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Two Dimensional Template of Polystyrene Latex as an Alignment Layer of Liquid Crystals

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Two-dimensional polystyrene (PS) latex particles as a template of an alignment of liquid crystals are investigated. The highly ordered arrays of PS latex and its application to liquid crystal alignments have been studied.

Keywords: two-dimensional array; template; alignment; polystyrene

INTRODUCTION

2D and 3D arrays of PS latex particles have been concentrated because of their possibilities of various applications in the optical storage medium, electronics, and photonic crystal as templates. Our group studied the surface modified liquid crystal alignment with the LB method[1] and domain-dispersed film[2]. In this paper, highly ordered arrays of PS latex have been studied for possible applications as a template of the alignment layers in the liquid crystal display because of their ordered structure.

EXPERIMENTAL

PS latex particles were synthesized by emulsifier-free emulsion polymerization[3]. The zeta-potential of the particles was measured by a zeta-potential analyzer(Zetaplus, Brookhaven). The latex particles were deposited onto substrates by dipping method[4], casting[5], and movement of x-y stage[6]. The poly(amic acid) (SE150, Nissan) was spin-coated. After curing poly(amic acid) at 250°C, the polystyrene particles were dissolved in toluene for 1 hr. Nematic liquid crystal(E7, Merck) was filled into a liquid crystal cell. The ordered arrays of the particles were monitored by a microscope(CSB-HP5, Samwon Co.) and the Scanning Electron Microscope(XL30SFEG, Philips).

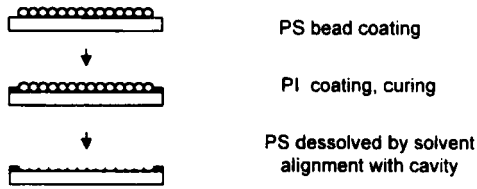

FIGURE 1 Preparation process of alignment layer with cavity.

RESULTS AND DISCUSSION

Synthesized polystyrene latex particles were negatively charged due to the initiator[3]. In order to increase hydrophobic attraction between the particles, the cationic surfactant was utilized for the coupling of the negative charges on the surface of the beads[4]. Measured zeta-potentials were -30.59mV for cationic surfactant-free particles, -29.33 mV for 10^{-6} M of CTAB added, -15.9mV for 10^{-4} M, 39.9mV for 10^{-3}

M, and 58.31mV for 10^{-2} M, respectively. The 2D PS latex particles were easily packed in highly oriented layers over a wide surface area due to water evaporation and lateral capillary forces[4-5]. Fig. 2(a) shows the microscopic image of the 1μm particle aggregates on the silanized hydrophobic glass. Some aggregates of multi-layered particles and particle-free surfaces were shown. The microscopic images of the latex particles on the hydrophilic slide glasses show two-dimensional hexagonal array despite some defects because of the size distribution of the particles in the case of synthesized polystyrene particles. As shown in Fig. 3, the smaller particles were inserted between the particles of two-dimensional array. We could solve this problem by perfect separation of the smaller particles by filtration after emulsion polymerization.

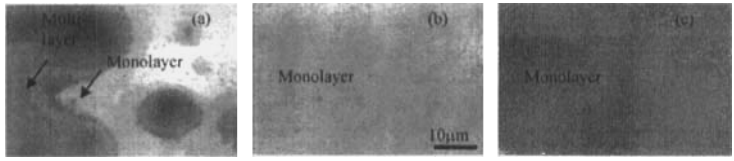

FIGURE 2 Microscopic images of PS array on the glasses; (a) 1μm particles on the silanized glass, (b) 1μm particles on the slide glass , (c) 1.7μm particles on the slide glass.

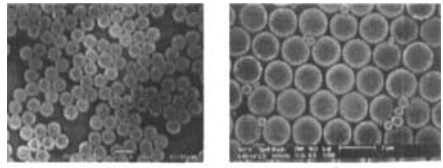

FIGURE 3 SEM image of latex particles on the glass; (a) 1μm, on the silanized glass, (b) 1.7μm, on the slide glass.

Fig. 4 illustrates the textures of the LC cell. Because the spin-coated PI film can align the liquid crystals with homogeneous orientation without rubbing, nematic liquid crystals subjected to the surface of the cavity can have various directors. Each domain of the random orientation was the same order of the size of the polystyrene latex. Some large domains also exist because of the aggregates due to multi-layer of the PS during the dissolution process. A similar structure of multi-domain alignment was reported by using 90μm size of conic-cylindrical-cavities[7]. If we adapt the homeotropic alignment, the template process can be applied to the multi-domain vertical alignment[8].

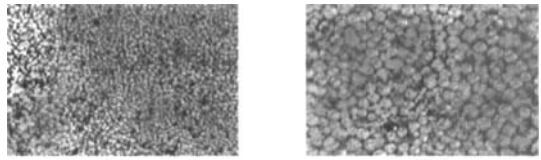

FIGURE 4 Polarized microscope images of the textures of the nematic liquid crystals: (a) ×5, (b) ×10 objective lens.

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