POLING OF POLYMER FILMS WITH FERROELECTRIC ELECTRODES

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Abstract

A novel technique for the poling of polymer ferroelectrics and electrets is applied to polyvinylidene fluoride/trifluoroethylene (P(VDF-TrFE)) copolymers. The polymer film to be poled is placed between the polished unmetallized surfaces of homogeneously polarized ferroelectric crystals (TGS, $BaTiO_3$) or ceramics (PLZT). Only the external surfaces of the ferroelectric electrodes are covered with metal. For the poling process the polarization of the ferroelectric electrodes is switched by an appropriate high voltage connected to the stack. The FEP (ferroelectric electrode poling) technique completely avoids destructive electric breakdown, a problem frequently occuring when polymer films are poled between metal electrodes. A high and uniform polarization is achieved in the copolymer films. The experiments show that charge injection from metal electrodes is not essential for the poling of P(VDF-TrFE) copolymers.

1. Introduction

Procedures for the preparation of a ferroelectric in a state with a high macroscopic polarization are important for both fundamental research and applications. For many experimental studies it is favourable to have a single domain state of the ferroelectric to avoid domain wall effects. Applications, i.e. in pyroelectric sensors, piezoelectric sensors and actuators or electrooptical devices, make use of physical properties directly related to the macroscopic polarization.
A variety of poling procedures are reported in the literature and used in practice [1]. Electrode poling is performed by the application of an electrical field through conductive electrodes. For many polar polymers, however, the coercive field strength is only slightly lower than the electrical breakdown field strength. Thus in samples with slightly inhomogenous thickness or defects dielectric breakdown causes problems. As an efficient energy transport in the metal electrode is possible, all the energy stored in the sample capacitor is dissipated at the location of the breakdown and frequently the sample is destroyed. A method of avoiding a major breakdown utilizes a soda lime glass plate of proper conductivity placed between one metal electrode and the polymer film [2]. A disadvantage of this procedure is the long poling time (> 10 min), as the sample capacity has to be loaded over the resistance of the glass plate. Furthermore, the voltage drop across the PVDF film cannot be measured accurately. Further common poling procedures for PVDF films are corona poling and electron beam poling. However, the polarization profiles achieved with these methods are less uniform than with electrode poling [3].

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