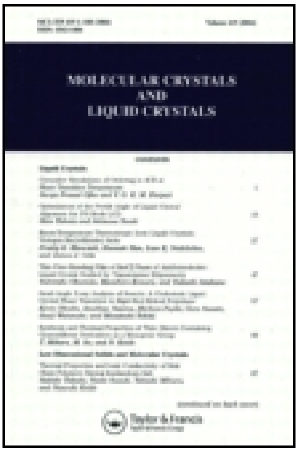

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Morphology and Luminescence of Poly (*p*-Phenylene Vinylene) Films Prepared by Chemical Vapor Deposition

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The films of poly(*p*-phenylene vinylene) (PPV) were prepared by chemical vapor deposition (CVD) of α,α'-dichloro-*p*-xylene on the surface of crystalline silicon (001) wafer. Atomic force microscopy (AFM) and reflective IR were used for measuring the topographic images and the orientations of PPV chains, respectively. Photoluminescent (PL) property of the PPV films indicates that the details of PL spectrum are dependent on the thickness of the films deposited on the wafer surface. The UV-vis spectrum was also measured for the PPV films deposited on the amorphous quartz substrate.

Keywords: PPV; atomic force microscopy; photoluminescence; reflective IR; chemical vapor deposition; silicon wafer

INTRODUCTION

Poly(*p*-phenylene vinylene) (PPV) has gained significant interest due to its promising electrical, optical and, electroluminescent properties[1]. The PPV films prepared by the chemical vapor deposition (CVD) have the advantage of their high purity as well as the potential to control their architecture on the molecular level. In order to understand the relationship between the structure of thin films and the luminescent property, PPV films with different thicknesses were fabricated by CVD via vapor phase pyrolysis of α,α'-dichloro-*p*-xylene on the surface of the silicon (001) wafer. The topographic images of PPV and its precursor polymers were scanned by AFM. The optical properties of the films were also studied in this investigation.

EXPERIMENTAL SECTION

α,α'-Dichloro-*p*-xylene was purchased from Aldrich and used after recrystallization from benzene. The substrate used for deposition was the surface of a crystal silicon (001) wafer. The synthetic details can be found elsewhere[2].

RESULTS AND DISCUSSION

In order to understand the process of PPV deposition, both the precursor and PPV polymers deposited on the surfaces of silicon (001) were examined by AFM. The results of AFM show that the precursor polymer films are rougher than PPV, which was independent of their thicknesses. This may tell us that the molecular rearrangement occurred during the thermal conversion of the precursors to the final PPV molecules. The reflective IR spectra at different incident angles are shown in Figure 1. We can see from Figure 1 that the chain orientation in the precursor is random, whereas in PPV they have a certain order. The PPV chains appear to have oriented themselves toward the surface with a certain tilt angle.

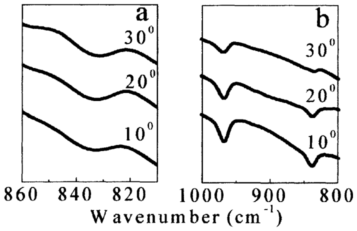

FIGURE 1. The reflective IR spectra of the precursor (a) and PPV (b) obtained at varying incident angles.

963 cm^{-1}: vinylene C-H bending (OOP)

837 cm^{-1}: phenylene C-H bending (OOP)

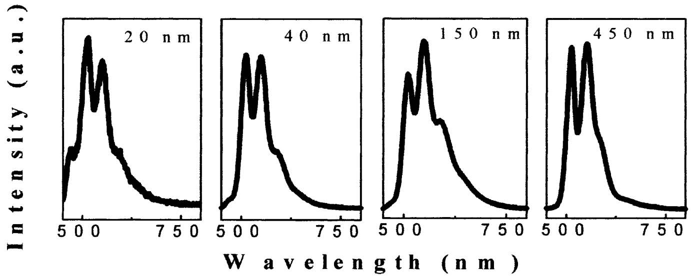

FIGURE 2. The PL spectra of PPV with different thicknesses.

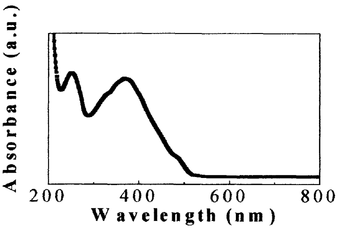

FIGURE 3. The UV-vis spectrum of PPV.

The films with the thickness of 20, 40, 150, and 450 nm were deposited on the silicon wafer and their photoluminescence (PL) spectra were measured at the excitation wavelength of 350 nm. They are displayed in Figure 2. Usually, three emission peaks are observed at 510, 550, and 590 nm and they are assigned to relaxations from the excited singlet state to the different ground ones. As one can see from Figure 2, the relative intensity of the peak at 510 nm is become weaker as the thickness of PPV films is increased. At the same time, UV-vis spectrum of PPV deposited on the substrate of quartz is shown in Figure 3. After comparing the spectra of PL and UV-vis, we can conclude that the self-absorption exists in the luminescent system of PPV. That means we can tune the emission peaks by controlling the thicknesses of the films. When the thickness of the film is greater than 100 nm, the peak intensity at 510 nm is less than that at 550 nm[3].

CONCLUSIONS

We have obtained the PPV films of different thickness by CVD on the silicon (001) wafer. The molecular reorientation appears to occur during the thermal conversion of the precursor to PPV. The PL spectra were effected by the thickness of the film. The PPV chains seem to have ordered chain morphology.

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