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FABRICATION SENSORS BASED ON NANOCOMPOSITES ZnO/PVDF

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Abstract

This paper focused on generated output voltage by converting the mechanical energy to electrical response piezoelectric output voltage by tapping the finger of the hand on flexible nanogenerators fabrication of nanocomposites fibers (zinc oxide/polyvinylidene fluoride) ZnO/PVDF. Since, zinc oxide nanostructured materials have unique properties as their nanostructures, semiconducting, and piezoelectric which synthesize practically simply by a hydrothermal process at low temperatures. The structure and morphology of reactant materials, and, the fabricated nanofibers of the nanocomposites are characterized by XRD and SEM. The output is measured by an oscilloscope. The maximum output piezoelectric voltage for 18%ZnO–16%PVDF was 1.600 V. Therefore, the generators can be used as sensors in medical applications and other fields.

Keywords: ZnO NPs; PVDF; Electrospinning; Piezoelectric.

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Introduction

Harvesting of energy by mechanical piezoelectric nanogenerators, its diverse edibility developed to directly transform mechanical energy into electricity used in many included requests that have received a great amount of attention [1, 2].

The nanostructures of ZnO probably have excellent categorization concerning all materials, properties, and structures, which led to novel applications in biomedical sciences sensors, transducers, and optoelectronics. Fig. 1 represents the use of ZnO cited in the text [3, 4].

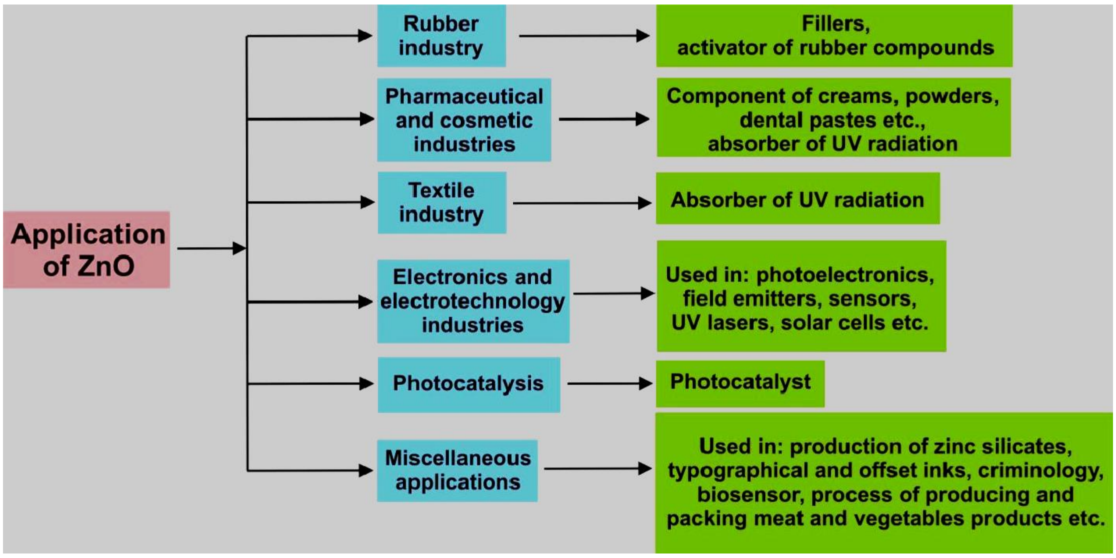


Fig. (1): Reviewed application approaches of ZnO [4].

Previous experiments have studied organic piezoelectric materials such as PVDF due to their high piezoelectricity and their copolymers. It has been advised to use alters of methodologies for devising polymeric piezoelectric generators, and great efforts have been structured in PVDF to create electro-active β-phase crystalline [5-7].

The polar β-phase possibly will be convinced by poling, mechanical stretching, filler addition, electrospinning, and thermal annealing. Electric field and stretching force as of electrospinning practice align dipoles in the nanofiber crystal such as the nonpolar α-phase their benefit is converted into polar β-phase. Therefore electrospinning techniques-within-poling and situ mechanical stretchings can create piezoelectric PVDF nanofibers [8-10].

Mechanical vibrations devices have achieved unique attention because of generally, harvest electrical energy as an environmental source, it's convenient to convey for instance alteration in the required energy of linked self-sufficient sensors designed for the sensing of human health and environment apparatuses, in addition to the possibility of diagnosing diseases of the gums and teeth. In this work, the researcher seeks to obtain energies from three generated fabricated nanocomposites ZnO/PVDF to achieve high output piezoelectric voltage is 1.600 V by tapping the finger hand on a device fabricated from 18%ZnO-16%PVDF.

