Nematic Colloidal Crystals and Superstructures

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1. INTRODUCTION

We shall discuss the general properties and recent development in the field of nematic colloids, which are dispersions of microparticles in a nematic liquid crystal. As the nematic liquid crystal is an orientationally ordered fluid, it interacts with the surfaces of inclusions that impose a preferential order at a curved interface. This interaction generates topological defects, which are responsible for structural forces between dispersed microparticles [1].

2. STRUCTURAL FORCES AND COLLOIDAL ASSEMBLY IN NEMATIC LIQUID CRYSTALS

The structural forces in liquid crystals are extremely strong, anisotropic and long-range, and are responsible for directed assembly of a broad variety of colloidal superstructures in liquid crystals: 2D colloidal crystals [2], colloidal wires, assembled by entangled topological defects [3], superstructures in the mixtures of large and small colloidal particles [4] and a broad variety of 2D nematic colloidal crystals [5]. In all cases, the colloidal binding energy is several orders of magnitude stronger compared to water based colloids, and could provide assembly of nanometer-sized colloidal particles of various shapes [6]. The methods of manipulation of microparticles and the mechanisms of their assembly in the nematic liquid crystal will be discussed. Comparison between theoretical predictions based on Landau-de Gennes theory and the experiments will be addressed. Possible application of directed and robust colloidal assembly for photonic devices will be discussed, as it has recently been shown, that a single nematic microdroplet in a liquid or polymer matrix provides a novel class of tunable optical microresonators. Light can be trapped in a microdroplet due to the total internal reflection and the resonant eigenmodes can be tuned by an external electric field [7]. This could be a basic tunable optical resonant element for future technological platform for soft matter photonic devices.

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