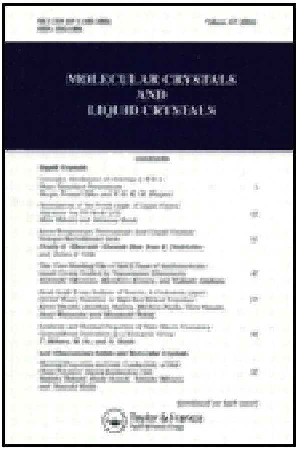


Molecular Crystals and Liquid Crystals Incorporating Nonlinear Optics

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl17

Investigation of Dielectric Hysteresis in Ferroelectric Liquid Crystals

G. S. Chilaya [a] & B. A. Loginov [a]

[a] Institute of Cybernetics, Georgian SSR Academy of Sciences, Tbilisi, 380086, USSR

Version of record first published: 17 Oct 2011.

To cite this article: G. S. Chilaya & B. A. Loginov (1987): Investigation of Dielectric Hysteresis in Ferroelectric Liquid Crystals, Molecular Crystals and Liquid Crystals Incorporating Nonlinear Optics, 151:1, 165-170

To link to this article: http://dx.doi.org/10.1080/00268948708075328

Mol. Cryst. Liq. Cryst., 1987, Vol. 151, pp. 165-170
Photocopying permitted by license only

Printed in the United States of America

INVESTIGATION OF DIELECTRIC HYSTERESIS IN FERROELECTRIC LIQUID CRYSTALS

G.S.CHILAYA and B.A.LOGINOV
Institute of Cybernetics, Georgian SSR
Academy of Sciences, Tbilisi 380086, USSR

Abstract The device for measurement of spontaneous polarization, resistance and capacity of ferroelectric liquid crystals in a wide amplitude and frequency range of applied electric field is described. Data for spontaneous polarization and different type hysteresis loops for smectic C^* liquid crystals are presented.

The study of dielectric hysteresis in ferroelectric liquid crystals gives the information not only about the quantity of spontaneous polarization P_s but also about the nature of ferroelectricity in liquid crystals.

To study the first Sawyer-Tawer scheme was used.[1] To illiminate its disadvantage which is the impossibility to get rid of linear loss on of total dielectric loss in the process of research of the polarization vector P_s reorientation in phenomenon the bridge circuits were used.[2,3] Similar circuits were used to study liquid crystal ferroelectrics.[5-10] The circuits taken from[4] was made our prototipe in which the pattern was grounded and this brought to the simplification of both the cell construction and electronic part. Because of the specificity of liquid crystals we expanded the range of linear loss compensation and introduced electronic protection for frequent breakdown of liquid crystals.

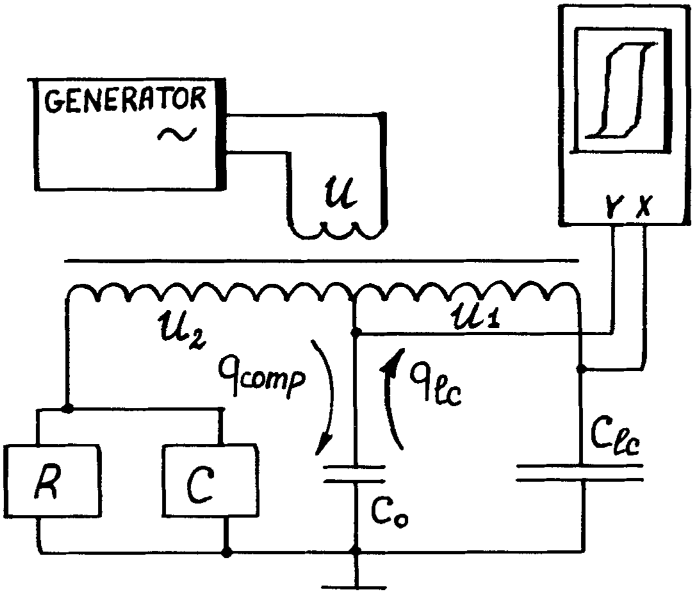
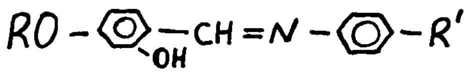


