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| Title: | Piezoelectric activity assessment of size-dependent naturally acquired mud volcano clay nanoparticles assisted highly pressure sensitive nanogenerator for green mechanical energy harvesting and body motion sensing Author links open overlay panel |
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| Abstract: | Over the last few years, there are several methodical and productive ongoing research based on the development of high performing, sustainable, non-hazardous energy harvesting nanogenerators. It is a substantial challenge to construct an energy harvester that has a superior output performance as well as an eco-friendly character. In this work, the utilization of naturally available, biodegradable mud volcano clay from Andaman and Nicobar Islands, India was done to design two simple, portable, cost-effective, biocompatible, eco-friendly piezoelectric nanogenerators (PENGs). In the first place, we developed two types of multifunctional poly-(vinylidene fluoride) (PVDF) thin film incorporated with mortar pestle ground clay nanoparticles (average size of 600–700 nm) for 3 mass% (MP1, MP5, MP10) and ball mill ground nanoparticles (average size of 200–300 nm) for 3 mass% (BM0.5, BM1.0, BM1.5), with large electroactive β crystallinity. The incorporation of clay NPs into the PVDF matrix led to notable nucleation of piezoelectric β crystallite {F(β)} of 80.7% and 84.8% for mortar pestle ground (5% doping) and ball mill ground (1% doping) clay NPs respectively. Using these two multifaceted composite thin films we designed two devices using MP5 (MPENG) and using BM1 (BPENG), which possess good energy harvesting potency, commendable power density values and very fast charging capability. Our MPENG and BPENG generate output voltage of ~ 85 V with a short circuit current of ~ 1.6 μA and output voltage of ~ 125 V with a short circuit current of ~ 1.9 μA, respectively and power densities of 4115 μW/cm3 and 7187 μW/cm3 respectively, on the application of periodic force by hand. The calculated piezoelectric coefficient d33 of MP5 and BM1.0 were 39.75 pC/N and 50.10 pC/N at 50 Hz, respectively. To check the real-life applications, MPENG and BPENG were used to lighten up 25 and 40 no. of blue LEDs when connected a series connection and we charged a 2.2 μF capacitor within few seconds. These nanogenerators could also generate a notable voltage from various body movements like heel pressing, jogging or from vibrations or air flow from various instruments. On further advancement, our proposed devices can be used to power up various self-chargeable portable gadgets in our daily lives and in biomedical fields. |
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