



Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and
subscription information:

<http://www.tandfonline.com/loi/gmcl19>

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Version of record first published: 24 Sep 2006

To cite this article: Moojong Lim, Dong-Ho Shin, Jongweon Moon, Sin-Doo Lee, Ki Hong Park & Nakjoong Kim (1997): Nonlinear Optical Properties of Poled Films of Side-Chain Polymers, Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals, 294:1, 267-270

To link to this article: <http://dx.doi.org/10.1080/10587259708032298>

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NONLINEAR OPTICAL PROPERTIES OF POLED FILMS OF SIDE-CHAIN POLYMERS

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Abstract The poling process in nonlinear optical (NLO) polymer films is studied by the second harmonic generation (SHG) and optical retardation measurements. The PMSt polymer is used as a NLO chromophore whose dipole moment is aligned transverse to the main-chain backbone. Both the optical retardation and the SHG intensity increase during poling process and decay after poling in the same fashion. The optical retardation is found to be more sensitive to the thermal fluctuations than the SHG.

INTRODUCTION

Recently, nonlinear optical (NLO) organic materials have attracted considerable attention for their use in the area of optical communications and data processing [1]. Among them, polymeric materials have been frequently used for constructing waveguides and electro-optic modulators [2]. For practical applications, they are required to maintain thermal and temporal stabilities of the polar order acquired during the electric field poling process. The study of the enhancement and relaxation processes of the optical nonlinearity in poled polymer films provides a basis for understanding the dynamics of NLO chromophores in a polymer matrix below the glass transition temperature.

In this paper, the dynamics of the axial as well as the polar orders acquired during poling in NLO polymers are studied by performing the second harmonic generation (SHG) and optical retardation (birefringence) measurements.

EXPERIMENTAL

The NLO polymer used in this study is PMSt of which dipole moment is transverse to the main-chain backbone. A corona-poling method was used for aligning the dipoles [3]. In our corona-poling apparatus, a tungsten wire was placed above a grounded electrode on which the polymer film of $0.7\ \mu\text{m}$ thick was coated. The distance between the poling wire and the polymer film was about 8 mm. During poling, the transmitted SHG at 532 nm, the birefringence (B), the film temperature, and the strength of the poling voltage were measured simultaneously. The polarization modulation method was employed for measuring the optical retardation [4], and the SHG measurements were carried out with a Q switched Nd:YAG laser operated at 10 Hz. Both the optical retardation and the SHG intensity were measured as a function of temperature and poling voltage at an oblique angle of 40° to the normal incidence.

RESULTS AND DISCUSSION

Since the poling voltage aligns the NLO chromophores in PMSt polymer along the field direction [5], the optic axis of the poled film coincides with the field direction and the film has the ∞_{mm} symmetry. Based on the absorption spectra, the resonance effect of SHG was ignored because of no absorption at 532 nm. After poling, the absorption intensity was decreased because the azobenzene dye oriented to the direction transverse to the film by poling. The temperature dependences of d_{33} and B are shown in Fig. 1. The poling voltage V_p was fixed at 5 kV. The d_{33} values were measured from the Maker fringe profiles in reference to a x-cut quartz plate ($d_{11} = 1 \times 10^{-9}$ esu). As shown in Fig. 1, the increase in B is larger than that in d_{33} . Moreover, it is found that B is more sensitive to variations in temperature and time. In fact, the relaxation of d_{33} is 3 times slower than that of B [6]. Since the NLO chromophores align along the direction of the field against the thermal randomization, the poling process increases effectively the dipolar density. Thus, the increase in both the SHG intensity and B attributes to the enhancement of the degree of order in addition to the dipolar density. The SHG intensity and B become to saturate at about 150°C in the presence of the poling field.

