A note on 'ferroelectricity in polymer films containing TGS powder'

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Abstract. Ferroelectric polymer films have been made by dispersing TGS powder. The dielectric constant ϵ' of the films has been measured. The thermal behaviour of ϵ' is also reported. Data have been obtained from samples prepared with different weight concentrations (10-75%) of TGS.

Keywords. Ferroelectricity ; polymer films ; triglycine-sulphate.

1. Introduction

In recent years, triglycine-sulphate (TGS) has been studied in detail (Savage and Miller 1959 ; Fatuzzo 1960 ; Jona and Shirane 1962 ; Beerman 1971 ; Simhony and Shanlov 1972 ; Bye *et al* 1974 ; Pykacz 1978) as it is one of the most important pyroelectric materials used in IR detectors and IR vidicons. For these applications, one needs large area single crystals. The problems in growing such crystals are enormous. Besides, cutting and polishing of TGS crystal is an involved process. Therefore, search was made for pyroelectric effect in a number of polymers (Miller and Murray 1966 ; Fukurawa *et al* 1968 ; Mopsik and Broadhurst 1975). The most promising among these polymers, polyvinylidene fluoride (PVF₂) was used as a vidicon target (Teranishi *et al* 1976). However, the quality of the target was much inferior. It was felt that dispersion of TGS might improve the pyroelectric behaviour of PVF₂ films. To study the effect of dispersion of TGS alone we studied the effect in a non-pyroelectric polymer-polystyrene (PS). This eliminated many variables encountered in the combination of PVF₂ and TGS and only one variable namely concentration of TGS was left. The present communication reports the results of these studies.

2. Experimental

TGS crystals were grown by slow evaporation of the saturated solution of TGS (Mathur *et al* 1980). The glycine (CH₂NH₂COOH, puriss grade 'Fluka') and sulphuric acid (electronic grade, BDH, England) mixed in stoichiometric ratio were used to prepare the saturated solution of TGS. The crystals were powdered

and sieved to select uniform particle size of rgs. Different quantities of rgs powder were mixed in the benzene solution of polystyrene and films were prepared by solution cast technique (Baker and Moulton 1960). Concentrations of rgs taken were 10%, 25%, 50% and 75% by weight. It may be mentioned that as the percentage of rgs was increased, the film adhered more and more to the glass plate and the mechanical strength of the film also appeared to decrease.

Small samples were cut from the films and air drying silver-conducting paint was used to form full face electrodes on both sides. After the application of silver-conducting paint, the samples were kept in an oven at 65° C for 6 hr to remove any moisture. Dielectric measurements were made at 5 kHz using a capacitance measuring assembly (General Radio 1620-AP). The cooling rate observed was 0.1° C min⁻¹.

3. Results

The results given in table 1 show that the critical temperature, T_c , keeps on increasing with increasing concentration of rgs. In the T_c vs concentration of rgs curve extrapolation suggests that for 100% rgs the critical temperature coincides with the T_c value for pure rgs crystal. However, the approach to single crystal T_c value is not linear, it becomes sharper with increase in the concentration of rgs powder. The peak value of the dielectric constant also increases with increasing concentration of rgs. It may also be pointed out that the peak becomes sharper with increasing rgs concentration.

4. Conclusion

The above observations suggest that the effect of rgs powder is to make the film ferroelectric and one may hope to improve the ferroelectric properties of PVF₂ film by dispersing rgs powder in it. At present it is difficult to comment on the particle size dependence.

Table 1. Dielectric data for polymer films

Concentration of TGS wt%	Position of the peak T_c (°C)	Peak value of dielectric constant
0	No peak is observed	
10	46.63	3.63
25	46.86	3.66
50	47.26	9.48
75	48.50	10.76

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