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Nonlinear Dielectric Permittivity of PT/PVDF–TrFE Composites

Bernd PLOSS, Beatrix PLOSS, F.G. SHIN, H.L.W. CHAN and C.L. CHOY
Department of Applied Physics and Centre for Smart Materials
The Hong Kong Polytechnic University, Hung Hom, Kowloon
Hong Kong

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The nonlinear dielectric permittivities of 0–3 composite films of lead titanate (PT) nanoparticles in 56/44 mol % polyvinylidenefluoride trifluoroethylene (PVDF–TrFE) with 0.08 and 0.27 ceramic volume fractions and with various polarization states (only the matrix or the inclusions polarized, or the two phases polarized in parallel or antiparallel directions) have been investigated. An effective medium model for the dielectric nonlinearities of nonlinear inclusions in a nonlinear matrix has been developed. The theoretical predictions are found to be in good agreement with the experimental results. Comparing the composite dielectric nonlinearities with experimental data of the pure PVDF–TrFE copolymer gives access to the nonlinear properties of the PT nanoparticles.

Keywords: Nonlinear response; dielectric; ferroelectric; composites; PT; PVDF-TrFE

INTRODUCTION

Dielectric composites of linear media have been extensively studied in the past and a variety of effective medium theories have been developed. Only some special cases of nonlinear dielectric composites are discussed in literature, e.g.: nonlinear spheres in a linear matrix [1], composites of two nonlinear materials with vanishing second order permittivity [2], or a serial–parallel circuit model for semicrystalline polymers [3]. In the following, we introduce a model on nonlinear