ABSTRACT

To minimize the energy crises and electronics wastes, searching for alternative renewable energy resources is the prime challenge for our civilization. Mechanical energy is the most abundant renewable energy because of its greater accessibility. The generation of electricity through minute deformation of piezoelectric materials prompted the research in the arena of micro/nano scale mechanical energy harvester, also known as nanogenerator. Though a variety of advanced inorganic piezoelectric micro/nanostructures have been fabricated, but they have major limitations in terms of cost, toxicity, brittleness, electrical poling, and moldability. Development of flexible, biocompatible, durable, and efficient self-poled piezoelectric nanogenerators (PNGs) with remarkable output performances is of great challenge for powering smart electronics. To overcome these limitations, present work focuses towards development of piezoelectric poly(vinylidene fluoride) (PVDF) based PNGs with greater flexibility and durability. Furthermore, nature driven bio-inspired polysaccharides and protein materials based PNGs have shown potentiality as next generation possible biomedical applications due to their effectiveness in designing biocompatible/biodegradable smart electronics without any electronics wastes. The present research proposed various effective ways to harvest green electricity using different bio/non-bio based piezoelectric materials and their effective potential applications. The effectiveness of metal oxides decorated reduced graphene oxides (RGO) with PVDF was explored to enhance the piezoelectric performance of the materials and their usefulness in energy harvesting fields. Our study on iron oxides doped RGO (Fe-RGO)/PVDF based PNG device delivered high output performances, and aluminum oxides doped RGO (Al-RGO)/PVDF based PNG device using steel fabric as electrodes has turned the piezoelectric performances and durability in new directions. Again, vitamin (VB_2) is first time introduced as an effective β-phase stabilizer (~93%) in designing PVDF/VB_2 based PNG which shows outstanding performances in terms of high power density and energy conversion efficiency. Furthermore, nature driven bio-waste materials like onion skin (OS), and spider silk (SS) fibers have been introduced as an innovative and effective new bio-piezoelectric materials for effective green energy harvesting. Here, OS and SS based bio-PNGs (BPNG) without any chemical/surface treatment provided outstanding piezoelectric properties (output voltage/current and energy conversion efficiency of ≈60%) under small pressure. These flexible, self-powered, high energy conversion efficient durable PNGs and BPNGs can have significant impact in piezoelectric energy harvesting fields for powering portable electronics, *in- vitro*/*in-vivo* biomedical applications, and many more.

KEYWORDS: Flexibility, PVDF, Bio-materials, Piezoelectric nanogenerator, Energy harvesting, Biomechanical activities.