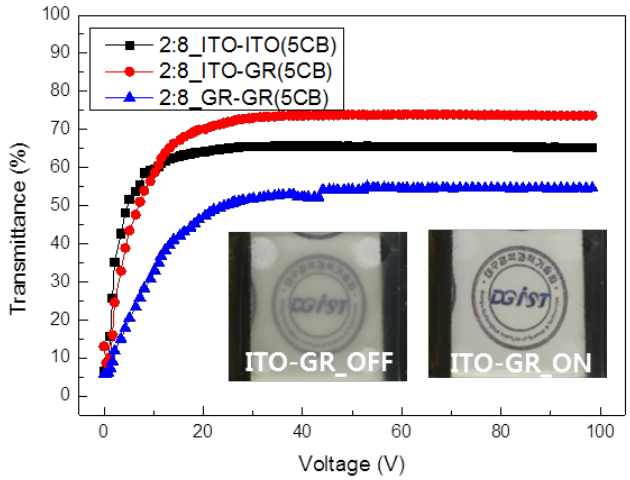

Fig. 1. Transmittance vs. Applied Voltage (V-T)

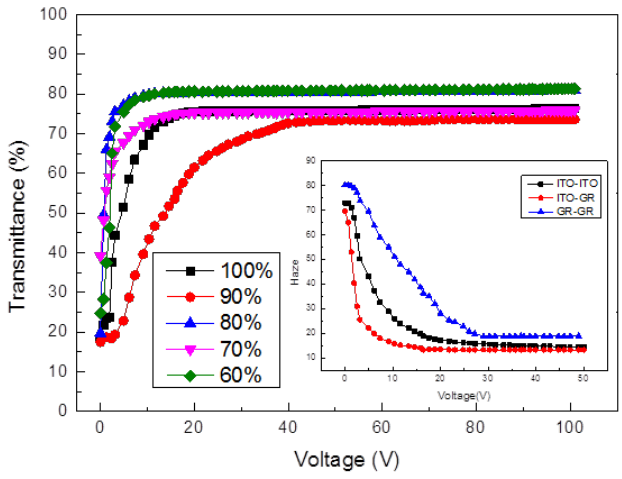

Fig. 2. UV dose dependence of V-T & Haze (inset)

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