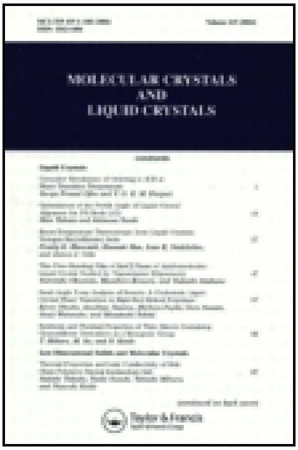

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Polarized Electroluminescence of Oligophenyl Thin Films Prepared on Friction Transferred Poly(p-Phenylenes)

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Polarized Electroluminescence of Oligophenyl Thin Films Prepared on Friction Transferred Poly(*p*-Phenylenes)

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We confirmed 6P thin films were uniaxially grown on friction transferred poly(*p*-phenylene) (PPP) films. Highly polarized absorption and emission of 6P were observed in the direction parallel to the friction direction of PPP. In this study, we have fabricated a polarized LED with an uniaxially oriented 6P layer. The polarization ratio of EL is 2.6 at maximum wavelength of 450 nm.

Key words Polarized emission; Electroluminescence; Oligophenyls; Friction transfer; Poly(*p*-phenylenes)

INTRODUCTION

Recently there has been interest in polarized electroluminescence (EL) from one-dimensional π-conjugated polymers and oligomers for useful applications[1]. One important feature of these compounds is the potential for tuning optoelectrical properties by controlling molecular orientations. Many researchers have achieved to prepare polarized ligh-emitting diodes (LED) by aligning organic emitters, such as alignments by a thermotropic liquid crystalline phase, epitaxial growth on a rubbed substrates, Langmuir-Blodgett techniques[1]. The friction transfer technique has been developed for achieving high molecular alignments[2]. Various organic materials have been reported to form thin films on friction transferred poly(tetrafluoroethylene) (PTFE)[2].

Currently Tanigaki has accomplished to prepare friction transferred films of electroactive and photoactive polymers, such as polysilanes, poly(*p*-phenylene) (PPP)[3]. Also, we confirmed various π-conjugated oligomers were epitaxially grown on friction transferred PPP films so that uniaxially oriented parallel to the friction deirection. The highly polarized emissions of the π-conjugated oligomers such as oligophenyls and thiophene/phenylene co-oligomers were observed [4].

In this study, we have fabricated a polarized LED of oligophenyl by using epitaxial growth on friction transferred PPP films. The polarized properties of LED of oriented oligophenyl were evaluated.

EXPERIMENTAL

Oligophenyls, *p*-sexiphenyl (6P) were purchased by Tokyo Kasei Co. Ltd. Poly(*p*-phenylenes) (PPP) were synthesized by Yamamoto's methods. PPP thin films were prepared onto indium tin oxide (ITO) substrates by friction transfer methods. Vacuum deposition of oligophenyls was performed at following conditions; pressure of $2X10^{-7}$ Torr, deposition rate of 0.1 nm/s, substrate temperature of 18°C. The LED were composed of an ITO anode, oriented PPP layer (20 nm), oriented 6P layer (60 nm), triazole derivative (TAZ) hole blocking layer (50 nm) and Al cathode.

The polarized electroluminescence (EL) spectra of the devices were measured by CCD camera (Princeton Instruments, Ltd.) equipped with a rotationg polarizer. The polarized photoluminescence (PL) spectra were measured by spectrofluorimeter (JASCO, FP777).

