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ABSTRACT

Title: Preparation of Piezo-, Pyro-electric and Ferroelectret Composites towards Multidimensional Applications

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Renewable energy is one of the crucial resources for maintaining our modern life-style. Moreover, a notable revolution in science and technology is shrinking the power requirement as well as the device size. In the last few decades, harvesting mechanical and thermal energies from our natural environment has been the focus of multiple research efforts. In this scenario, nanogenerators (NGs) are an emerging new energy harvesting technology towards self-powered electronics and human health monitoring. NGs particularly harvest mechanical vibration and temperature fluctuation, which are ubiquitous and accessible in our living environment, and convert it into electrical energy. The recent advancement in smart electronics and portable light weight devices will shed light on the development of self-powered electronics; which will impact a broad range of applications in wireless sensors, biomedical implants, infrastructure monitoring, and wearable electronics. This thesis research covers the material synthesis, designs, fabrications, characterizations, simulations and applications of piezo-, pyro-electric and ferroelectret nanogenerator based energy harvesting technologies.

We have proposed a new strategy to develop new class of mechanical energy harvester (MEH) using self-poled ferroelectret film through a facile route. The addition of external porous material such as, 3D metal-organic framework (MOF) leads to orientation of -CH_2-/-CF_2-dipoles in poly(vinylidene fluoride) (PVDF) through different interactions and self-poling phenomena. Moreover, the simple scalable process results in the formation of highly sensitive porous electret structure with enhanced piezoelectric co-efficient value. These features make it enable to detect physiological signal to wrist pulse. All of these coupled with wireless data transmission indicate the promising application of composite ferroelectret in non-invasive real-time remote healthcare monitoring.

Additionally, electrospun composite PVDF nano-fibers were also prepared in order to fabricate piezoelectric (PNG) and pyroelectric nanogenerator (PyNG) for mechanical and thermal energy harvesting respectively. To improve the efficiency of the NGs, several additives such as 2D MOF, graphene oxide (GO), CdS grafted reduced graphene oxide (CdS-rGO) were synthesized and successively incorporated in PVDF matrix. These PNGs and PyNGs were used to drive several consumer electronics, such as, LEDs, LCD, calculator etc. In addition, NGs were further implied for developing self-powered human physiological signal monitoring system. Consequently, the developed flexible NGs address vast range of applications including the biomedical sensors as well as flexible portable electronic gadgets in the quest of lead free self-powered piezo- and pyro-electric energy harvesters.

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