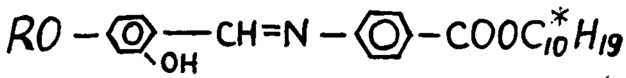
FIGURE 1

The principal set is shown in Fig.1. The sine signale from the generator which the frequency within 17 HZ - 200 kHZ and 5 Volt peak value fields the step-up transformeter. The voltage of U_1=100 V by means of standart capacity C_0 causes a flow of repolarization charges $q_p=P_sS$ and linear charges $q_{lc}=(1/R)\int(U_1-Y)dt + C_{lc}(U_1-Y)$ from the cell. The voltage U_2 causes the reverse flow of linear charges of capacity box C and resistance box R: $q_{comp}=(1/R)\int(U_2+Y)dt + C(U_2+Y)$. The choise of $C_0 \gg C, C_{1c}$ results in $Y \ll U_1, U_2$. The sum of all charges througt C_0 is: $q=P_sS + (k/R_{1c} - 1/R)\int U_2 dt + (kC_{1c}-C)U_2$, where $k=U_1/U_2$. After adjusting R and C so that $R=R_{1c}/k$ and $C=kC_{1c}$ the linear loss is compensated and the voltage on C_0 is the only to repolarization charges: $Y=P_sS/C_0$. The resistance and capacity of liquid crystal then may be measured according to $C_{1c}=C/k$, $R_{1c}=kR$. The signals Y and X proportional to the field E gives a hysteresis loop on the screen of oscillograph. While utilization the principle set includes also scale amplifiers, supply units and electronic protection of electrical breakdown in the cell. The range of linear loss compensation is 200 MOhms till 200 Ohms and from 1 pF till 10 nF. The detailed description is given in [11].

For ferroelectric liquid crystals different C smectic liquid crystal of alkoxysalicylidene alkylaniline series



with optically active additives of alkoxysalicylidene-(1-menthylbenzoate)aniline were used.



Some characteristics of these mixtures (temperature dependence of helix pitch, helix twisting power) are considered in [12].

The spontaneous polarization P_s of this mixtures is about $5 \cdot 10^{-9}$ C/cm^2 but for some mixtures as it is shown in Fig.2 the increase of P_s is observed. Phase diagram, the dependence of P_s and θ on optically active additives concentration for the mixture 1 is studied in [13].

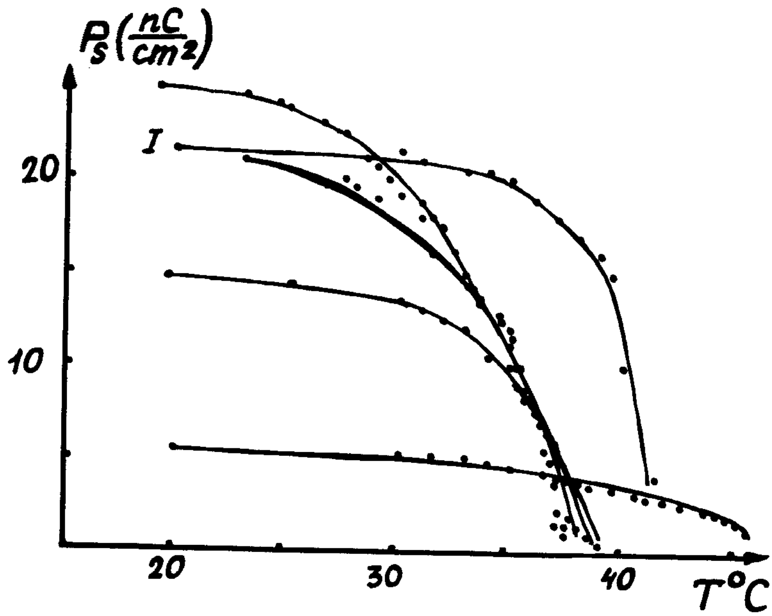


FIGURE 2

Fig.3 represents hysteresis oscillogramms for the mixture 1 detected for different frequences and applied field voltage. With the increase of voltage E one can detect hysteresis "triple" loops connected with nonlinearity of dielectric susceptibility. Similar "triple" loops for voltage more that 20 kV/cm are described in [14,15].

