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Step Synthesis, Electrical Generator of PVDF/CNTsPiezoelectric

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Abstracts:
The piezoelectric is a material that can convert mechanical energy into electrical energy and can convert electrical energy into mechanical energy. It is a device that is fabricated from a piezoelectric material. It may be in the elemental form or composite materials in general. The composite material, or composite material, was one material as the main body and the other was the first dispersed material using polyvinylidene fluoride (PVDF, $(C_2H_2F_2)_x$) powder, PVDF1% by fill weight. 6 samples were doped with carbon-nanotube CNT powder, 0.001%, 0.002%, 0.003%, 0.004%, and 0.005%. The N-Methyl-2-pyrrolidone solution. [NMP (C_5H_9NO)]20 mL, the solution was rolled, casting tape at 80 C°, then extruded and molded to 200 μm thick. The film was inspected with XRD to determine the structure from preparation to make the pole with silver glue. Conducted to arrange the electrodes with a 1.5 kV / 200μm field was conducted to arrange, the dielectric coefficient d_{33}-2.90 to 9.77 pC/N, the highest of 3wt% in 6 samples was measured, measure the potential difference 21.2V was also measured, the highest value 3wt%. Maximum current at 0.3μA, maximum power 230 μW, respectively, the capacitance of 0.1μF, the potential difference at 2.9V, as a result of the application to wind turbines. 3V at a frequency range of 1-15Hz.

***Keywords**:PVDF materials, synthesis Piezoelectric, Electrical properties.*

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I. Introduction

Energy is essential to human beings. There are many forms of energy such as thermal energy, optical energy, electrical energy, mechanical energy which can be transformed from mechanical to electrical energy. The piezoelectric is a material that can convert mechanical energy into electrical energyand can convert electrical energy into mechanical energy as well. May be in elemental form or composite materials in general composites, or composite materials, where one type of material as the main body and the other being the dispersed material of the first material. The combined components differ in form and form. Chemical elements and are not mutually solvent. The original properties of each component will have one of the more prominent properties, resulting in a new material with all the good properties of the substrate [1-3]. The piezoelectric composite material is fabricated. Is polyvinylidene-fluorine and carbon-nanotubes. The prepare polyvinylidene-fluoride (PVDF, $(C_2H_2F_2)x$), is a material with some outstanding properties such as high flexibility and flexibility[4-6]. Has a smooth finish without the need for polishing. It is lightweight, can be rolled into a thin sheet, and has multiple production processes. The carbon nanotubes are good electrical and thermal materials. When it is fabricated as a composite material[7-11]. A good electrical piezoelectric element is expected to be useful for other electrical and electronic measurement applications.

II. Material And Methods

Preparation of substances.

Prepare polyvinylidene fluoride (PVDF, $(C_2H_2F_2)_x$), white powder, weigh 1 gram of 6 samples in a test glass tube, sealed with aluminum foil, then carbon nanotubes. (MWCNT) multi-walled black powder, weighing 0.001 grams, 0.002g, 0.003g, 0.004g, 0.005g respectively, stored in 5 test tubes. Next, measure the N-Methyl-2-pyrrolidone solution. [NMP (C_5H_9NO)] White clear liquid Get a volume of 20 ml., Amount 6 samples respectivelyFigure1.

