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Morphology of poly(*p*-phenylenevinylene) thin films prepared directly on the surface of silicon wafers by the chemical vapor deposition polymerization

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Abstract

The chemical vapor deposition polymerization (CVDP) of α,α′-dichloro-*p*-xylene on the (0 0 1) plane of silicon wafer surface followed by thermal dehydrochlorination produced PPV nanofilms in which the polymer chains are found to be in highly ordered morphology. The same CVDP polymerization of α,α′-dichloro-*p*-xylene on the quartz surface, however, produced disordered polymer chains. The morphology and chain orientations were studied by X-ray diffractometry and polarized UV-Vis absorption and polarizesd photoluminescence spectroscopies. The angle dependence of IR refractive absorption spectra of the PPV films also were studied.

Keywords: PPV; Chemical vapor deposition polymerization; CVD; Morphology; Polarized UV-Vis absorption; Polarized PL; IRRAS

1. Introduction

In future, polyconjugated polymers can be useful for various applications in nano-sized organic electro- or optic-devices. Many of polyconjugated polymers, however, are insoluble and infusible and, thus, are very difficult to be fabricated to desired shapes and architectures having a nano dimensions. This problem can be circumvented by the chemical vapor deposition polymerization (CVDP) method [1] if a proper monomer and reaction condition can be found. The CVDP method is unique in that the activated species formed by pyrolysis of a monomerat an elevated temperature in the gas phase undergo self-addition on cold substrate surface to produce the final polymer or a precursor polymer that can be transformed, usually thermally, to the final polymer. This method does not require the use of any solvent and additional chemicals during the polymerization process and have excellent gap-filling and step coverage properties. Moreover, since synthesis can be performed directly on the surface of desired substrates, we can obtain uncontaminated polymers in various shapes. In addition, the CVDP method can be successfully utilized for the preparation of the polymer samples of nano structure and dimensions.

Poly(*p*-phenylenevinylene), PPV, and copolymers belongs to a class of polyconjugated polymers revealing many interesting properties such as electrical conductivity [2–4], photo- and electroluminescence [5], and nonlinear optical behavior [6]. PPV can also be thermally converted to graphitic or carbonaceous products [7]. Recently, we [8] reported that PPV nanofilms, nanotubes and nanorods can be easily prepared by performing the chemical vapor deposition polymerization of α,α′-dichloro-*p*-xylene (Scheme 1) on the inner suface of pores of organic or inorganic membranes. Staring et al. [9] and Shäfer et al. [10] earlier obtained thin films of PPV by CVDP method. They studied electroluminescence properties of those PPV films. Iwatsuki et al. [11] could prepare PPV by CVDP of dichlorocyclophane. Vaeth and Jensen [12] suggested that control of the chain orientation of the polymer can be achieved with the CVD method. They [13] also studied in detail the reaction mechanism of this polymerization method. Moreover, the nano objects of PPV could be converted thermally to carbonaceous nanotubes and nanorods.

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