Polarisation profiles in VDF-TrFE copolymer bilayers of molar ratio 70/30 and 56/44

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Abstract: Ferroelectric bilayers have been fabricated by hot-pressing vinylidene fluoride-trifluoroethylene (VDF-TrFE) copolymer films of molar ratios 70/30 and 56/44 and polarized by electrode poling. The laser-intensity-modulation method (LIMM) has been used to investigate profiles of the pyroelectric activity. After poling a quite homogeneous polarisation is observed in the bilayer. Annealing at 80° C essentially depolarizes the layer of molar ratio 56/44. The layer of molar ratio 70/30 stays polarized, but polarization is declining smoothly through the thickness of the bilayer.

Keywords: ferroelectric polymers, bilayers, polarization profiles, LIMM

Introduction

The formation of bilayers of ferroelectric materials is an attractive way to fabricate systems with modified dielectric and polarisation properties [1]. In a recent study the effective properties of bilayers of VDF-TrFE ferroelectric copolymer thin films of molar ratios 56/44 and 70/30 have been characterized in terms of polarisation behaviour and dielectric nonlinearities [2].

Results and Discussion

To investigate the polarization in more detail ferroelectric VDF-TrFE copolymer bilayers have been fabricated by hot-pressing and polarized with electrodes. The laser intensity modulation method (LIMM) [3,4] has been applied to measure profiles of the pyroelectric activity. Figure 1 shows a relative homogeneous polarisation in the bilayer after poling. After annealing the bilayer at temperature 80° C, i.e. above the Curie temperature of the copolymer with 56/44 molar ratio, the polarization in the 56/44 layer is drastically reduced but essentially maintained in the 70/30 layer as shown in figure 2.

Conclusions

Annealing an initially homogeneously polarised bilayer of VDF-TrFE copolymer films with molar ratios 70/30 and 56/44 above the Curie temperature of the 56/44 material essentially depolarizes this layer. The resulting profile is not a step function, however, but shows a smooth decline of the polarization through the bilayer. This may be caused by electric fields arising when the 56/44 material is being depolarised. (This decline is significant and not an effect of the limited resolution of the thermal scanning technique only.)

References

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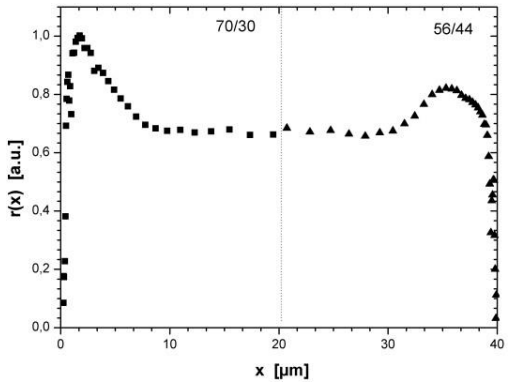

Figure 1: The spatial distribution of the pyroelectric coefficient r(x) of a 40 µm thick VDF-TrFE bilayer of molar ratios 70/30 and 56/44 after electrode poling.

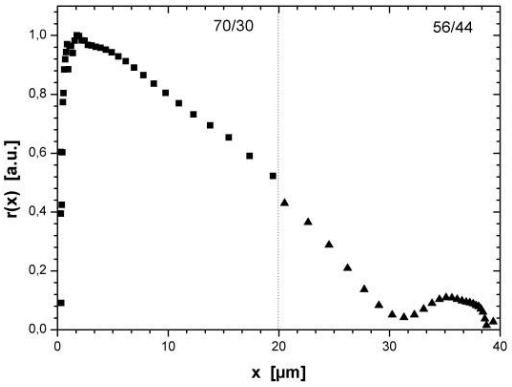

Figure 2: The spatial distribution of the pyroelectric coefficient r(x) of the sample of Fig. 1 after annealing at temperature 80° C.