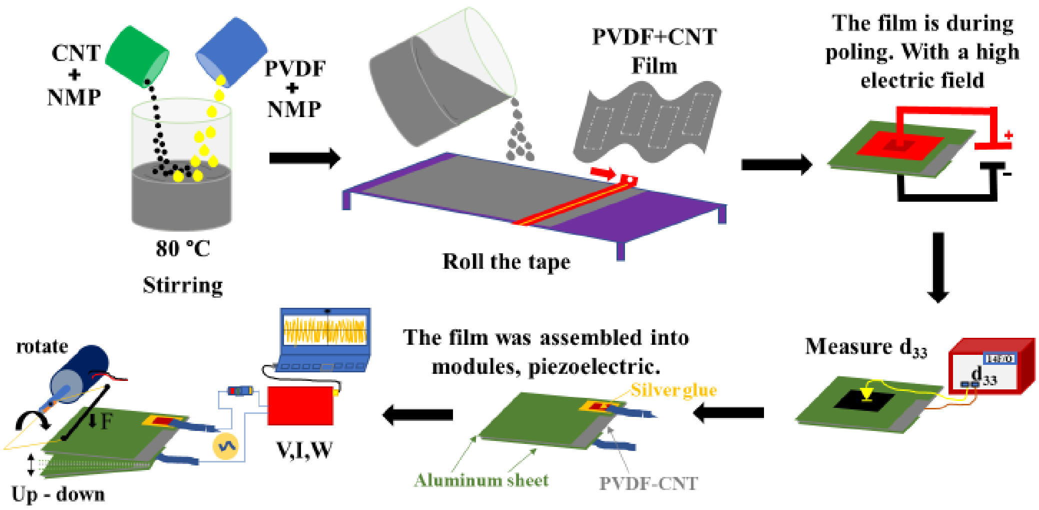

Figure1.Simulation of the process of invention of the piezoelectric coefficient measurement and electrical measurement.

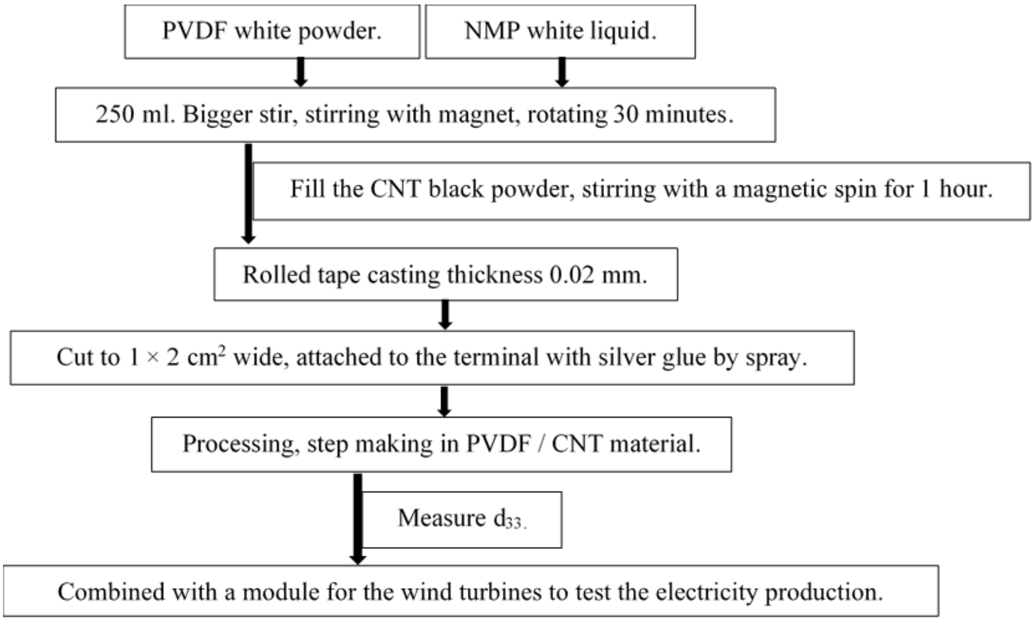

Figure2.Procedure sequence for the experiment in making a piezoelectric device.

Materials preparation of Piezoelectric samples.
Prepare the solution.

The next step is to prepare an unused carbon PVDF solution. Take 20 ml of NMP solution and pour it into a 250 ml bigger, then place it on an electric stove that was set to a temperature of 80C° after that. Pour 1 g of PVDF powder into a bigger containing patterned material, then stirwith a magnetic spin for 1 hour. Example 1 is a solution that dissolves into white, bright, carbon-nanotube PVDF. The next step is to prepare the PVDF-CNT solution with carbon-nanotubes. By pouring 20 ml of NMP solution into 250 ml of the bigger, then place on the electric stove with temperature setting at 80 C°, then pour the 1 g PVDF powder into the bigger containing the substance is then stirred and stirred by a magnet to spin autism. Take 30 minutes and then mix the carbon nanotubes into the solution. Example 2 is a solution that dissolves into a thin black color. After spinning for 1 hour, PVDF-CNT with carbon nanotube 0.001g was obtained. Example 2,the next step is to prepare the sample at 3,4,5,6 like the 2nd sample, respectively.

Rolled casting tape.

