Abstract

This thesis provides information about the development of highly flexible ferroelectric nanocomposite materials in thin film form and their applications in energy storage, conversion and detection process. Polyvinylidene fluoride (PVDF) is synthesized in flexible thin film form, which is dielectric, ferroelectric, piezoelectric and pyroelectric in nature. A cost effective chemical solution based method is adopted to fabricate PVDF nanocomposite membranes with nanofillers like zinc oxide (ZnO), graphene oxide (GO) and both ZnO and GO loaded into that.

PVDF polymer membrane possesses energy density of 11.3×10^4 J/m^3 which increases to 65.5×10^4 J/m^3 when ZnO nanoparticles are added to it. Inclusion of GO nanofiller completely destroys its energy density to 0.06×10^4 J/m^3. Addition of both nanofillers increases energy density to 61.7×10^4 J/m^3. Polarization of PVDF at an external electric field of 15kV/cm is 5.94 μC/cm^2 which increases greatly to 15.98 μC/cm^2 by ZnO incorporation into it. For tri-phase PVDF/ZnO/GO nanocomposite membrane, the polarization value is 14.14 μC/cm^2. A great improvement in dielectric constant is observed from 47 for PVDF to 261 for PVDF/ZnO composite. For PVDF/ZnO/GO composite dielectric constant is 151. Dielectric loss for PVDF is 2.31 which reduce to 0.46 for PVDF/GO.

PVDF/ZnO/GO tri-phase composite shows higher open circuit voltage (V_{oc}) and short circuit current density (J_{sc}) resulting in highest output power delivering composite in different modes like finger tapping, periodic bending and repetitive stretching. PVDF membrane shows responsivity of 0.004 (μA/cm^2/W) in presence of solar spectrum at an external bias of 10 V with rise time of 44 sec. Introduction of increasing GO amount upto 15% (v/v) gradually increases the photocurrent to 4.0 μA/cm^2 with shorter response time of 21 sec. Further, in mechanically bend condition, all of these composites show higher dark and photocurrent due to formation of piezo-potential. Impedance spectroscopic study is conducted to gain proper insight of these occurrences along with effect of filler inclusions. Also, effect of external stimuli like mechanical stress and light irradiation on those composites are explained from the changes in various parameters obtained from the fitting of Nyquist plots drawn from impedance spectroscopic measurements.