PIEZOELECTRIC NANOGENERATORS BASED ON PVDF-HFP/ZNO MESOPOROUS SILICA NANOCOMPOSITES FOR SELF-POWERING DEVICES

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1. Introduction

Due to the rising global concern over **energy catastrophe** and **environmental issues**, attention has been diverted towards future energy. In recent times, **rechargeable power** and **renewable energy sources** have been considered as an attractive substitute for resolving the future environmental problems. Among them, mechanical energy is one of the most abundant energy sources, and easily transformable to other useful energy forms, such as electrical energy. For such purposes, **piezoelectric materials** with ability to convert the **mechanical energy** generated by various activities into **electrical energy**. This study explores the **morphology, structure** and **piezoelectric performances** of **nanocomposites** fabricated by **electrospinning**.

2. Methodology

- **Mesoporous silica nanoparticles** prepared by sol gel method
- **zinc oxide nanoparticles** prepared by Precipitation method
- **nanocomposite solution** prepared by solution mixing method
- **Five different types of PVDF nanocomposites** prepared by Electrospinning

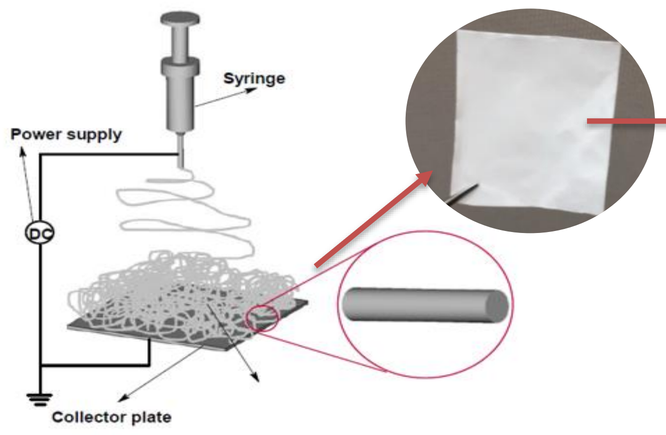

Figure 1: Schematic of the electrospinning set up.

Five different types of PVDF nanocomposites:
1. Neat PVDF-HFP.
2. PVDF-HFP/ZnO.
3. PVDF-HFP/Mesoporous silica.
4. PVDF-HFP/1% ZnO-Mesoporous silica.
5. PVDF-HFP/3% ZnO-Mesoporous silica.

3. Results and Discussion

3.1 Samples Characterization

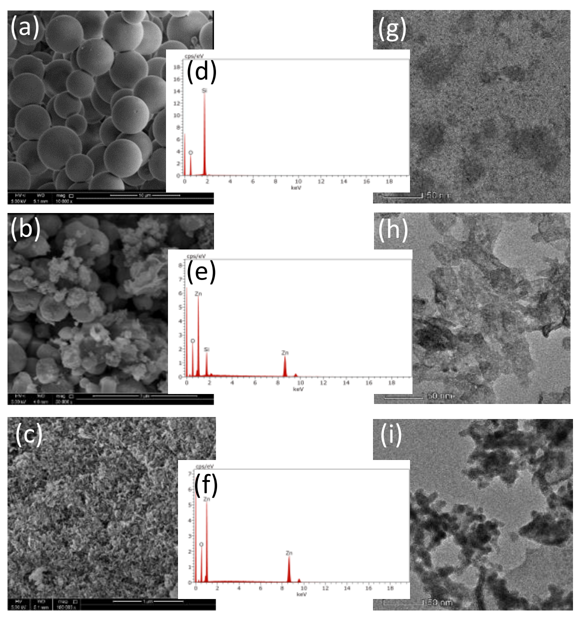

Figure 2: (a-c) SEM images (d-f), EDX plots (g-i), TEM images of ZnO and Mesoporous silica and ZnO-Mesoporous silica composites respectively.