Next, take the solution 1-6 to roll the tape. By bringing each sample solution to be poured ontoa sheet of tape extruder containing heat, adjust the temperature to 80 C° and then extrude the PVDF solution to a thickness of 0.02 mm. After that, wait for the PVDF solution to evaporate the solvent. after 30 minutes, it will turn into a solid film tape. After letting it cool down, will get a film tape. Piezoelectric PVDF example 1 and example 2-6 perform the casting of the same type of film tape, respectively.

Measure structure.

Measurement of d_{33} / hysteresis / XRD / FTIR

The synthesized samples were analyzed with d_{33} YE2730-d_{33}Meter / Fourier Transform Infrared Spectroscopy (FT-IR) using VERTEX 70 using 532nm lasers in the wavelength of 400–1,400 cm^{-1} / X- analysis. Ray diffraction (XRD) is achieved by SHIMADZU-LABX-XRD-6100 / TREK dielectric meter MODEL20 / 20c-Hs HIGH VOLTAGE AMPLIFIER / morphological examination of the above samples using a shining electron microscope.

Module.

Take the PVDF, and PVDF-CNT film tapes,example 1-6 to cut to 1×2 cm^2 in width to do a module. At this stage, prepare a silver glue solution mixed with 1 to 10 distilled water in a spray bottle. Prepare two screens that are strung with a frame that has a screen size of 0.9×1.9 cm^2 in length. Next, take the PVDF film tape to place between the polar screen and spray the prepared silver glue on the screen on both sides, then iron with the screen and remove the PVDF from wait for the screen to dry for 30 minutes and continue for 2-6 samples respectively.

Piezoelectric device fabrication.

The process of fabricating modules PVDF-CNT and electrical measurement results.

Prepare the Piezoelectric PVDF-CNT plate after rolling the tape into the sheet. Cut to 1 cm wide, 2 cm wide, with silver glue on both sides. Top-bottom by not allowing the edges of the electrode to match the top and bottom. After that, dry the silver glue. Lamp with heat to wipe the silver glue. Take it for 1 hour. When the silver glue is dry, check the electrical conductivity of the polarity. Piezoelectric PVDF-CNT then leads the pole after the pole was finished to coat the Piezoelectric sheet PVDF-CNT with hot-rolled plastic, size 1.2 cm wide and 2.2 cm long, then puncture the poles made alternately. Take copper to create a connector. Clamp it to the silver adhesive pad and PVDF-CNT. Tightly closed together.

III. Result and Discussion

Table 1. Preparation of PVDF / CNT / NMP dosage for the preparation of PVDF-CNT piezoelectric solution.

EXPT NO	PVDF	Additive	Solvent
1	1g	-	20cc NMP
2	1g	0.001g CNTs	20cc NMP
3	1g	0.002g CNTs	20cc NMP
4	1g	0.003g CNTs	20cc NMP
5	1g	0.004g CNTs	20cc NMP
6	1g	0.005g CNTs	20cc NMP

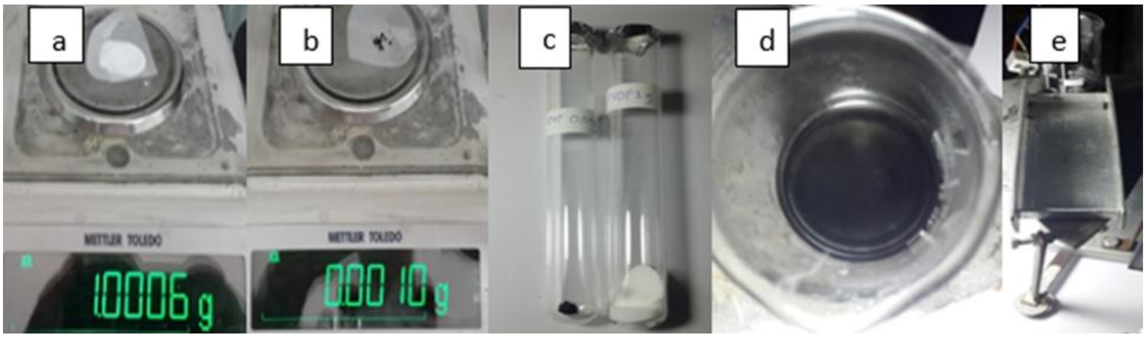

Figure3.Shows PVDF content (a), CNT content (b), PVDF-CNT preparation in vitro(c),dissolved PVDF-CNT effect in NMP (d),extrusion solution to casting tape (e).

