

Electroactive Polymer Nanocomposites-A New Paradigm For Energy Security Applications

Nandakumar Kalarikkal

International Centre for Ultrafast Studies

&

School of Nanoscience and Nanotechnology

&

International and Inter University Centre for Nanoscience and Nanotechnology

Mahatma Gandhi University

Kerala-686 560, INDIA

Abstract

Multifunctional materials are proving to be highly promising for advancing various technologies, including magneto-mechano-electric energy harvesting devices and flexible sensors. Industry 4.0 is leading a global lifestyle revolution by digitalizing various sectors, such as energy, transportation, healthcare, agriculture, and more, while also expanding the use of IoT devices and networks. With this digital transformation, the demand for energy is surging, driven by the increasing prevalence of human-machine interactions [1]. Energy harvesters are devices that convert any type of ambient energy from the environment into electrical energy[2]. Piezoelectric polymers like polyvinylidene fluoride (PVDF) and its co-polymers thrive in nanogenerator and sensing applications due to their flexibility, promising electroactive nature and non-toxic nature [12][13], [14]. This talk will cover our recent research activities in the area of electroactive polymer nanocomposites for nanoenergy generation and its applications.

- [1] IEA (2021), "Global Energy Review 2021," IEA, Paris, 2021. [Online]. Available: <https://www.iea.org/repo/0Arts/global-energy-review-2021>.
- [2] S. M. Purushothaman, N Kalarikkal *et al.*, "A review on electrospun PVDF-based nanocomposites: Recent trends and developments in energy harvesting and sensing applications," *Polymer (Guildf)*, vol. 283, p. 126179, Sep. 2023, doi: 10.1016/j.polymer.2023.126179.
- [3] M. T. Rahul, N Kalarikkal *et al.*, "Hydrated metal salt and Y₃Fe₅O₁₂-Na_{0.5}K_{0.5}NbO₃-incorporated P(VDF-HFP) films: a promising combination of materials with multiferroic and energy harvesting properties," *J. Mater. Sci.*, vol. 57, no. 15, pp. 7653–7666, 2022, doi: 10.1007/s10853-022-07142-7.
- [4] Bhadrapriya, B. C. *et al.* Unleashing the potential: Multifunctionality of PVDF-HFP based ternary nanocomposite films - magnetoelectric, energy harvesting and impact sensing performance. *Mater. Chem. Phys.* **315**, 129057 (2024).
- [5] Ponnann, S. *et al.* Bi-filler Interacted β -Phase Enhancement in Polyvinylidene Fluoride Compositised with Cellulose Nanocrystals and Nickel Ferrite: A Multifunctional Energy Harvester and Sleep Monitoring Sensor. *ACS Appl. Electron. Mater.* **6**, 4963–4976 (2024).
- [6] Lekha, C. . C. *et al.* Flexible Piezoelectric and Hybrid Nanogenerators Based on Single Layered and Stacked Multilayered PVDF/CoFe₂O₄/KNaNbO₃ Composite Electrospun Nanofibers. *Polymer*. 128257 (2025) doi:10.1016/j.polymer.2025.128257