Nanocomposite based piezoelectric energy harvesting for self-powered sensors

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Abstract (300 word limit)

Harvesting small scale mechanical energy to obtain electricity with assist of Nanogenerator (NG) are one of the most important technologies which can tremendously cooperates to meet the rapid-growing world-wide energy depletions and fulfil the realization of the self-powered electronic devices and sensor networks in our high-tech life-style. Polyvinylidene fluoride (PVDF) and its copolymers like Poly(vinylidenefluoride-co-hexafluoropropylene) (PVDF-HFP), in their extended β-electroactive phase is the most promising contender for real-field application of NG. Among the various techniques to attain β-PVDF, introduction of nano Ferrites is designated as the most cost-effective and industrial-friendly technique for large scale production. In this work, Zinc Ferrite (ZF) was considered as alternative nucleating agent due to its high remnant polarization value (1μC/cm2). ZF was wet-chemically synthesized with different geometry and their respective solvent casted PVDF-based composite was fabricated. The geometry, concentration, dispersion of filler in PVDF matrix and filler-PVDF inter phase compatibility were the controlling factors to determine nucleation and stabilization of electroactive (β and γ) phase fraction for obtaining superior output performance. Electroactive phase transformation in PVDF and interfacial interaction between ZF and dipoles of PVDF was studied by both spectroscopic and microscopic techniques. Dielectric spectroscopy and P-E hysteresis loops were measured to determine electrical percolation threshold which is very decisive factor to determine threshold concentration of Ferrite-polymer composite. For further improvement in piezo output, ZF nanorod was introduced to copolymer PVDF-HFP and superior dielectric, ferroelectric and piezoelectric properties were obtained. Finally, some probable applications such as capacitor charging, illuminating light emitting diodes, monitoring height with desired level of accuracy and scavenging mechanical energy from various environmental source like body movements, air flow etc. were explored for optimized composite systems. These research work established the feasibility of using ZF-PVDF/PVDF-HFP composite as alternative material as piezoelectric NG for self-powered sensor application.

Image

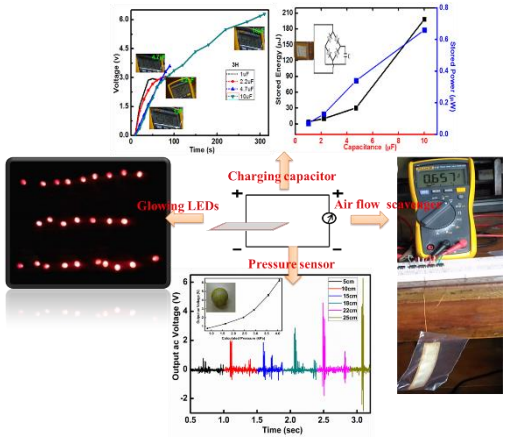


Figure: Graphical abstract of the work

Recent Publications (minimum 5)

1. Chinya I, et. al. (2020) Conducting Polyaniline decorated in-situ Poled Ferrite nanorod-PVDF based nanocomposite as piezoelectric energy harvester. J. Alloy Compd. 815:152312-152319.
2. Chinya I, et. al. (2019) Flexible, hybrid nanogenerator based on Zinc Ferrite nanorods incorporated Poly (vinylidene fluoride-co-hexafluoropropylene) nanocomposite for versatile mechanical energy harvesting. Mater. Res. Bull. 118: 110515- 110525.
3. Chinya I, et. al. (2019) Flexible piezoelectric energy harvesters using different architectures of ferrite-based nanocomposites. Crys. Eng. Comm. 21: 3478-3488.
4. Chinya I, et. al. (2017) Improved dielectric and touch sensing performance of surface modified Zinc Ferrite (ZF)/ Polyvinylidene Fluoride (PVDF) composite. Sens. Actuator A: Physical 267: 301-309.
5. Chinya I, et. al. (2017) Polyglycolated Zinc Ferrite incorporated Poly(vinylidene fluoride) (PVDF) composites with enhanced piezoelectric response. J. Alloy Compd. 722: 829-838.

Photograph



Biography (150 word limit)

Dr Ipsita has her expertise in mechanical energy harvesting by means of piezoelectric and triboelecric method. She pursued her B.Sc. (Hons) in Chemistry and Post B.Sc. B.Tech. in Polymer Science and Technology from University of Calcutta. She received her Master degree (Glass and Ceramic Engineering) and Ph.D. from Academy of Scientific and Innovative Research in Engineering Sciences. After that she works in IIT Madras, IIT Bombay and IIT-Bubaneswar as post-doctoral fellow mainly with ferroelectric materials and polymer nanocomposite based self-power biosensors and health care applications. Her main research interests are surface-modified nanoparticles, polymer nanocomposite based piezoelectric and triboelectric self-powered sensors and bio senosrs, and nano-electrochemistry. He has received several major grants and prestigious awards in India. Presently she is heading the department of Chemical Engineering, Dr. V.R. Godhania College of Engineering and Technology, Porbandar, Gujrat, India.

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Notes/Comments