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Preparation and characterization of MgO nanoparticles/ferroelectric liquid crystal composites for faster display devices with improved contrast†

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In this article, we present the formulation and characterization of a ferroelectric liquid crystal (FLC) mixture W301 composed of pyrimidine compounds. We observed that upon doping magnesium oxide nanoparticles (MgO NPs) into the host FLC, the MgO NPs/FLC composite showed significantly faster response and improved optical tilt angle. The decreased response time in the MgO NPs/FLC composite has been attributed to the decrease in rotational viscosity and increase in surface anchoring energy. The decrease in rotational viscosity of the composite is due to the torque experienced by both MgO NPs and FLC in the presence of an electric field and perturbations of order parameters of FLC. Due to the enhanced surface interaction of MgO NPs having surface defects with mesogens, strong surface anchoring is experienced on the FLC molecules that not only increased the speed of the response but also improved the optical tilt angle of the MgO NPs/FLC composites, which ultimately resulted in improved contrast. A systematic approach has been followed to elucidate the idea of designing faster display devices with improved contrast based on MgO NPs/FLC composites.

Introduction

Liquid crystals (LCs) constitute a fascinating state of condensed matter which is widely utilized in electro-optical applications due to their attractive physical anisotropic properties. High resolution, light weight, compactness and low power consumption with good enough image quality make LC display devices more popular than other counterparts. Still, these devices need improvement as they have slow responses and limited viewing angles as compared to electroluminescent displays. Faster operating LC materials are needed for colour sequential and true 3D LCDs.[1,2] Ferroelectric LCs (FLCs), special members of the LC family, have attracted considerable attention from fundamental and applied aspects because of their faster response, low threshold voltage, memory effect *etc.*[3–6] Even FLCs need improvement in electro-optical characteristics for use in next generation advanced display devices with wide viewing angles, fast electro-optic responses and good optical contrast. In the case of FLCs, getting good alignment of mesogens on large scale flat panels is also a difficult task. On the other hand, attempts were started by researchers to enhance the electro-optical properties of LCs by the incorporation of nanometric size particles to the LC host matrix to form nanoparticles (NPs)/LC composites having novel dynamic properties different from the original LC medium due to perturbation of the self-assembly properties of the LCs. The nano-materials reported as a dispersed phase in LCDs involve fullerene, carbon nanotubes, diamond powder, noble metal NPs, and semiconductor NPs *etc.*[7–11] When these nano-materials are used as a dopant for LCDs then the latter are expected to show improved contrast, ion capture, high voltage holding ratio, frequency modulation response and decreased driving voltage. Most of the work in this area is based on nematic LCs; especially for display applications. The observed enhancement of electro-optical properties of these composites is attributed to the changes in the order parameters and the increase of steric interaction between LC molecules and NPs, which produces a significant alteration of the properties of the LCs such as dielectric anisotropy, birefringence, elastic constants, viscosity *etc.* Also, the preparation of nanocomposites based on LC mixtures and inorganic NPs is an effective way to tune the electronic and optical properties of the NPs/LC system with the functional and structural flexibilities of the host LC materials.

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