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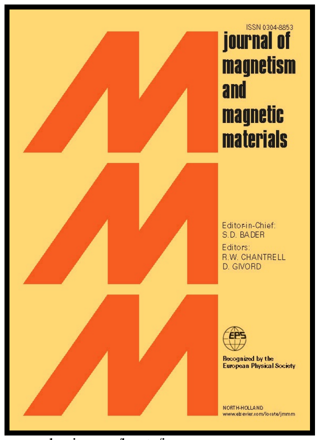

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Influence of the particle parameters on the stability of magnetic dopants in a ferrolyotropic suspension

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Abstract

The doping of liquid crystals with magnetic nanoparticles increases the magnetic susceptibility and the sensitivity to small magnetic fields. This offers interesting possibilities for controlling optical properties simultaneously via external magnetic and / or electric fields. The stabilization of magnetic nanoparticles in the liquid crystalline host, however, is challenging, since magnetic dipolar interactions and LC-mediated forces may result in their aggregation and even phase separation. So far, only few groups have investigated the long-term stability of these systems. In the present study, a set of magnetic iron oxide nanoparticles with different particle size, shape and surface properties was synthesized by thermal decomposition or co-precipitation. The magnetic nanoparticles were further integrated in a model liquid crystalline host (i.e., the lyotropic system potassium laurate / 1-decanol / water) to investigate the effect of the different particle parameters on the stability of the resulting ferrolyotrope.

Keywords

Liquid crystal, ferrolyotrope, magnetic nanoparticles, iron oxide, nematic phase

1. Introduction

Liquid crystalline (LC) materials are soft, self-assembled materials, forming ordered states via nanophase segregation (i.e., lyotropes) or intermolecular interactions (i.e., thermotropes).[1] They combine the fluidity of liquids with the anisotropic physical properties of crystals giving rise, e.g., to their birefringent character. This birefringence can be switched via external electric fields, which is technologically exploited for electronic components (e.g., liquid crystal displays).[2] As theoretically predicted by Brochard and de Gennes in 1970, the embedding of magnetic nanoparticles (MNPs) into LCs increases the magnetic anisotropy and, thus, the sensitivity of the LCs to small magnetic fields.[3] The stabilization of the MNPs in the LC matrix, however, has remained a challenge and forces mediated by the LC host and magnetic dipolar interactions may lead to particle aggregation and even macroscopic phase separation.[4] Up to now, a plethora of examples has been reported where MNPs have been integrated in both thermotropic or lyotropic LCs with interesting magneto-orientational behaviour.[5,6,7,8,9,10] Although some reports referred to aggregate formation, even followed by macroscopic phase separation, only few groups investigated the long-term stability of such systems.[6,11,12,13,14] Nonetheless, the long-term stability seems to be an important issue not only with respect to a potential future application of these systems.

In the present study, we prepared a set of magnetic iron oxide nanoparticles with different particle sizes, shapes and surface properties. A lyotrope (potassium laurate / 1-decanol / water) was chosen as a model host to study the influence of the particle parameters on the stability of the resulting