J. Opt. A: Pure Appl. Opt. **11** (2009) 024006 (5pp) doi:10.1088/1464-4258/11/2/024006

Preparation of ferroelectric nanoparticles for their use in liquid crystalline colloids

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Received 15 September 2008, accepted for publication 19 December 2008
Published 14 January 2009
Online at stacks.iop.org/JOptA/11/024006

Abstract
In this paper we summarize our many years of experience in the preparation and optimization of stable colloids of ferroelectric nanoparticles dispersed in an isotropic carrier and in a liquid crystal host. The colloids are of interest for use in electro-optic devices, photorefractive hybrids and nonlinear optical elements. We also outline some of the most interesting features the nanoparticles bring to liquid crystals, along with the potential of these relatively new colloids.

Keywords: ferroelectric nanoparticles, surfactant, ball mill, liquid crystals, colloids

(Some figures in this article are in colour only in the electronic version)

1. Introduction

Liquid crystalline suspensions of various micro- or nanoparticles have recently been the subject of renewed interest[8] because they combine the fluidity and anisotropy of liquid crystals with the specific properties of the particles [1–3]. In particular, ferroelectric nanoparticles, being doped into liquid crystals at very low concentrations, introduce a number of effects [4].

Earlier, we have described and discussed these unexpected phenomena in detail in two papers. The first paper [5] reported the development of a dilute suspension of ferroelectric particles in a nematic liquid crystal host. Specifically, the suspension possessed enhanced dielectric anisotropy and is sensitive to the sign of an applied electric field, demonstrating a linear rather than quadratic electro-optic effect. The linear electro-optic response is intrinsic to ferroelectric liquid crystals, not nematics; therefore, these dispersions introduce all the benefits of nematic liquid crystals (ease and stability of alignment) while adding sensitivity to the polarity of an electric field. Our second paper [6, 7] described the physical properties of ferroelectric nanoparticles/liquid crystal colloids investigated by means of calorimetry, optical methods, infrared spectroscopy and capacitance studies. We found that the colloids possess an increased order parameter that is manifested in an increase of several degrees in the clearing temperature. We proposed a theoretical model in which the ferroelectric nanoparticles induce local dipoles whose effective interaction is proportional to the square of the orientational order parameter.

Our research has shown how critical the preparation process is to the properties of the resulting colloids. Therefore, this paper is devoted to the description of how to prepare optimized and reproducible colloids and how the use of optimized mixtures determines the largest influence of the nanoparticles on the electro-optics of liquid crystals.

[8] At the 22nd International Liquid Crystal Conference held in Jeju (South Korea) in July 2008 the number of presentations on various liquid crystalline colloids increased by an order of magnitude, reaching almost 100, compared with the same conference (21st) held in 2006 in Keystone (CO, USA).

