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ENERGY HARVESTING PERFORMANCE OF A LEAD FREE HYBRID PIEZOELECTRIC NANOGENERATON

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ABSTRACT

A comparative study of a high-performance flexible piezoelectric hybrid nanogenerator (HNG) based on lead free perovskite zinc stannate ($ZnSnO_3$) nanocubes and polydimethylsiloxane (PDMS) composite with two individual conducting supplement fillers, e.g., multiwall carbon nanotubes (MWCNTs) and polyaniline (PANI) are studied. It has been observed that without any electrical poling treatment, the HNGs possesses open-circuit voltage of ~40 V under repeated human finger impact due to the stress induced dipole alignment. In this work we demonstrated that the output power density of 10.8 $\mu W/cm^3$ from HNG can drive multicolour several light emitting diodes (LEDs) and power up a calculator, indicating an effective means of energy harvesting power source for portable electronic devices.

Keywords: Lead-free $ZnSnO_3$, MWCNTs, PANI, Self-poled nanogenerator, Piezotronic

INTRODUCTION

Harvest mechanical energy from our environment for building self-powered systems is an effective and practically applicable technology to ensure the independently and sustainable operation of mobile electronics and sensor networks without the use of a battery. Recently, many authors have reported that perovskite structures, *i.e.,* $Pb(Zr,Ti)O_3$ [1], $BaTiO_3$ [2] $NaNbO_3$ [3],$KNbO_3$ [4], $LiNbO_3$ [5] and $ZnSnO_3$ [6] can be utilized to fabricate flexible piezoelectric nanogenerators (NGs) . Among the perovskite structures $ZnSnO_3$ isone of the most promising lead-free materials that exhibit a unique non-centrosymmetric structure due to its spontaneous polarization properties.Thus $ZnSnO_3$ material with nano- dimensional functionality demonstrates a great potential in piezotronic applications due to its self-poled property [6].

Herein, we report on piezoelectric power generation from the hybrid nanogenerator (HNG) based on piezoelectric $ZnSnO_3$ nanoparticles and polydimethylsiloxane (PDMS) composite with conducting filler (MWCNTs/PANI). To make the HNG flexible, PDMS was taken as the host polymer which is essential requirement in piezoelectric based potential applications. A recordable large output voltage up to 40 V from an unpoled HNG is successfully obtained by simply human finger impact. Furthermore, it has been demonstrated that several light emitting diodes (LEDs) of different colours (blue, green, yellow and red) are directly powered up from the HNG. The capacitor charging performance from the HNG indicates that it has efficient charging capability within a short span of time (~sec) which enable to power up the calculator. Thus, we believe that this cost-effective technique is well suits for large scale high performance flexible HNG fabrication that can drive the portable tiny electronic devices.