The poling voltage dependences of d_{33} and B , shown in Fig. 2, are quite different from Fig. 1. The measurements were carried out at 140°C . Both d_{33} and B increase sharply at about $V_p = 4$ kV and stay fairly constant above $V_p = 5$ kV. However, at relatively low temperatures, the degree of order acquired during poling is small. This indicates that temperature plays an important role in the magnitude of both

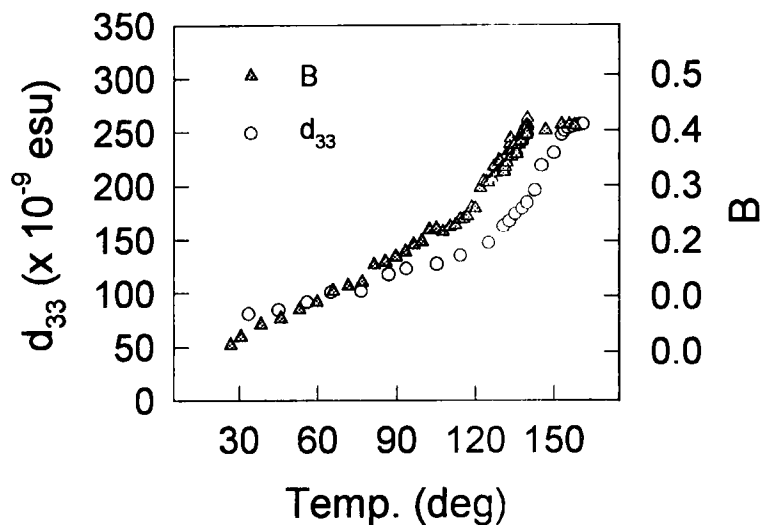


FIGURE 1 The temperature dependences of d_{33} and B . Poling voltage V_p is fixed at 5 kV.

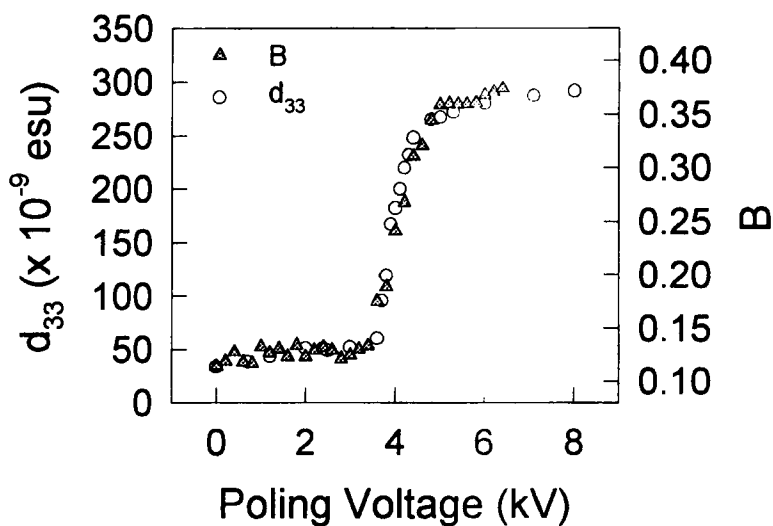


FIGURE 2 The poling voltage dependences of d_{33} and B . The measurements were made at 140 °C.

d_{33} and B .

CONCLUSION

We have studied the poling dynamics of side-chain polymer by means of SHG and optical retardation measurements. For fixed temperature, it was found that there exist a critical strength of the poling field. Moreover, both d_{33} and B become to saturate above a certain temperature, glass transition.

ACKNOWLEDGMENT

This work was supported in part by Korea Science and Engineering Foundation through RCDAMP at Pusan National University.

REFERENCES

1. P. N. Prasad and D. J. Williams, Introduction to Nonlinear Optical Effects in Molecules and Polymers (Wiley, New York, 1991).
2. K. Singer, M. Kuzyk, W. Holland, J. Sohn, S. Lalama, R. Comizzoli, H. Katz, and M. Schilling, Appl. Phys. Lett. **53**, 180 (1988).
3. M. Eich, G. C. Bjorklund, and D. Y. Yoon, Polymers for Advanced Technologies Vol. **1**, p189 (1990).
4. J. C. Kemp, J. Opt. Soc. Am. **59**, 950 (1970).
5. K. D. Singer, J. E. Sohn, and S. Lalama, Appl. Phys. Lett. **49**, 248 (1986).
6. B. Park, S. Y. Eom, S.-W. Suh, M. Lim, W.-K. Lee, and S.-D. Lee, Mol. Cryst. Liq. Cryst. **267**, 21 (1995).