Phase Transitions
Vol. 84, No. 1, January 2011, 38–48

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Characteristic switching parameters of an antiferroelectric liquid crystal 4H6Bi(S)

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(*Received 4 May 2010; final version received 16 July 2010*)

Switching study of an antiferroelectric liquid crystal (S)-4-(1-methylheptyloxycarbonyl)phenyl-4′-(6-pentanoyloxyhex-1-oxy)biphenyl-4-carboxylate (4H6Bi(S)) have been carried out for the planar aligned sample as a function of temperature by the polarization reversal current technique. Switching time (t_S), spontaneous polarization (P_S) and torsional viscosity (γ_t) of the material have been determined. t_S is found to be in the range 2–4 ms in the ferroelectric (SmC^*) phase and 0.4–0.7 ms in the antiferroelectric (SmC^*_A) phase. Above the critical electric field E_C where the helix unwinds, t_S is found to be inversely proportional to E but P_S is found to be independent of E. P_S lies between 5 and 106 nC cm^{-2} in the SmC^* phase and between 120 and 235 nC cm^{-2} in the SmC^*_A phase. It obeys the power law $P_S = P_0(1-(T/T_C))^{\beta}$ with $P_0 = 343.2 \pm 8.1$ nC cm^{-2}, $T_C = 94.9 \pm 0.07$°C and $\beta = 0.37 \pm 0.01$. The activation energies calculated from the Arrhenius plot of γ_t are 520 and 41 kJ mol^{-1} for the SmC^* and SmC^*_A phases, respectively.

Keywords: switching time; spontaneous polarization; torsional viscosity; ferroelectric; antiferroelectric

1. Introduction

Since the proposal of fast bistable electro-optic switching in ferroelectric liquid crystals (FLCs) by Clark and Lagerwall [1] in 1980, extensive studies have been made towards a fundamental understanding as well as for realizing high-quality fast display devices. Further, the discovery of thresholdless, hysteresis-free and V-shaped switching in surface-stabilized ferroelectric liquid crystals (SSFLCs) has attracted considerable attention due to the possibility of achieving grey scale [1–4]. But their industrial production was hampered because of the insufficient threshold, insufficient contrast (due to chevron defects) and insufficient bistability due to difficulty in controlling alignment [5].

Chandani et al. [6], for the first time, considered antiferroelelctric liquid crystals (AFLCs) with good electro-optical properties as a promising material for display devices. AFLCs are now regarded as an attractive alternative to FLCs for quality multimedia displays with high resolution due to their tristate switching behaviour (double hysteresis),

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ISSN 0141–1594 print/ISSN 1029–0338 online

DOI: 10.1080/01411594.2010.509643
http://www.informaworld.com