Proc. XIth Nat. Symp. SSNTD
Oct. 12-14, 1998, Amritsar, pp. 153-155
Surinder Singh (Ed.)

SIGNIFICANCE OF DIELECTRIC PROPERTIES FOR ELECTROCHEMICAL ETCHING RESPONSE OF A NUCLEAR TRACK DETECTOR

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ABSTRACT

Effect of various physical parameters such as dielectric constant and dissipation factor on ECE response at various frequencies was investigated. This study reveals that dipole moment and dielectric loss are important parameters on which the tree formation in the ECE process depends.

1. INTRODUCTION

The insulating material absobs energy when subjected to an alternating electric field. The energy transferred is a function of not only of field strength across material and its frequency but also of the physical characteristics of the material which futher depends on the field frequency (Al-Najjar et al, 1979; Somogyi et al 1979; Sohrabi, 1981; Tommasino et al, 1981). A possible way to analyze these effects would be to measure the dielectric loss factor, $\varepsilon \tan \delta$, as a function of frequency, freferably under the same electrical conditions as those used during electrochemical etching.

Detector materials have been studied until now are polar in nature. The existence of dipole moment (μ) considerably alters behavior of the dielectric. Visualizing the relevance of this study, the dielectric factor has been investigated at various field frequencies and their effect on ECE response is discussed. An attempt has also been made to correlate the dipole moment (μ) with ECE behaviour of polymeric track detectors such as Laxan polycarbonate (PC), CR-39, Cellulose triacetate (CTA), Cellulose nitrate (CN) and Polyethylene terephthalate (PET).

2. EXPERIMENTAL PROCEDURE

The experiment was carried out to determine ε & $\tan \delta$ of various plastics in the frequency range from 0.1 to 100 kHz GR Capacitance Bridge-1615 A. For the measurement of dipole moment (μ), the polarization current through the sample was measured for an external triangular wave field. From the polarization current the charge on the electrode plates and thus polarization was calculated. From the measurement of polarization and ε, dipole moment was calculated using the Clausious-Mossotti relation.

3. DISCUSSION OF RESULTS AND CONCLUSIONS

The value of ε for polycarbonate is fairly constant (Fig. 1) in the frequency range from 0.1-100 kHz, but tan δ has a high value in the low frequency region (<1kHz) as compare to high frequency region, which support the results obtained during ECE of PC (Singh and Virk 1987).

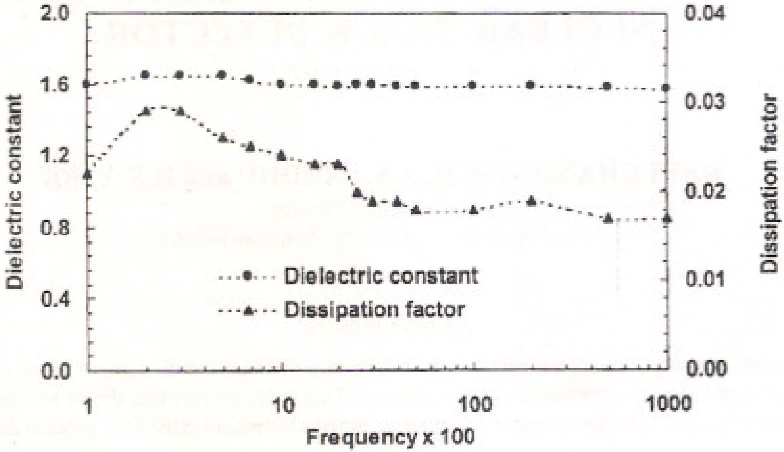

Fig.1. The dielectric constant (ε') and dissipation factor (tanδ) as functions of log(f) for Lexan polycarbonate

The variation of tan ε for CR-39 plastic suggests that a better ECE response is expected at higher frequencies (Fig. 2). The observations in case of CTA & CN plastic suggest that ECE should be carried out in a low frequency region.

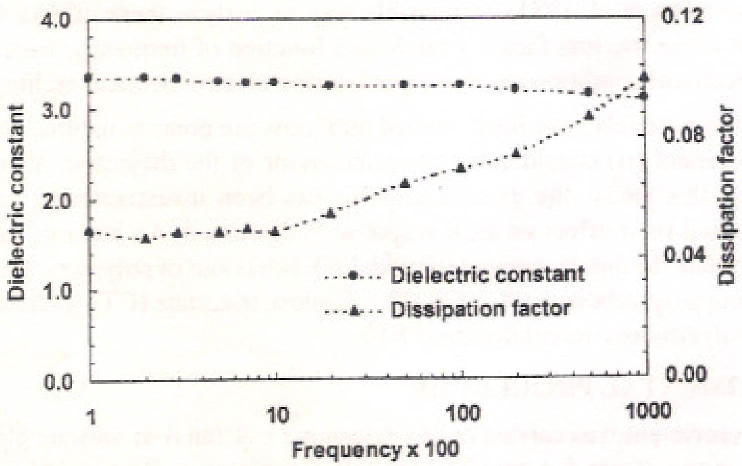

Fig. 2. The dielectric constant(ε') and dissipation factor (tanδ) as functions of log (f) for CR-39

In the present study the role of dipole polarization in ECE process is emphasized. Dipole polarization is absent in non polar dielectrics such as polyethylene, polystyrence etc., that is these are no polar molecules present in these materials and therefore their

ECE response is poorest of all the polymeric track detectors (Table 1). It is also observed that a material having a low value of dielectric constant gives better ECE result. Polycarbonate and CR-39 both have high value of dipole moment and low value of dielectic constant as a consequent both are good ECE materials.

Table 1.Physical parameters for various dielectrics

Material	Dielectric Constant ($\varepsilon^{\prime}$) at lkHz	Dissipation Factor ($\tan \delta$) at lkHz	Dielectric Loss ($\varepsilon^{\prime} \tan \delta$) at lkHz	Dipole Moment (μ) Cm $\times 10^{-30}$
CN	5.56	0.037	0.210	8.07
CR-39	3.31	0.015	0.049	6.05
Makrofol	1.91	0.007	0.013	5.01
PET	3.20	0.011	0.035	3.03
CTA	3.38	0.056	0.189	2.66
PE	2.20	0.004	0.009	0.00

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