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SHORT ABSTRACT OF THESIS

Piezoelectric material based sensors, actuator are widely used in many engineering fields such as aerospace, medical, marine, consumer sports, etc. Many research groups have been extensively studying piezoelectric based nanofiber mats over the years due to their higher sensing capability. Flexible piezoelectronics are the key components in various micro, nano-scale energy harvesting devices, structural health monitoring, and medical devices. A wide range of devices have been developed specifically for energy harvesting applications. Moreover, these devices can be used to power small electronic devices such as sensors, capacitors, light-emitting diodes, watches, etc. Piezoelectric materials such as lead zirconate titanate PZT-5A and PZT-5H are highly brittle due to which complex shapes, robust stringent loading, and boundary conditions limits their application for developing nano or microdevices for sensing or actuation purpose. Hence, piezoelectric polymer-ceramic based nanofibers are better option for the sensing and energy harvesting applications. The sensitivity of nanofiber composite mats depends upon the manufacturing/fabrication method. Fiber mats can be manufactured using solution casting, thermal evaporation, spin coating, hydrothermal, and electrospinning, etc. Electrospinning is the most suitable fabrication method due to its ability to fabricate nanostructures with novel properties such as small diameter, long length, diversified composition, high surface area to volume ratio, inter/intra fibrous porosity, flexibility in surface functionalities, and self poling. Electrospun nanofibers have been used in various areas such as tissue engineering, wound dressing, filtration, drug delivery systems, desalination, protective clothing fabrication, optical electronics, personal care, sound absorption, and biosensors. The sensing and actuating capacity of these fibers significantly depends on various parameters, which affect the morphology of fabricated nanofibers. The aim of this research is to develop P(VDFTrFE) based flexible piezoelectric mats for energy harvesting and sensing applications. Since pure P(VDF-TrFE) based mats have low power output. Some piezoceramic nanoparticles such as ZnO, $BaTiO_3$, and TiO_2 are added to enhance the power output of the electrospun mats. P(VDFTrFE)/ZnO nanofiber membranes are synthesized by optimizing the electrospinning parameter. Electrospun PVDF/$BaTiO_3$ functionally graded webs are fabricated for the energy harvesting application. Further, hybrid nanocomposite mats are synthesized and incorporated as wearable devices. P(VDF-TrFE)/TiO_2 based hybrid nanogenerators comprised of piezoelectric and triboelectric nanogenerators are also designed for energy harvesting and impact sensor application. The optimization of process parameters (applied voltage, ow rate, spinning distance, shape of spinneret), solution parameters (molecular weight, polymer concentration, viscosity, conductivity), and ambient parameters (humidity, temperature, and type of atmosphere), which affect the nanofiber power output are also studied. Electrospun nanofiber composites are then investigated for their energy capturing and sensing capability by varying the matrix and reinforcing fillers concentration. Subsequently, the surface morphology, mechanical behavior, crystallinity, fraction of beta phase, thermal stability, rheological properties, storage modulus, loss modulus, damping factor, and piezoelectric performance of various fiber composite have been analyzed. Piezoelectric nanogenerator (PENG) devices are designed using nanofiber mats as an active layer placed between the top and bottom electrodes for energy harvesting and sensing applications. These devices are subjected to pressing, bending, tapping, and impact load, and output is recorded using a digital storage oscilloscope (DSO). These devices can be used as biomechanical sensors, impact sensors, and energy harvesting applications. The present research output can be a basis for the futuristic development of wearable medical and energy harvesting devices.