When analyzing the polymer with X-ray diffraction technique (XRD), it was found that the form of adding carbon nanotubes to 1wt% -5wt% polyvinylidene fluoride had an effect. To the internal structureusingthe sample, there is a mixed crystal structure α and β. In every substance, it was also found that the deflection angle shifted to a higher value when the carbon nanotube added percentage shown in figure 4.The addition of carbon nanotubes in polyvinylidene fluoride changes within the internal structure.

When the results were analyzed by Fourier Transform Infrared Spectroscopy of Polymer Materials (PVDF) techniques with the addition of carbon nanotubes (CNT) by percentage weight (1wt%, 2wt%, 3wt%), 4wt%, 5wt%) into the structure of polyvinylidene fluoride by analysis from Fourier Transform Infrared Spectroscopy (FTIR) technique. As showninfigure 5, it was found that (frequency) or wave number (wave number)PVDFat613.01cm^{-1},871.42 cm^{-1},1179.42 cm^{-1}, 1401.57 cm^{-1} / PVDF-CNTwt1% at 613.02cm^{-1},871.53 cm^{-1},1179.55cm^{-1},1401.54 cm $^{-1}$PVDF-CNTwt2% at 613.06cm^{-1},871.56 cm^{-1},1179.42cm^{-1}, 1401.37 cm^{-1} / PVDF-CNTwt3% at 613.12cm^{-1},871.67 cm^{-1},1179.65cm^{-1}, 1401.18 cm^{-1} / PVDF- CNTwt4% at 613.15cm^{-1},871.66 cm^{-1},1179.65cm^{-1}, 1401.18 $cm^{-1}$and PVDF-CNTwt5% at 613.00cm^{-1},871.18cm^{-1},1179.69cm^{-1}, 1401.14 cm^{-1}were found to have various peaks. As in the PVDF spectrum, there was no chemical interaction between CNT and PVDF .Thermal stability andthe nanometer addition in PVDF increased after composite with CNT as a result ofquarantinethe movement of the polymer chains with CNT according to the theory of inorganic-polymer composite materials as shown in figure 5.

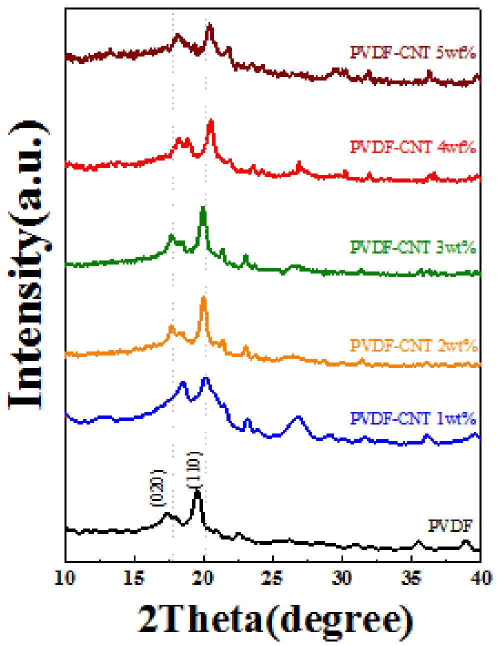

Figure 4.Polymer X-ray diffraction patterns (PVDF-CNT) when conditional nanotubes were added 1wt%, 2wt%, 3wt%, 4wt%, 5wt%, respectively.

