

Thermal and Electro-Optic Properties of a Side Chain Liquid Crystalline Polysiloxanes containing a Low Molecular Weight Liquid Crystal

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Abstract

Aggregation states and electro-optic properties of a binary mixture by mixing a side chain type liquid crystalline polymer(LCP) and a low molecular weight liquid crystal(LMLC) have been studied.

Side chain liquid crystalline polysiloxanes were synthesized from allyl bromide, p-hydroxy benzoic acid, p-cyanophenol, p-methoxyphenol and polysiloxanes. Low molecular weight liquid crystals were synthesized from allyl bromide, p-hydroxy benzoic acid and 4-cyano 4'-hydroxy biphenyl. And then, their properties were compared with blended liquid crystals. The thermal properties of the blended liquid crystals were evaluated using differential scanning calorimetry. The phase behavior of blended sample with temperature were also observed polarized microscope with hot stage. Thus, it seemed to us that a study of LC polysiloxanes with LMLC would be useful, especially in view of the fact that, systematic investigations have been carried out on the effects of changes in LCP/LMLC binary system on the properties of this relatively new type of liquid crystal.

1. INTRODUCTION

Side chain liquid crystalline polymers(SCLCPs) have a rather flexible polymer backbone to which are appended, usually via flexible spacer groups, the mesogenic side chain. The pendant groups in these comb-like polymers therefore have molecular structures compatible with LC or mesophase formation as in low molar mass system. Polysiloxanes have several advantages over other types of polymer, particularly because of the great flexibility of the backbone, which consequently confers a low glass transition temperature(T_g) upon the polymer. The flexible alkylene spacer is necessary to decouple¹, to some extent, the motions of the mesogenic moieties and the backbone, thereby allowing the production of a room-temperature mesophase.

Most of the initial interest in liquid crystalline polymers lay in the production of nematic materials for possible use in electro-optical display devices, this may have discouraged further investigation of such system. Results, however, increasingly show that the viscosities, and hence the response times of most nematic polymers are too high for them to be considered as useful replacements for low molar mass nematic materials in any fast-switching device, such as the twisted nematic device². Attention is, therefore, increasingly being directed towards the use of polymer liquid crystals as

durable storage display devices, where information may be stored below T_g or in the smectic state, or as a light-reflecting helical cholesteric structure that may be retained indefinitely below T_g . Low molar mass smectic A devices³ with a storage capability are already well-established, and it seems likely that LC polymers may be usefully employed in this area.

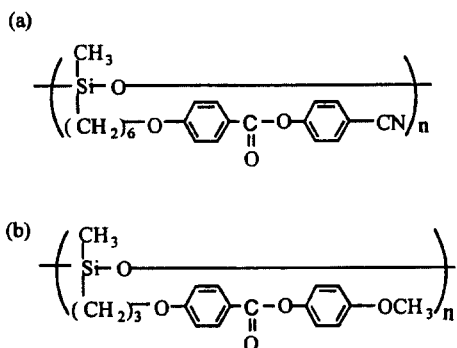
The main purpose of this paper was not only to make a system having both the dynamic stability which is an inherent quality of liquid crystalline polymers and the high speed response of low molecular liquid, but also to investigate the thermal motion and the electro-optic effect of induced smectic phase (ISP) by producing a mixture of liquid crystalline polymers and low molecular liquid crystals, and then evaluating the phase transition behavior and the molecular motion.

2. EXPERIMENTAL

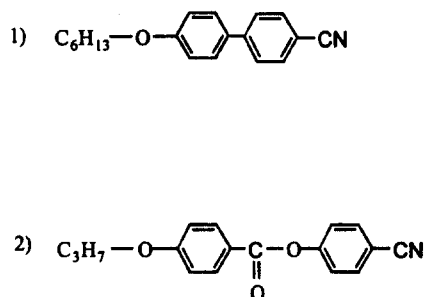
2-1. Materials

The synthesis of the side chain liquid crystalline polysiloxanes is same as the published synthesis method⁴⁻⁶. And low molecular liquid crystals are synthesized as followed.

LCPs



Low Molecular Weight Liquid Crystals



The blended LCP of nematic side chain liquid crystalline polymer and low molecular liquid crystals was dissolved by acetone, and then, volatilized it. Mole fraction had been calculated to consider a repeating unit of polymer to be one molecule.

2-2. Thermal behavior

Thermal transitions were measured with Seico. DSC 220 differential scanning calorimeters at heating and cooling rates of 2°C/min.

2-3. Optical microscopy

The anisotropic textures were observed with a Carl Zeiss optical polarizing microscope in conjunction with a THMS-600 hot stage.

2-4. Electro-optic properties

The anisotropic textures were observed with a Carl Zeiss optical polarizing microscope in conjunction with a THMS-600 hot stage.

The electro-optic transmission characteristics were measured under white light and in normal transmission geometry using a polarizing microscope, photomultiplier tube and digital storage oscilloscope. The sinusoidal signal to the liquid crystal film was supplied by an oscillator and for a few seconds only.

3. RESULTS AND DISCUSSION

Figure 1 shows the DSC curves to obtain the reproducible DSC data. In the case of above 50 mol% low molecular weight liquid crystal(LMLC), it shows the phase separation about 50°C transition temperature. The sharpness of each endothermic peak increased gradually with increasing the molar percentage of LCP. This may be due to a more homogeneous thermal transition order with a decrease in the LCP fraction.

And the transition temperature of LCP shifted to the lower temperature with increasing the molar percentage of LMLC, it was indicated that LMLC played role in plasticizer of LCP.

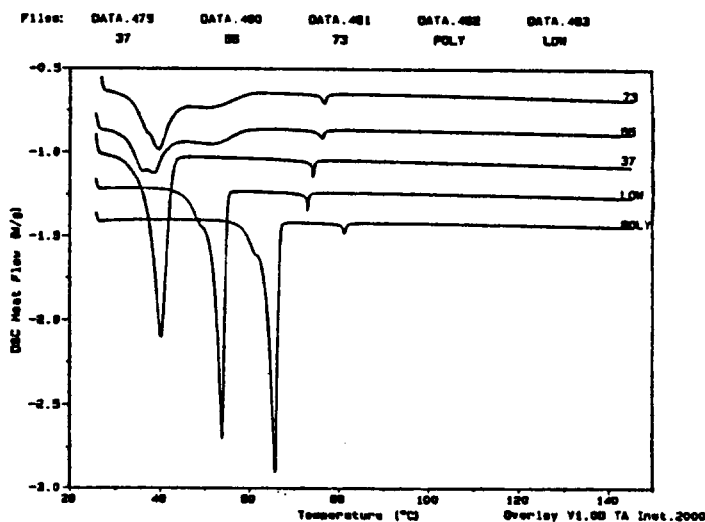


Fig. 1 DSC curves of the(LCP/LMLC :100/0, 70/30, 50/50, 30/70, and 0/100 mol%) binary system.

Figure 2 shows the optical microphotograph of LCP/LMLC binary system. It was found that the LCP/LMLC(50/50 mol%) had a smectic texture.



Fig. 2. Microphotograph of LCP/LMLC(50/50 mol%) binary system.

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