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ABSTRACT

We describe a new polymer patterning technique that produces controllable morphological and optical anisotropy in a polymer network. This technique is based on the use of pattern-forming states of nematic and cholesteric liquid crystals as templates for forming ordered polymer networks. One and two-dimensional optical patterns are induced by applying an electric field across a narrow gap of an electro-optical cell. These field-induced optical patterns are then stabilized by UV-induced polymerization of a typically 5 wt% reactive monomer in liquid crystal host. Depending on specific conditions (e.g., thickness to pitch ratio of a cholesteric, applied electric field, and wavelength of UV illumination), the polymer captures various degrees of the orientational order and spatial periodicity of the pattern-forming states of liquid crystals. The fidelity of the templating effect is explored using polarizing optical microscopy and SEM. We also describe the effect of UV wavelength on the network morphology and the morphological control over the "third" dimension (normal to the cell substrates).

INTRODUCTION

Functional polymers and polymer networks are critical materials for organic electronics and photonics [1]. Polymers provide the processing, stability, conformability, and connectivity advantages for effectively implementing the desired photonic or electronic properties of small molecules on longer length scales. However, making electronic or photonic polymers is only a first step. Their applications potential and cost-effectiveness are significantly compromised if they cannot be assembled, using reasonably straightforward techniques, with multidimensional spatial control [2]. In order to realize and optimize the performance of practical devices, one must frequently control, in one or more dimensions, both the spatial distribution of the polymers (patterning) and the degree of orientational order contained in their collective assembly. Ideally, one would prefer to achieve these goals through a self-assembly process, or at least without the need for inordinate influence by external agencies [3-7]. Such a process not only saves considerable cost, but is also frequently a requirement with soft materials, which are not compatible with the processing techniques developed for conventional solids. We address these issues with fundamentally a self-assembly approach – the use of pattern-forming states of nematic and cholesteric liquid crystal "hosts" to template spatial and orientational order into polymer networks [8-12].

We developed a novel technique for imparting multidimensional spatial and orientational order into polymer networks. This approach is based on the use of pattern forming states of liquid crystals as templates for the network formation. Our prototypical procedure involves first dissolving a photo-reactive monomer in a nematic or chiral nematic (cholesteric) liquid crystal