Electrooptics of two-dimensional colloidal crystals based on nematic liquid crystal drops

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Electrooptical devices based on two and three dimensional arrays of polymer-encapsulated nematic liquid crystal offer considerable promise for large-area flexible displays that can be assembled on plastic substrates. Optimization of their design and performance demands a detailed understanding of the physics of their switching. These devices are generally modelled as bipolar droplets, with the nematic director, **n**, aligned, on average, between two disclinations positioned at opposite poles of the droplet. Disclinations, which are singular points about which **n** rotates through a multiple of π radians, are required by the topological constraints enforced by the confinement of the liquid crystal, and the parallel boundary conditions typically found. Switching of bipolar droplets is generally thought to require application of an electric field, E, greater than a critical Fréedericksz field, E_c. In this work, we study a two dimensional colloidal crystal comprised of nearly identical, well defined bipolar nematic droplets, and show that the current understanding of the switching mechanism must be revised[1]. We study individual droplets and show that there is no critical Fréedericksz field. Instead it is the surface region that responds first to the applied field, driving the average bipolar director field to reorient with E; moreover, this response occurs for vanishingly small E. By exploiting the periodic packing of the uniformly sized droplets, we can switch both the intensity and the direction of the light, producing a very simple new material equivalent to a holographic polymer disperse liquid crystal[2]. Moreover, since there is no critical E-field transition, very low switching voltages (0.1 V/μm) and relatively fast switching speeds can be achieved by exploiting the interference effects exhibited by these phase gratings.

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