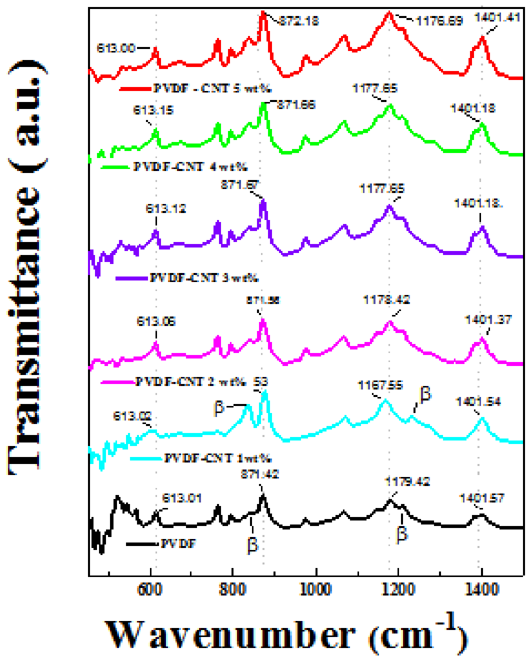

Figure 5.When analyzed by Fourier Transform Infrared spectroscopy of polymer material (PVDF) by adding carbon nanotubes (CNT).

The piezoelectric material obtained by extruding PVDF and PVDF-CNT tape with a thickness of 0.02 mm tape was made by cutting into a 1×1 cm^2 wide sheet and applied with silver glue. In the area of the top-bottom surface of the piezoelectric and leave the edge of the 0.5 mm piezoelectric surface with masking tape and let the silver glue dry, take 2 hours and check the polarity. By testing the completely dry silver glue conductivity, and checking the electrodes above and below the PVDF plate, the piezoelectric was not short-circuited. After that, the polling tool was polled. In which the device has two parts the first part is the Hi-Volt generator set. The second part of the refrigeration unit, the pole, the upper copper plate head, connected to the PVDF plate, the piezoelectric, prepared to glue silver, size 1×1 cm^2. A polling quantity of 6 kV per 1 mm thickness of PVDF, which must be polled at least 0.12 kV potential difference. In the experiment, the polls at 1.5 kV with PVDF-CNT poles ranged from 0%
to 5%, respectively, figure 6 and the measurement results of the d_{33} coefficient are shown in Figure 7.

Figure 6. shows the process of polling the PVDF-CNT

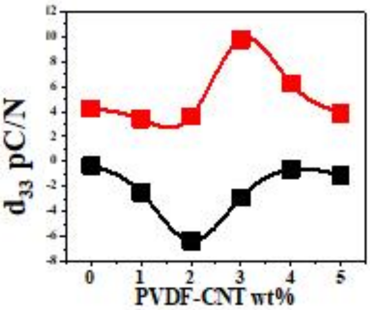

Figure 7. Measurement results of the d_{33} coefficient

The process of fabricating module PVDF-CNT and electrical measurement results

Piezoelectric sheet PVDF-CNT was prepared afterthe extrusion of the tape. Cut to a size width 1cm, length 2 cm, apply with silver glue on both sides top - bottom by leaving the edges of the electrodes not aligned for the top and bottom. After that, dry the silver glue with heat to dry the silver glue completely, take 1 hour.Once the silver glue dries, check the electrode conductivity. Piezoelectric PVDF-CNT, then pole light, after thepole is finished, apply to coat the plate. Piezoelectric PVDF-CNT with hot rolled plastic, 1.2 cm wide, 2.2 cm long, and then pierce the alternating pole. Bring copper to make a connector clamp to the electrode plate with silver glue and PVDF-CNT in Figure 8.

