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Polarization Properties and Polarization Depth Profiles of (Cd:Zn)S/P(VDF-TrFE) Composite Films in Dependence of Optical Excitation

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Received: 25 September 2018; Accepted: 28 October 2018; Published: 30 October 2018

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Abstract: The influence of optical excitation intensity on the electrical, ferroelectric and pyroelectric properties of ferroelectric-semiconductor-composites was investigated. For this purpose, composite thin films consisting of poly(vinylidene fluoride-*co*-trifluoroethylene) and 10 vol % (Cd:Zn)S particles with a thickness of 34 μm were fabricated. The samples were used to measure the absolute pyrocoefficient and to determine the relative pyroelectric depth profile using Laser Intensity Modulated Method. It was shown that a polarization of the samples without an optical excitation at the utilized relatively small peak-to-peak voltages could not be verified by the Sawyer–Tower circuit and the measurement setup of the pyroelectric coefficient, respectively. Both remanent polarization and pyroelectric coefficients increased with increasing optical excitation intensity during poling as well as increasing peak-to-peak voltage. The pyrocoefficient shows a temporal decay in the first hours after poling. The specific heat and thermal conductivity or the thermal diffusivity are required for the calibration of the pyroelectric depth profile. Rule of mixture and photo-acoustic investigations proved that the thermal properties of the utilized composites do not differ significantly from those of the pristine polymer. Based on the pyroelectric depth profile which is proportional to the polarization profile, the existing "three phase model" has been extended to generate a replacement circuit diagram, explaining the local polarization due to the optical excitation dependency for both local resistivity and local field strength.

Keywords: composite; ferroelectric polymer; semiconductor; optical excitation

1. Introduction

Ferroelectrics made of polymers are characterized by advantageous compared to their ceramic competitors due to their low processing temperatures, large electrical resistivity, and their high mechanical flexibility. They are of particular interest for engineering flexible electronic devices such as energy harvesting systems, memory devices and sensors [1–9]. A specific example of this type of material is poly(vinylidene fluoride-*co*-trifluoroethylene) P(VDF-TrFE), which exhibits a well-ordered, polar, and ferroelectric β-phase structure [10,11]. For a TrFE content in the range of 20–45 mol %, P(VDF-TrFE) crystallizes directly in this ferroelectric β-phase, independent of processing routes or post-treatment procedures [12]. In addition, the solubility of P(VDF-TrFE) in various solvents makes