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13. ABSTRACT (Maximum 200 words)

Many polymeric glasses must be orientationally ordered for the materials to exhibit useful characteristics. The objective of this work was to understand the dynamics of the orientation and relaxation processes and to relate these behaviors to the structural characteristics of the polymeric material. In this study we considered materials suitable for nonlinear optical applications. In particular, thin polymer films, either doped with nonlinear optical chromophores or films with the chromophores covalently bonded to side groups were studied. Orientation of these chromophores was achieved by the birefringence resulting from chromophore concentration, spacer length, and molecular dominant factor determining the steady state and transient behaviors. The relationship between monomer and polymer structure and the resulting effect on the orientation dynamics is discussed. Qualitative agreement with theoretical predictions was obtained for the simpler guest/host system, but the model was shown to be inadequate to explain the behaviors of the more complex systems studied. The results reported here have provided valuable insight into the molecular processes that occur during the chromophore orientation and relaxation, and the effects of structural characteristics of the polymers on these mechanisms.

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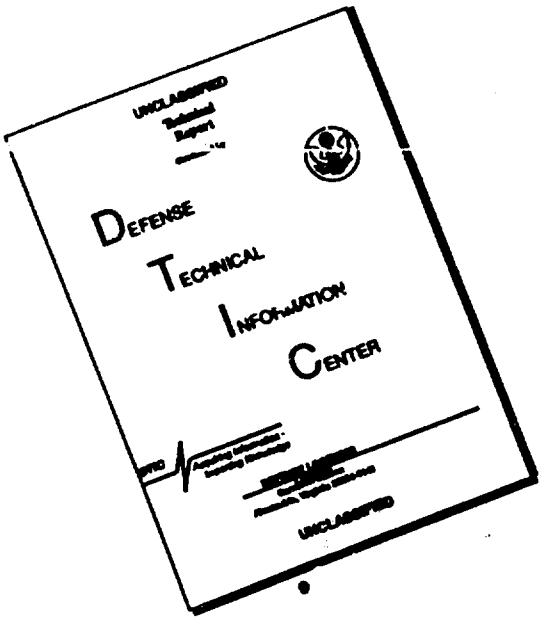

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FINAL REPORT

ARO Proposal Number 26883-MS

Contract Number: DAAL03-90-G-0081

Poling of Thin Polymer Films in Electro Optic Applications
Gerald G. Fuller, Stanford University

Many polymeric glasses must be orientationally ordered for the materials to exhibit useful characteristics. The objective of this work was to understand the dynamics of the orientation and relaxation processes and to relate these behaviors to the structural characteristics of the polymeric material. In this study we considered materials suitable for nonlinear optical applications. In particular, thin polymer films, either doped with nonlinear optical chromophores or films with the chromophores covalently bonded to side groups were studied. Orientation of these chromophores was achieved by the birefringence resulting from chromophore concentration, spacer length, and molecular dominant factor determining the steady state and transient behaviors. The relationship between monomer and polymer structure and the resulting effect on the orientation dynamics is discussed. Qualitative agreement with theoretical predictions was obtained for the simpler guest/host system, but the model was shown to be inadequate to explain the behaviors of the more complex systems studied. The results reported here have provided valuable insight into the molecular processes that occur during the chromophore orientation and relaxation, and the effects of structural characteristics of the polymers on these mechanisms.

In addition to orientation of thin polymer films by electric field poling, research was commenced on the problem of flow field orientation of polymer monolayers during Langmuir-Blodgett deposition. In this work, a stagnation point extensional flow was created by simultaneously immersing two identical glass substrates into a Langmuir trough supporting a monolayer of "hairy" rod-like macromolecules. The materials that were studied were polyglutames with alkyl side chains distributed along the backbone. It was observed that very well characterized, homogeneous extensional flows could be generated between the two substrates as evidenced by tracking the trajectories of tracer particles residing on top of the polymer firm. Consequently, very high degrees of planar polymer orientations could be achieved, which could potentially yield products with large nonlinear optical properties. Presently, optical probe experiments combining Brewster angle microscopy and polarimetry are being used to provide *real time, in situ* measurements of the orientational dynamics of the macromolecules contained within the thin polymer film.

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