

A model of adsorption of liquid crystal on the polymer surface based on the analysis of the surface alignment of the adsorbed layer

Sejun Oh, Tetsuya Miyashita, and Tatsuo Uchida

Dept. of Electronics, Graduate School of Engineering, Tohoku University, 6-6-05 Aza-Aoba, Aramaki, Aoba-ku, Sendai 980-8579, Japan

Tel.:81-22-795-7119, E-mail: oh.sejoon@ec.ecei.tohoku.ac.jp

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Abstract

The adsorption strength of liquid crystal molecules on the polymer surface was compared measuring temperature dependence of retardation above Nematic-Isotropic transition temperature (T_{NI}). The relationship between surface order parameter and adsorption strength on the polymer surface was discussed.

1. Introduction

The alignment of the LC molecules at the substrate surface is important because the orientation of the LC molecules on the surface dominates elastically over the bulk LC layer [1]. The LC molecules at the substrate surface, which was coated a polymer (PI), align in a preferential direction that depends on the history of the orientation of the liquid crystal near the interface between LC and polymer. This phenomenon is very interesting because it makes it possible to align liquid crystal molecules on a polymer without alignment treatment, such as rubbing [2]. This phenomenon is caused by adsorption and desorption of LC molecules interact with the polymers near the surface. [3] To clarify the adsorption and desorption between LC and polymers, we focused on the adsorption strength of LC molecules on the surface of various PIs. Adsorption strength of LC molecules was compared measuring the birefringence of LC molecules adsorbed on a polymer surface, excluding the bulk LC. We also discussed the relationship between the adsorption strength and surface order parameter of the adsorbed LC layer on various PIs.

2. Experimental

To measure the birefringence of LC molecules adsorbed on a polymer surface, spectroscopic ellipsometry was used. The temperature of the cell was maintained constantly in the experiment. Three kinds of polyimide were coated on a glass substrate using spin coating to compare (AL1254, PI-3 (JSR) and SE7992 (Nissan chem.)) A homogeneous alignment LC cell is made by stacking the two substrates in an antiparallel rubbing direction. Nematic liquid crystal 5CB (Chisso) was used. The results of the birefringence measurement are shown in Fig. 1, in which the birefringence of the glass and polymer was subtracted. After the phase transition of bulk LCs, slight birefringence was detected on the AL1254, PI-3 (JSR) and SE7992 surface at temperatures over T_{NI} .

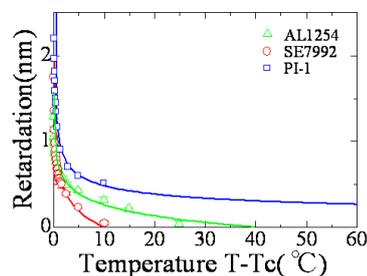


Fig. 1. Temperature dependence of retardation

To analyze measured retardation, we compared zero-retardation temperature, which indicates disappearance of adsorbed layer by heat energy. Greater the adsorption strength is, the higher the zero-retardation temperature. We also discussed a model

of the relationship between the surface order parameter of non rubbed LC cell and adsorption strength is shown in Fig. 2.

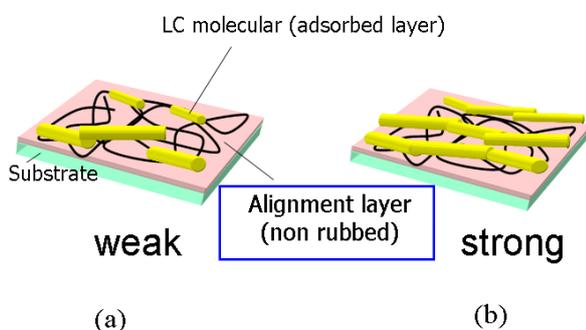


Fig. 2. Adsorption model

In the experiment, PIs does not undergo any rubbing treatment so that initially there is no preferential direction for LC alignment. The number of adsorbed LC molecules on the PIs depends on the adsorption strength, i.e., the greater adsorption strength, the larger number of adsorbed molecules at the PI surface. This means surface order parameter on the non rubbed PIs can change due to the adsorption strength of LC molecules.

To verify this model, we have examined the surface order parameter on a non-rubbed polymer surface, whose alignment is induced by strongly rubbed polymer surface of the opposite substrate. The surface order parameter was measured using the phase transition droplet method on the non rubbed PI surface [6]. We prepared three kinds of PIs, whose adsorption strength is various, for comparison.

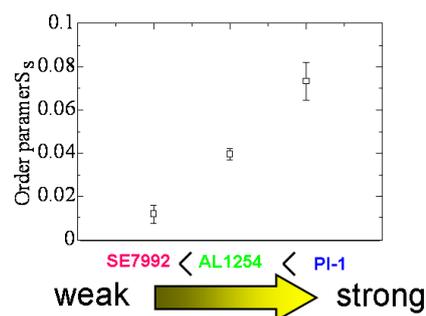


Fig 3. Order parameter of adsorbed LC

Figure 3 confirms that the surface order parameter of the adsorbed layer is strongly related to the adsorption strength, i.e., the greater the adsorption strength is, the greater surface order parameter of the adsorbed layer.

5. References

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