Controlling pre-tilt angles using rubbed PEDOT / PSS and DMOAP films for ITO-free LC devices

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1. Introduction

Currently, poly(3,4-ethylenedioxythiophene) polystyrene sulfonate or PEDOT / PSS is expected as a new transparent electrode material to replace the rare metal, indium tin oxide (ITO). The PEDOT / PSS film has a possibility to use not only transparent electrodes but also alignment films of liquid crystals (LCs) [1, 2]. PEDOT / PSS shows a good compatible with a plastic flexible substrate due to a low-temperature process since it is an organic material. If two functions such an electrode and an alignment film can be realized by using the PEDOT / PSS film, a low-cost LCD with plastic substrates may be realized due to a simple process. In our previous report, the electro-optical characteristics of the LC cell injected 5CB were reported,[3] and under 1° of small pretilt angle for the rubbed PEDOT / PSS film was observed. However, for application to various display modes, the vertical orientation and the high pretilt angle are required to apply PEDOT / PSS. And it is very important to realize them by a low-temperature process of amperometry 100°C in order to prevent deterioration of the organic conductive material and the flexible substrate. The dimethyloctadecyl [3- (trimethoxysilyl) propyl] ammonium chloride (DMOAP) is known as a vertical alignment material and can be easily deposited by spin coating. Also, unlike polyimide alignment materials, the effect can be obtained just by volatilizing the solvent. In this report, we propose a method to induce a high pretilt angle by laminating DMOAP film on PEDOT / PSS layer.

2. Method

A PEDOT / PSS solution TC-09 (Iwatsu Manufacturing) was spin-coated at 3000 rpm × 20 s onto the cleaned glass substrates coated with ITO and dried at 120 °C for 30 min. Here, the ITO electrode was supplementary used to maintain the stability of the measurement of pre-tilt angles. Thereafter, the rubbing treatment was carried out for the substrates and the hydrophilic treatment was applied. Then, the DMOAP (Sigma-Aldrich) solution diluted with methanol (FUJIFILM Wako Pure Chemical) was spin-coated at 3000 rpm × 20 s onto the PEDOT / PSS layer and dried at 120 °C for 30 min. Homogeneous orientation cells with 20μm thickness were assembled using the substrates. ZLI-2293 (Merck) of cyano-based nematic LC was injected into the cells with isotropic phase and cooled down to the room temperature.

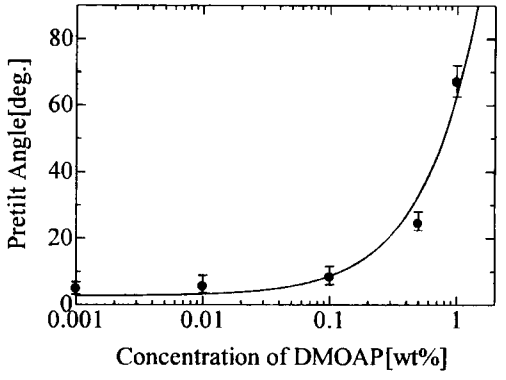

Figure 1: Measurement result of pre-tilt angles

3. Result and Discussion

Figure 1 shows the measurement result of pre-tilt angles by magnetic null method. The higher the concentration of DMOAP solution, the higher pre-tilt angle was obtained. This was because by using a high concentration DMOAP solution, the film thickness became thick and the influence of the rubbed PEDOT of the base was diminished. Furthermore, it was confirmed that the influence of the anisotropy generated by the rubbing treatment strongly gave the orientation control force even if the DMOAP film existed.

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References

[1] T. R. Chou, S. H. Chen, Y. T. Chiang, Y. T. Lin, and C. Y. Chao, "Highly conductive PEDOT:PSS films by post-treatment with dimethyl sulfoxide for ITO-free liquid crystal display," J. Mater. Chem. C, vol. 3, no. 15, pp. 3760–3766, Apr. 2015.

[2] J. De Smet, A. Avci, P. Joshi, D. Cuypers, and H. De Smet, "P-159L: Late-News Poster : A Liquid Crystal Based Contact Lens Display Using PEDOT: PSS and Obliquely Evaporated SiO2," SID Symp. Dig. Tech. Pap., vol. 43, no. 1, pp. 1375–1378, Jun. 2012.

[3] Y. Kudoh, H. Yoshioka, and T. Takahashi, "Liquid Crystal Alignment on Rubbed PEDOT/PSS Films ," Japanese Liquid Crystal Society Ekisho-Tronkai-Yokoshu, PA 35, Sept. 2016. (In Japanese)