RESULTS AND DISCUSSION

Figure 1 shows polarized PL spectra from an epitaxially grown film of 6P prepared onto friction transferred PPP. The major emission maxima are located at 425, 450, and 480 nm. The polarized ratio between parallel (0°) and perpendicular (90°) to the friction direction is 3.0 at a maximum wavelength of 450 nm. Next we measured a polarized EL spectra of an ITO/PPP/6P/TAZ/Al device. The EL spectra corresponds well to the PL spectra of PPP/6P films as shown in Figure 2. From this result, we have confirmed that emission region locates at oriented 6P layers in the LED. The polarized ratio of the EL intensity is 2.6 at a wavelength of 450 nm. Other researcher reported the polarization ratio of EL of 6P epitaxially grown on rubbed substrate was about 5, and that of poly(*p*-phenylene vinylene) derivertives on a friction transferred poly(tetrafluroethylene) was about 4 [5]. Slightly low polarization ratio is caused by insufficient orientation of 6P and/or PPP. It has became feasible to improve the polarization ratio by optimizing fabrication conditions.

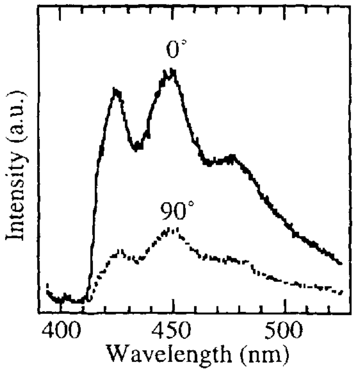

FIGURE 1 Polarized PL spectra of a PPP/6P thin film on an ITO substrate.

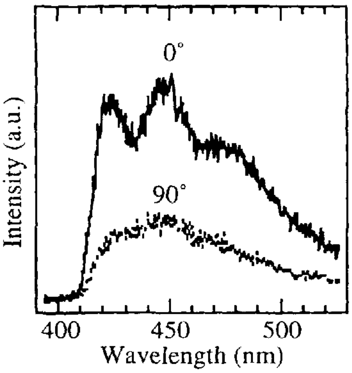

FIGURE 2 Polarized EL spectra of an ITO/PPP/6P/TAZ/Al device.

To compare with conventional EL spectra of 6P, we fabricated an ITO/6P/TAZ/Al device at same deposition conditions. Figure 3 shows the PL and EL spectra of a 6P layer. The major emission are located at 425, 450, and 480 nm in a similar manner as an oriented 6P layer. However the intensity of emission at 425 nm increases in these spectra. In tha case of PPP/6P layers, it indicates the emission spectra of 6P was affected by absorption of a PPP layer.

The current density as a function of electric field for the polarized and non-polarized LED of 6P was measured as shown in Fig. 4. The decrease of the current was observed for polarized LED with a PPP layer and an oriented 6P layer. We have assumed the effect of PPP buffer layer and/or oriented 6P for carrier injection. Then our discussion on the buffer effect of oriented PPP and other π-conjugated polymers is now in progress.

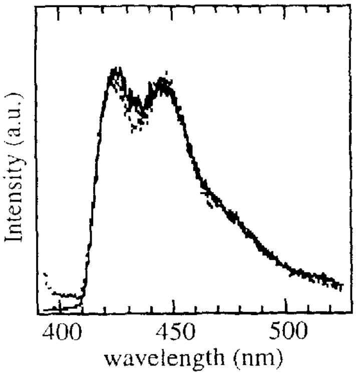

FIGURE 3 EL spectrum (solid line) of an ITO/6P/TAZ/Al device and PL spectrum (dotted line) of a 6P thin film on an ITO substrate.

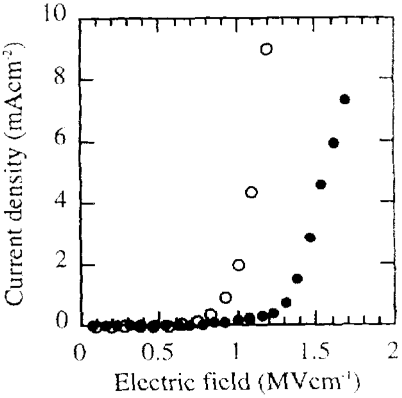

FIGURE 4 Current density as a function of electric field for an ITO/PPP/6P/TAZ/Al device (solid circle) and an ITO/6P/TAZ/Al device (open circle).

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