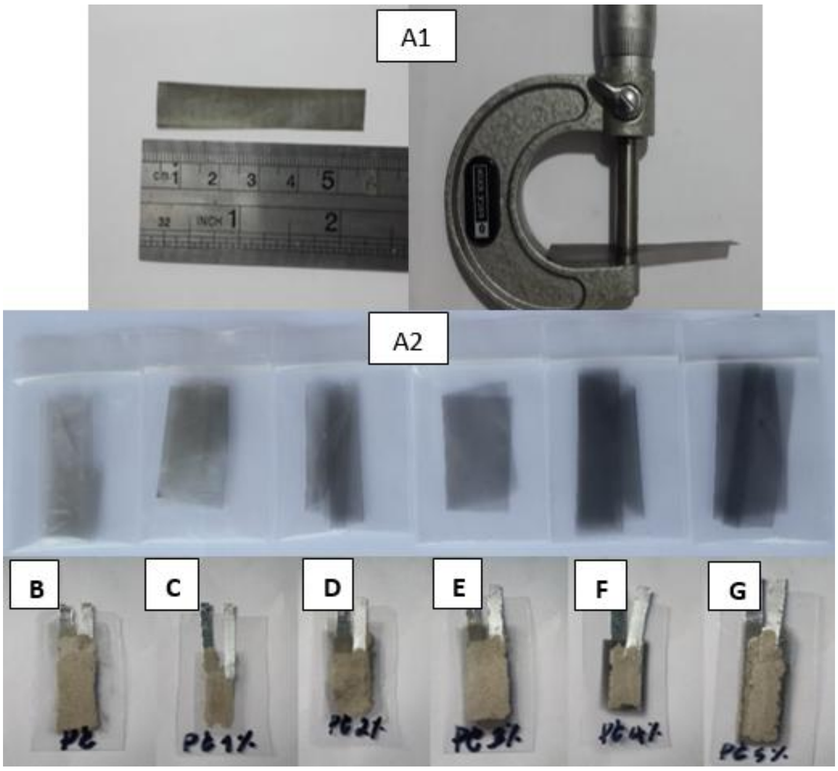

Figure 8. The model of P/C piezoelectric device design (A1,A2) PVDF (B) PVDF-CNT1% (C) PVDF-CNT2% (D) PVDF-CNT3% (E) PVDF-CNT4% (F) PVDF-CNT5%(G).

Electrical measurement procedure PVDF-CNT 0% to5% from the PVDF-CNT adulpisoelectric module is applied to a mechanical force device that is made into a device that can be applied to the surface of the adulpisoelectric surface. Rick connect the piso electrode to the probe of the oscilloscope. Connect it to the notebook, display on the screen and adjust the PVDF-CNT piezoelectric voltage measurement value from 0% to 5%. The result of the average voltage measurement of 3.8V, 4.9V, 8.1V, 21.2V, 7.9V, 6.1V, respectively, as shown in Figure 9. The effect of the electric voltage with the greatest percentage of CNT is 3%, as shown in Figure 10. At 230 μW shown in Figure 11, the effect ofthecapacitance of 0.1μF, voltage at 2.9 V, 1 μF, voltage at 1.5V, 10 μF, voltage at 1.2 V is shown in Figure 12.

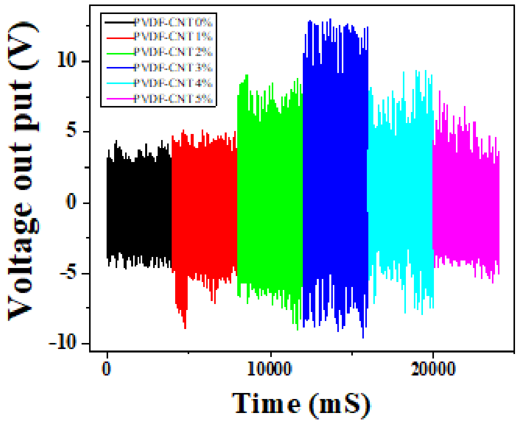

Figure9.The results of the measurement of average voltage difference 0% to5% at 3.8V, 4.9V, 8.1V, 21.2V.7.9V, 6.1V.

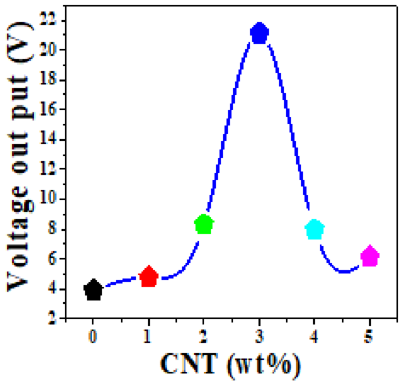

Figure 10.The effect of the electric potential difference with the largest percentage of CNT is 3%.

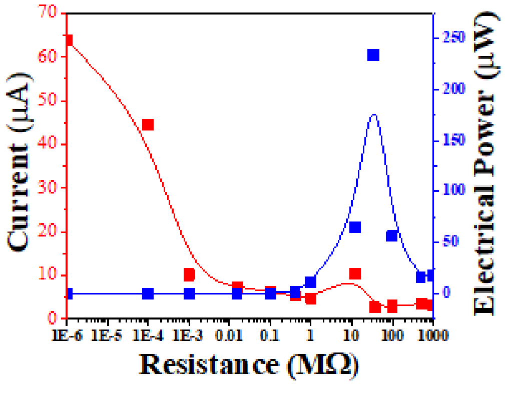

Figure 11. Effect of the maximum power output at 230 μW.