Characterization of the Nanocomposites:

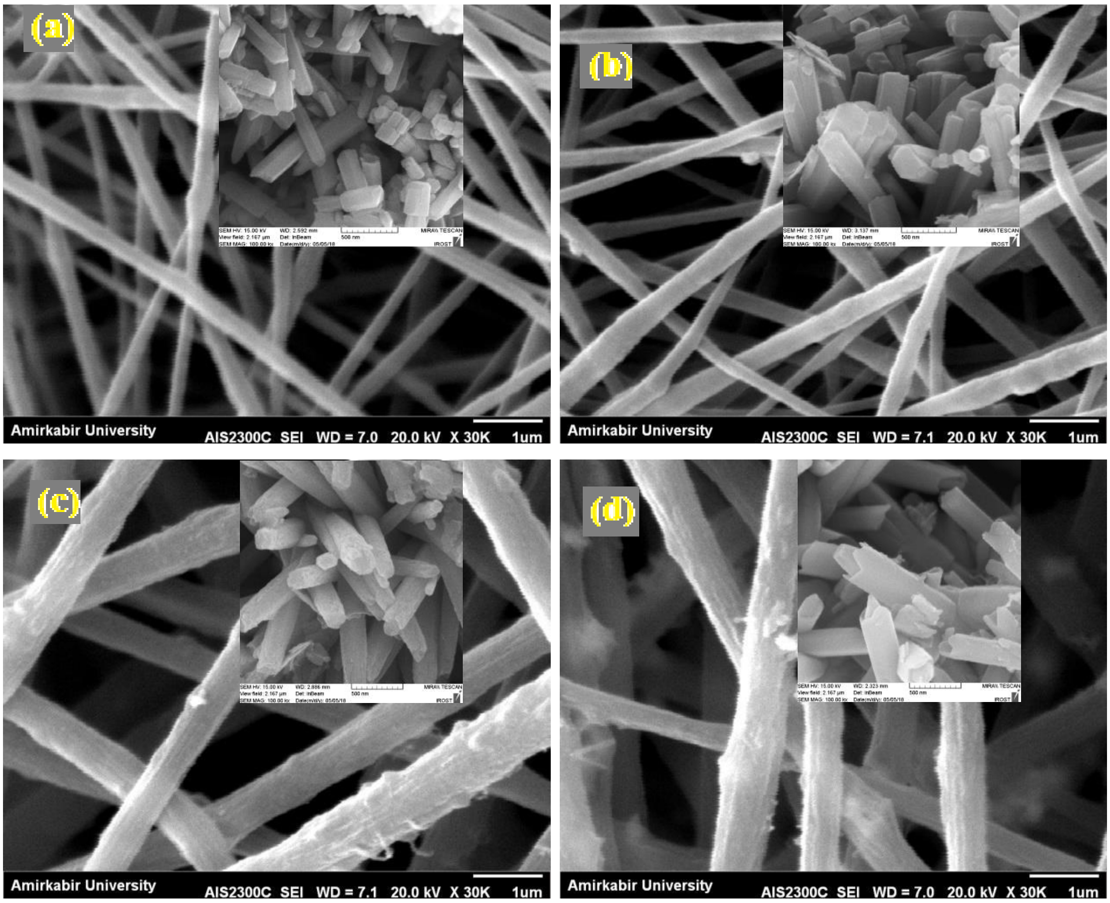
The nanofibers' crystalline structure is analyzed by XRD (Equinox 3000 model, INEL France Co.) with Cu-Kα radiation (wavelength 0.154 nm); where the samples are scrutinized with 2θ in range (5-60°). A scanning electron microscope (SEM, model: AIS 2100, South Korea) was used to characterize the morphology of nanofibers. So, PC an oscilloscope measured electrical response piezoelectric at room temperature.

Result and Discussion:

The experimental part and XRD, FESEM, and SEM of synthesis ZnO powder and the nanofibers of nanocomposites ZnO/PVDF were well identified from the previous work of Raad & Amel in 2019 [11].

Output Measurement of PVDF/ZnO:

Fabricated and scrutinized flexible generator (sensors) composed of the composites PVDF with different concentrations of synthesis ZnO NPs. It is experimental that ZnO NPs are well connected in PVDF. FE-SEM images in Figs. 2 confirm ZnO NP powder synthesis by hydrothermal process inside images SEM of composite PVDF/ZnO nanofibers, interactions between chains PVDF and ZnO NPs cause to stretch- crystalline β-phase which improvement well efficient self-generated electronic devices.



