P2b   FAST PICOSECOND REORIENTATION IN THE
ISOTROPIC PHASE OF NEMATOGENS

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The non-linear optical properties of the isotropic phases of nematic liquid crystals, especially the transient order induced therein by plane polarized waves of Q-switched [1 2] and mode-locked [3] lasers, have been much studied lately. The dynamics of the observed effect, near the isotropic meso morphic phase transition, is now well understood. We essen tially observe a "slow" response, corresponding to a relaxation time in the 10^{-9} — 10^{-6} s range attributable to the order parameter fluctuations of the Gennes' phenomenological theory [4]

We present here what we believe to be the first observation in the time domain of an additional fast individual molecular reorientation inside the pseudo-nematic domains of liquid crystals in the isotropic phase, leading to a direct and ac - curate measurement of the relative importance of the slow

and fast phenomena. We use the optical Kerr effect in the picosecond range. A transient birefringence is induced in the compound by a picosecond laser pulse at $\lambda_{ir} = 1060$ nm. An auxiliary picosecond wave at $\lambda_g = 530$ nm, derived from the infrared one, is used to analyze the induced birefringence. Results obtained with two nematogens clearly show two different optical Kerr responses. They can be well explained if we assume the presence of two rather different relaxation times in the medium: a slow one (τ_s in the nanosecond range) and a fast one (τ_f in the picosecond range). In this case, and for an input laser pulse with a gaussian shape of characteristic time τ_{ir} and intensity I_{ir}, the time dependent non-linear refractive index is given by:

$$\Delta n(z, t) = 2\pi/n_g B_{or} I_{ir}^0 *$$

$$\sum_{k=s,f} C_k/\tau_k \int_{-\infty}^{t} \exp[-(t' - zn_{ir}/c)^2/\tau_{ir}^2]$$

$$\exp(-\alpha_{ir}z) \exp[-(t - t')/\tau_k] dt' , \qquad (1)$$

where B_{or} is an orientational, temperature-dependent constant, proportional to the squared optical anisotropy of the molecule; n_{ir} and n_g the refractive indices at the wavelengths λ_{ir} and λ_g; and α_{ir} the absorption coefficient of the material at $\lambda_{ir} \perp C_k$ is a constant characteristic of the process.

Comparison of results computed from eq. (1) and experimental data leads to a relaxation time not larger than 5 psec. It also allows the determination of the ratio C_f/C_s. We find: $C_f/C_s = (1.7 \pm 0.3) \times 10^{-3}$ for MBBA at 47°C. We also checked the temperature dependence of both the amplitude and time constants of the fast relaxation. The important point is that the two parameters do not show critical behaviour as T decreases near T_c.

In conclusion, we have shown directly that fast molecular orientation can occur inside domains of strongly correlated molecules. Such direct investigations now become possible not only in the isotropic phases but also e.g. in properly oriented nematic and smectic A.

References

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