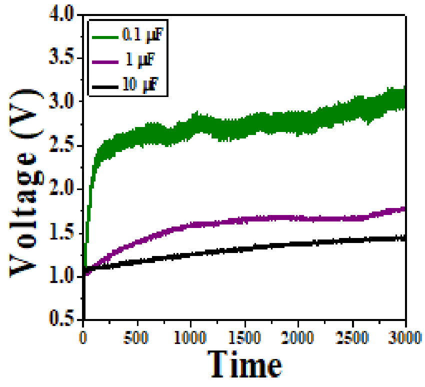

Figure 12. Effect of capacitance 0.1μF voltage at 2.9 V, 1μF voltage at 1.5V, 10μF potential difference at 1.2V.

Measure the electric potential of Piezoelectric electricthat is attached to the wind turbine vertical axis with a height of 1.5 meters, a radius of 1.2 meters wide, with 6 air receipts. Take the module with the piezoelectric attached to the vertical axis of the wind turbine. Then when the branchesofthe wind turbine rotates at a speed of 0.1Hz,1Hz,5Hz,10Hz,15Hz with mechanical energy causing the branches to touch pushing the module piezoelectric to bend which is attached to the center axis and therefore diverting electricity and measure the electric voltage with an oscilloscope.The electrical output comes in a periodic ripple which results from the turbine branches which has a gap of 6 branches per rotation and the potential difference average at 1.1V,1.8V,3.5V,4.8V,5.3V as in Figure 13.

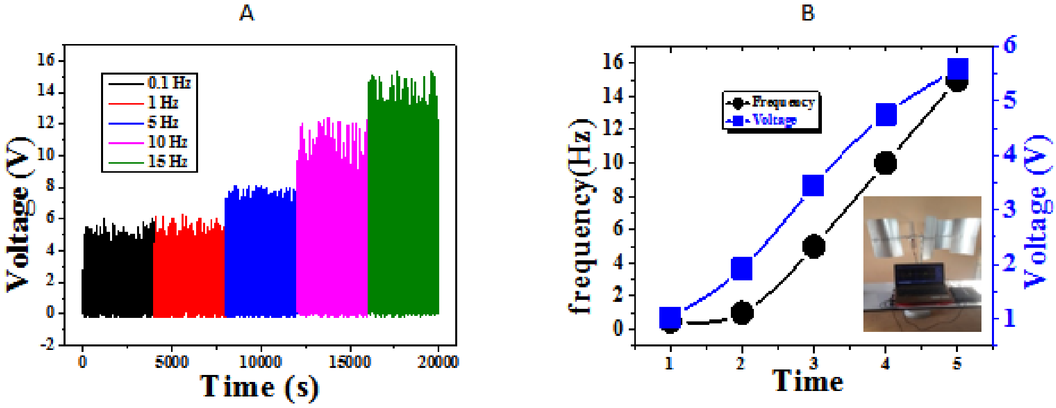

Figure 13. Shows the electric potential difference piezoelectric obtained from the rotation of the wind turbine at a speed of 0.1-15Hz(A) and the potential difference average at 1.1V,1.8V,3.5V,4.8V,5.3V (B)

IV. Conclusion

The 6 samples were prepared from PVDF-CNT piezoelectric material at a ratio of 1 g PVDF per CNT 0wt%, 1wt%, 2wt%, 3wt%, 4wt%, 5wt% dissolved in NMP 20mL solvent atatemperature of80 C° Rolled tape with a thickness of 200 µm at a temperature of 100 C°. Polarized by anelectric field of 1.5kV / is composed of 6 samples of 1x2 cm^2 piezoelectric device by structural inspection. The microstructure of the PVDF-CNT with XRD, FTIR, measure the photocatalytic coefficient. d_{33}, measuring electrical values, it was found that the peak angle at XRD at 020,110, the highest value d_{33} -2.9,9.7 3wt% in 6 samples. 3wt%, maximum current at 0.3µA, maximum power 230 µW, respectively, the capacitance effect 0.1µF, the potential difference at 2.9 V, as a result of theapplication to wind turbines. 3V at a frequency range of 1-15Hz.

Acknowledgments

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