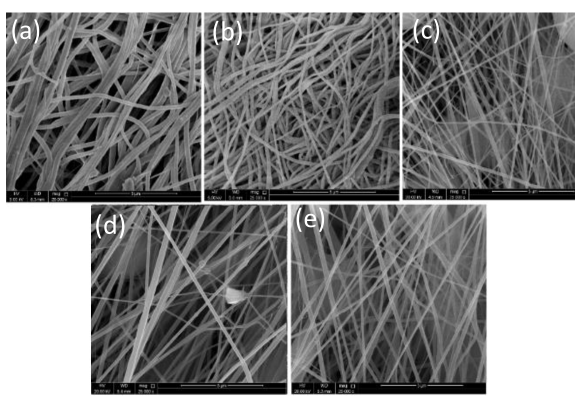

Figure 3: SEM images of electrospin fibers:a) Neat PVDF, b) PVDF-ZnO, c) PVDF-Mesoporous Silica,d) PVDF- ZnO-Mesoporous silica-1%, e) PVDF- ZnO-Mesoporous silica-3%.

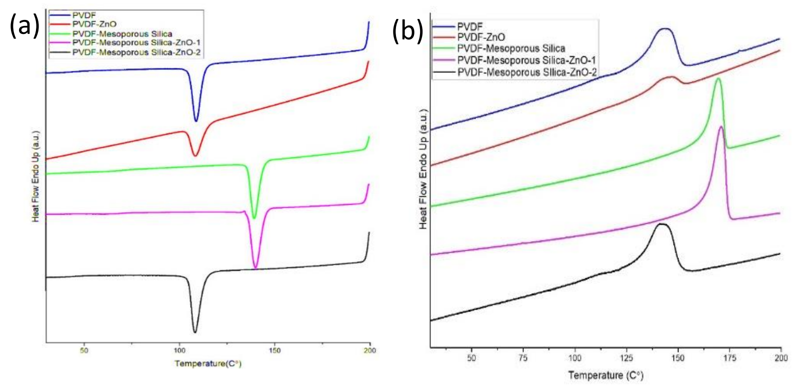

Figure 4: DSC curves of a) pure PVDF-HFP, b) PVDF-HFP nanocomposites.

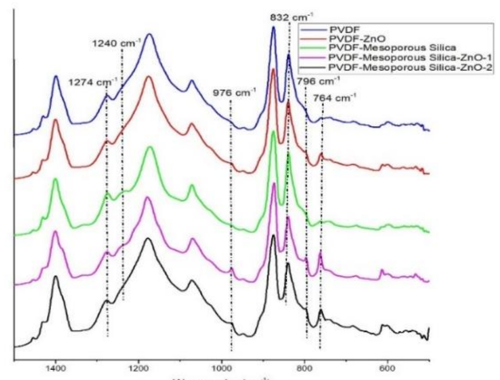

Figure 5: FTIR spectra of neat PVDF and the PVDF-nanocomposites.