REFERENCES

1. C.B.Sawyer, C.H.Tawer, Phys.rev. 35,269 (1930)
2. H.Diamant, K.Drenk, R.Pepinsky, Rev.Sci.Instr. 28, 30 (1957)

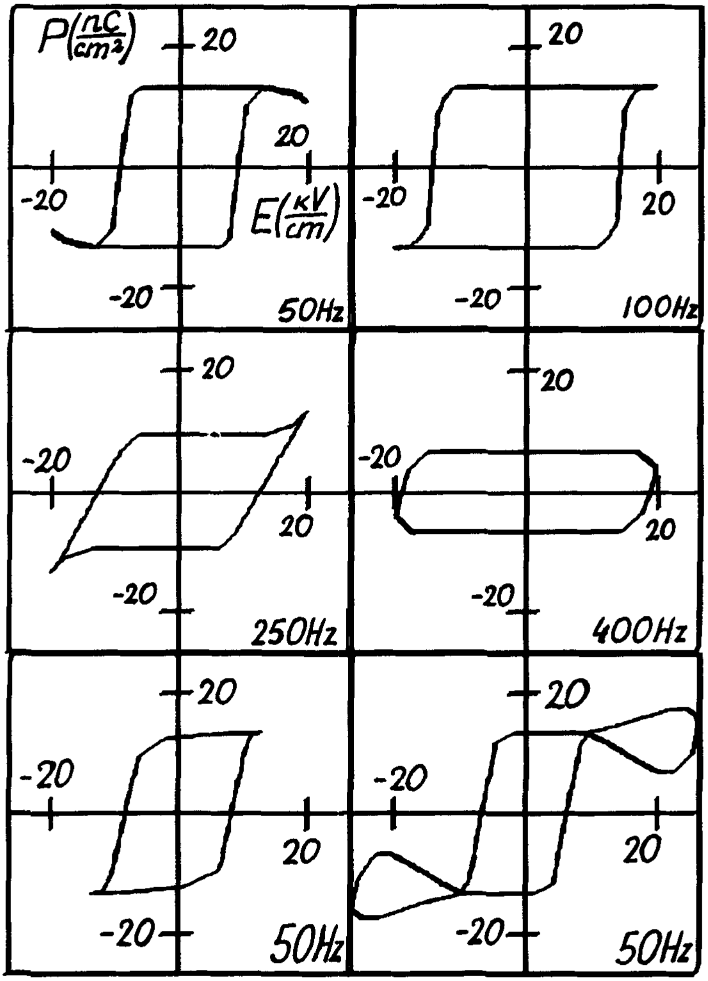


FIGURE 3

3. B.A.Strukov, Izv.VUZov Prib.,5, 25 (1960)
4. N.W.Schubring, J.P.Nolta, R.A.Dork, Rev.Sci. Instr. 35, 1517 (1964)
5. B.I.Ostrovski, A.Z.Rabinovich, A.S.Sonin, B.A.Strukov and N.I.Chernova, Sov.Phys. JETP Lett. 25, 70 (1977)
6. J.Hoffmann, W.Kuczynski, J.Malecki, Mol.Cryst. Liq.Cryst 44, 287 (1978)
7. M.V.Loseva, B.I.Ostrovski, A.Z.Rabinovich, A.S.Sonin, B.A.Strukov, S.A.Taraskin, Ferroelectrics 24, 309 (1980)
8. W.Kuczynski, H.Stegemeyer, Chem. Phys. Lett. 70, 309 (1980)
9. T.Uemoto, K.Yoshino, Y.Inushi, Mol.Cryst.Liq. Cryst 67, 137 (1981)
10. S.Kai, Y.Narushige, R.Fujimoto, M.Imasuki, Ferroelectrics 18, 25 (1984)
11. B.A.Loginov, G.S.Chilaya, Prib.Tekh.Eksp. (1987) (in press)
12. G.S.Chilaya, Z.M.Elashvili, M.N.Kushnirenko, K.D.Vinokur, B.M.Bolotin, N.I.Chernova, M.V.Loseva, Mol.Cryst.Liq.Cryst. (in press)
13. B.M.Bolotin, K.D.Vinokur, M.A.Gogadze, I.S. Narkevich, A.Z.Rabinovich, G.S.Chilaya, Z.M.Elashvili, Zh.Tekh.Fiz. (in press)
14. M.Imasaki, S.Kai, T.Hashimoto, M.Nomiyama, IEEE 54, 1542 (1985)
15. S.Kai, T.Hashimoto, K.Ose, M.Imasaki, Mol. Cryst.Liq.Cryst. 130, 143, (1985)