Development of suitable ferroelectric nanocomposites in thin film form for energy applications

Thesis submitted for the partial fulfillment of the requirements for the degree Doctor of Philosophy in Science

by

Eheta Samul Kadir

Department of Physics

Faculty of Natural and Mathematical Sciences

Presidency University

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Conclusion

We have successfully synthesized PVDF and its ZnO and/or GO filled nanocomposites by solution processed spin coating method. Different micro structural studies like XRD, XPS, FTIR confirm their formation in nanocomposite form. These studies provide significant insight about bonding environment and verify their formation in nanocomposite form. Inclusion of ZnO nanofiller improves its dielectric constant and ferroelectric polarization. On the other hand GO incorporation improves the conductivity of the composite. Therefore compositing different elements via formation of PVDF/ZnO/GO nanocomposite provide better dielectric and ferroelectric property along with increased conductivity in the material. These PVDF based composites are performed as piezoelectric nanogenerators. Among different synthesized composite membranes PVDF/ZnO/GO tri-phase composite exhibits highest power delivering capacity compared to its other counterparts. Synthesized PVDF membrane are responsive to broad band solar spectrum but with very poor responsivity. Incorporation of GO into the host matrix increases the photocurrent by preventing recombination loss thereby forming better conducting network. Moreover, in mechanically bend condition they produce higher current due to formation of piezo-potential. Due to having very high band gap, PVDF is also able to absorb UV light to a limited extent. But incorporation of ZnO into PVDF makes it an efficient UV absorber. PVDF loaded with ZnO nanoparticles exhibits combination of piezoelectric effect with photo sensitive property known as piezo-photonic effect.

Future work

Although PVDF is a well-established material in the field of ferroelectric, dielectric and piezoelectric techniques, but improvement of its performance to higher level through compositing various nanomaterials is yet to explore. But being a polymer substance its high resistive nature prevents production of sufficient current which in turn generates an obstruction in the path of their applicability in device fabrications. So improvement in its conductivity for better performance is still possesses a challenge. Moreover its photo-responsive property makes it a worthy candidate as a flexible photo-detecting substance which is not much examined till now. Additionally its piezo or pyro response combining with photo-responsive property may lead us towards further exploration of its piezo-phototronic and pyro-phototronic properties. Further its flexibility with pyroelectric nature can be utilized in the direction of fabrication of flexible temperature sensing devices.