Control of Self-Assembly Patterns Formed in Liquid Crystal-Polymer Mixture

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液晶と高分子の混合系は近年研究が盛んに行われており、例えば、数μmサイズのネマチック液晶のdropletを高分子中に分散させた高分子分散液晶は、偏光板を必要としない光シャッターとして実用化されている。一方、ネマチック液晶に少量の高分子を添加した系では、相分離により高分子のdropletが鎖状構造を自発的に形成することが報告されている[1]。本発表では、ネマチック液晶とシリコンオイルの混合系において、相分離により形成される高次構造(パターン)の電場やセル厚による制御について報告する。

Introduction

Recently, mixture of liquid crystals (LCs) and polymers has been actively studied both from fundamental and applicational interests. For instance, the polymer dispersed liquid crystal, that is the system where several μm liquid crystal droplets are dispersed to the polymer, has been put to practical use as an optical shutter that doesn't need the polarizers. On the other hand, in the system where a small amount of polymer is added to nematic liquid crystal, it is reported that polymer droplets organize chain structures through phase separation [1]. In this study, we report on various kinds of ordered structures (patterns) formed by phase separation in the mixture of nematic liquid crystal and silicon oil.

Control by the Thickness of the Cell

A droplet of the silicon oil appears and grows through coalescence when the mixture system is quenched from homogeneous nematic phase into coexistence phase of silicon oil and nematic liquid crystal. In this case, when the droplets reach a sufficient size, the droplet particle itself becomes a radial defect, and another defect called hyperbolic hedgehog is induced near by the particle. Such particle-defect pair is called "dipole" .

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The particles in dipole configuration self-assemble and form the chain structure as shown in Figure 1. We have found that the equilibrium droplet size and the configuration of particle-defect pair depend on the thickness of the sample cell. As the thickness of the cell spacing becomes thinner, the droplet size becomes smaller. Therefore, the other configuration called "saturn ring" is more stable than the dipole. In the saturn ring configuration, the particle is surrounded by disclination ring above the equator. Since the saturn ring has quadrupolar symmetry, the derived structure is different from that formed by the dipoles. As a result, we can control the pattern of the phase separation depending on the thickness of the cell spacing.

Control by Electric Field

In addition, we have succeeded in the formation of the crystal-like structure shown as Fig.2 by applying the alternating electric field after the chain structure has been formed. A colloid crystal that consists of the μm-size particles attracts attention of many researchers as a photonic crystal. Though Musevic *et al.* formed colloidal crystal by optical tweezers [2], it has not been reported the formation of colloidal crystal by using the phase separation of the liquid crystal and the polymer. Details of the controlled structure and the formation dynamics will be discussed.

Figure 1: Chain structure of silicon oil.

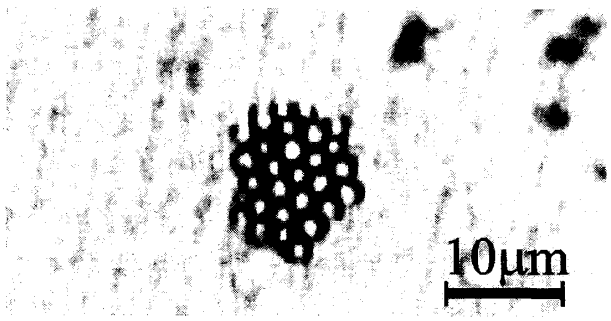

Figure 2: Crystal structure under AC electric field.

References

[1] J. C. Loudet, P. Barois,; P. Poulin, *Nature* **2000**, *407*, 611.

[2] I. Musevic, M. Skarabot, U. Tkalec, M. Ravnik, S. Zumer, *Science* **2006**, *313*, 954.