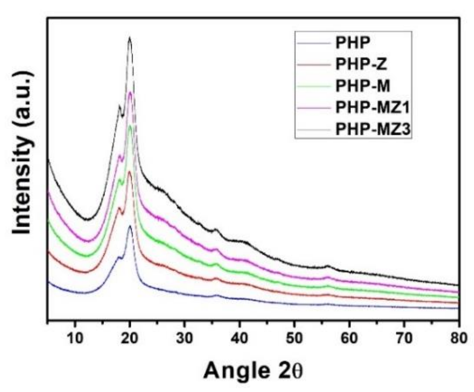

Figure 6: XRD spectra of neat PVDF and the PVDF-nanocomposites

3.2 Application

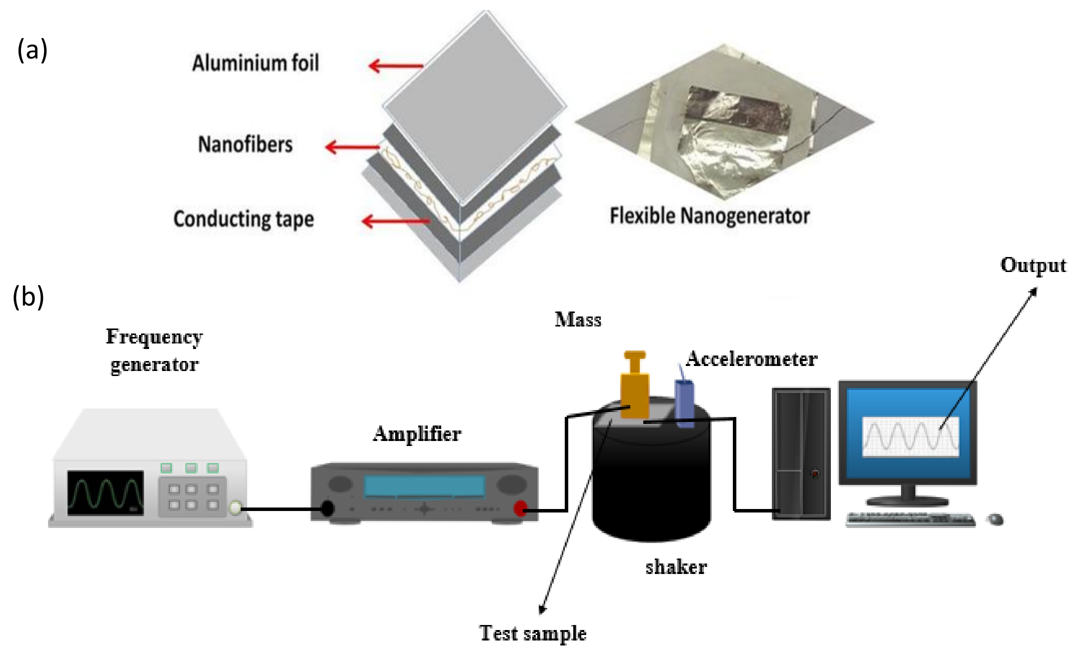

Figure 7: Schematic representation of (**a**) flexible nanogenerator and (**b**) piezoelectric experimental setup.

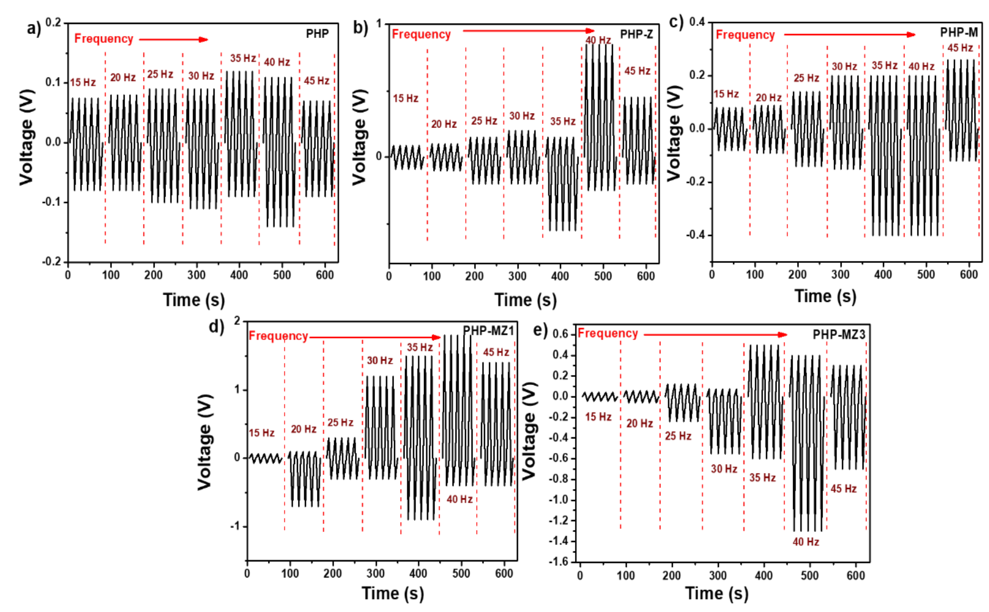

Figure 8: Generation of output voltages from neat PVDF-HFP and its nanocomposites.

4. Conclusion

- Five different types of PVDF nanocomposites are used to obtain electrospun membranes prepared using the technique of electrospinning.
- All the samples are tested for piezoelectric response within the frequency range of 20-50 Hz. The sample with 1% ZnO-Mesoporous used nanofiber was successfully silica shows the best response with 1.4 mV.
- These results indicate that the investigated nanocomposites are appropriate for fabricating various flexible and wearable self-powered electrical devices and systems.

5. References

1. Martínez-Ayuso, G., et al. (2017). "Homogenization of porous piezoelectric materials." International Journal of Solids and Structures 113-114(Supplement C): 218-229.
2. Priya, Shashank, and D. J. Inman. Energy harvesting technologies. Springer, 2010

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