UNIVERSITI TEKNOLOGI MARA

STUDIES OF BATIO3/PVDF/RGO BASED NANOCOMPOSITES FOR NANOGENERATOR APPLICATION

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ABSTRACT

Piezoelectric energy harvesting has recently attracted the attention of researchers and industry, primarily because of its energy efficiency and environmental advantages. In comparison with other types of energy harvesting methods, some piezoelectric components can provide high-efficiency power output by size and low cost, that would potentially enabling the replacement of batteries that brings environmental harm and high maintenance. Nanogenerator is one of the new technologies that harness power from the environment. Using the first law of thermodynamic, the nanogenerator converts mechanical, thermal, or kinetic energy from surrounding to electricity. In general, nanogenerator can be divided into three concepts. There are piezoelectric, triboelectric, and pyroelectric with known as PENG, TENG, and PyENG, respectively. PENG concepts are based on external mechanical load given to the materials and produced electricity, while the TENG-based friction to produce electricity and PyENG is based on different temperatures between active materials to produce electricity. In this work, we investigated PENG in the form of a nanocomposite. We proposed a system of $BaTiO_3$(BTO)/PVDF and BTO/PVDF/rGO. The BTO was synthesized via the sol-gel technique and calcined at 1100 ℃. BTO is a PENG active material with tetragonal phase that have piezoelectric effect and high crystalline nanopowder among other calcined temperatures. The rGO was prepared using modified Hummer's method with a green synthesis route. The PVDF was commercially obtained in the form of powder. All active materials were characterized via XRD, FTIR and FESEM, respectively. Subsequently, the nanocomposites were prepared with the variation of PVDF and rGO. Before PENG is tested, modeling and simulation on PENG energy with mechanical output was perform via COMSOL. The simulation provided a PENG model of efficient piezoelectric effect with various dimension. PENG dimension 20 x 20 x 0.15 mm yield maximum voltage at 0.00364 V as with mechanical result including maximum deflection at 1.0561 mm and von misses effect with maximum value of 1.18 x 10^8 N/m^2. Subsequently, PENG nanocomposite was prepared using spin coated method onto ITO plastic substrate according to COMSOL modeling dimension. Then gold electrode was coated on top of the nanocomposite. FESEM and AFM characterization of the prepared PENG nanocomposite thin film were identified to be the system of BTO/PVDF and BTO/PVDF/rGO nanocomposites. Then, the performance of PENG nanocomposite was determined using knocker system that provided external load onto the PENG nanocomposite. Hence, energy output of PENG nanocomposite were recorded using oscilloscope and source-meter. After series of testing, BTO/PVDF50%/rGO5% nanocomposite shows the highest voltage and current of 29 V and 16.2 nA, respectively with power density of 154.69 nW/cm^2. In general, we successfully prepared a nanocomposite that can be applied as a flexible piezoelectric for energy harvesting.

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“Undoubtly, with every hardship, there is ease” (Al-Insyirah, 6)

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