Figs. (2): Show FE-SEM morphologies characterization of nanofibers with images of synthesis ZnO powder inside its: (a)18% ZnO–14% PVDF (b)18% ZnO–16% PVDF (c)20% ZnO–16% PVDF (d)22% ZnO–16% PVDF

Table 1 can perform that piezoelectric output increases with increasing the additions of ZnO to the PVDF matrix of 18%ZnO–14%PVDF and 18%ZnO–16%PVDF from 480mV to 1600mV respectively. While the output voltage began decreasing with increasing of ZnO in 20%ZnO–16%PVDF and 22%ZnO–16%PVDF from 1020mV to 620 mV, in addition, to an increase in the diameters from 6.6nm to 7.4 nm respectively by using Image J.

Table (1): Demonstration of the nanocomposite, PVDF/ZnO fabricates the nanogenerators & their measured output piezoelectric.

Samples	Shape	Diameter in (nm)	Output Piezoelectric in (mV)
18%ZnO–14%PVDF	Nanosticks& nanorod	4.6	480
18%ZnO–16%PVDF	Nanorod	2.7	1600
20%ZnO–16%PVDF	Nanorod	6.6	1020
22%ZnO–16%PVDF	Nanotube	7.4	620

Fig. 3 illustrates the relation between the outputting piezoelectric of ZnO NPs composite with PVDF matrix and the diameters of ZnO/PVDF nanofibers. Wherever the results of piezoelectric output voltage harvest by tapping the finger of the hand was decreasing when increasing the content ZnO NP due to a decrease in the induced β-phase when increasing adding ZnO NPs concentration to a solution of PVDF as indicated in the references [12-14].

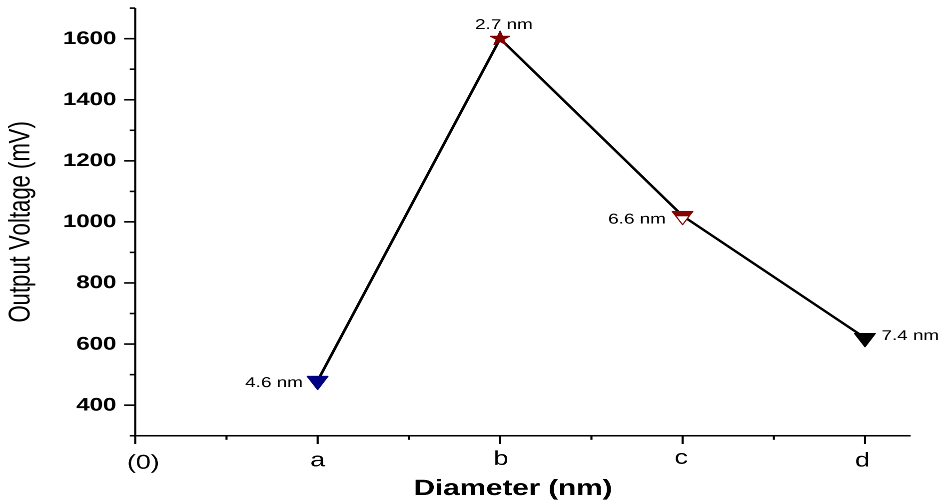


Fig. (4): Output voltage of nanocomposite ZnO/PVDF nanofibers: (a) 18% ZnO–14% PVDF (b) 18% ZnO–16% PVDF (c) 20% ZnO–16% PVDF (d) 22% ZnO–16% PVDF

Due to many previous works executed by the author in other papers were published in the same field (Piezoelectric) of pure and composite PVDF with ceramic $BaTiO_3$ NS pulse ZnO NPs, therefore, can be scrutinized that many parameters can affect the resulted output piezoelectric such as; [molar number, morphology, diameter, distribution of the final shape, concentration, high-voltage, the flexibility of generator, and in this paper can add the mechanism used to harvest the outputting piezoelectric], where the sensitivity of the generator can be affected by the way of force which applied to achieve the principal's piezoelectric [11, 15, 16].

Conclusion:

The development in the use of piezoelectric nanostructured materials to harvest effective power as of vibration of the human body for energy harvesting uses the mechanical tapping of the ZnO/PVDF nanocomposite fibers by the finger of a hand. The sensitivity to energy harvesting is very apparent towards the effect of the piezoelectric, which in conversion depends on the structure and concentration of the sample used. The researcher has shown in this research that when, less amount of ZnO which with less diameter in (nm), and with shape nanorod added to the PVDF matrix, enhances to have a high output voltage. So, it is possible to take advantage of this sensitivity in medical applications related to the human body or other applications.

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