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Photomechanical bending mechanics of polydomain azobenzene liquid crystal polymer network films

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ABSTRACT

Glassy, polydomain azobenzene liquid crystal polymer networks (azo-LCNs) have been synthesized, characterized, and modeled to understand composition dependence on large amplitude, bidirectional bending, and twisting deformation upon irradiation with linearly polarized blue-green (440–514 nm) light. These materials exhibit interesting properties for adaptive structure applications in which the shape of the photoresponsive material can be rapidly reconfigured with light. The basis for the photomechanical output observed in these materials is absorption of actinic light by azobenzene, which upon photoisomerization dictates an internal stress within the local polymer network. The photoinduced evolution of the underlying liquid crystal microstructure is manifested as macroscopic deformation of the glassy polymer film. Accordingly, this work examines the polarization-controlled bidirectional bending of highly concentrated azo-LCN materials and correlates the macroscopic output (observed as bending) to measured blocked stresses upon irradiation with blue-green light of varying polarization. The resulting photomechanical output is highly dependent on the concentration of crosslinked azobenzene mesogens employed in the formulation. Experiments that quantify photomechanical bending and photogenerated stress are compared to a large deformation photomechanical shell model to quantify the effect of polarized light interactions with the material during static and dynamic polarized light induced deformation. The model comparisons

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function of composition and external mechanical constraints.

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