IOCN 2025 Conference
The 5th International Online Conference on Nanomaterials
22–24 September 2025 | Online
MDPI

Piezoelectric-Like Response and Energy Harvesting Potential of a Moldable PVA/PANi Composite Prepared via Frozen-Gel Polymerization

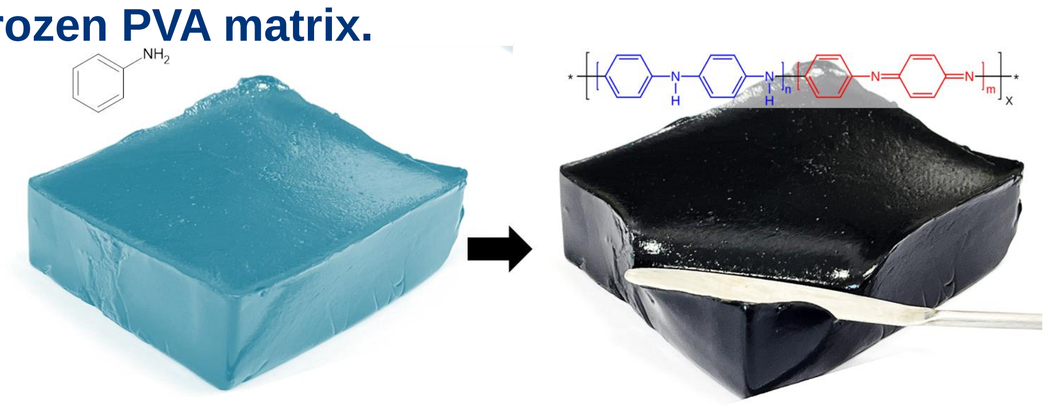
Andrei Honciuc*, Mirela Honciuc, Ana-Maria Solonaru
"Petru Poni" Institute of Macromolecular Chemistry, 41A Gr. Ghica Voda Alley, Iasi, 700487, Romania
honciuc.andrei@icmpp.ro

INTRODUCTION & AIM

Soft, stretchable materials that convert mechanical motion into electricity are paving the way for next-generation wearable and self-powered devices. This work aims to develop and characterize a soft, moldable composite material based on poly(vinyl alcohol) (PVA), glycerol, and polyaniline (PANi), prepared via a frozen-gel polymerization route. The objective is to explore its electromechanical behavior, particularly its ability to generate electrical signals under mechanical deformation, resembling a pseudo-piezoelectric response.

METHODS

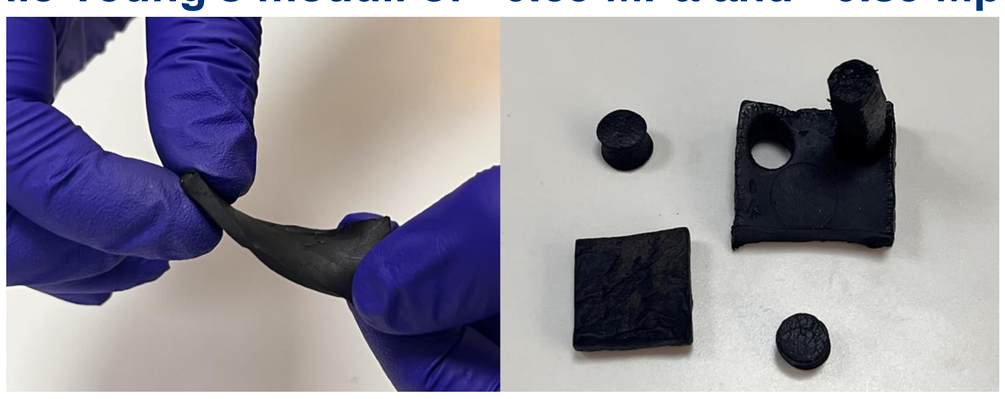
- **Synthesis and processing of the PVA/PANi composite into a dry, rubber-like elastomer, via polymerization of the aniline monomer inside a frozen PVA matrix.**



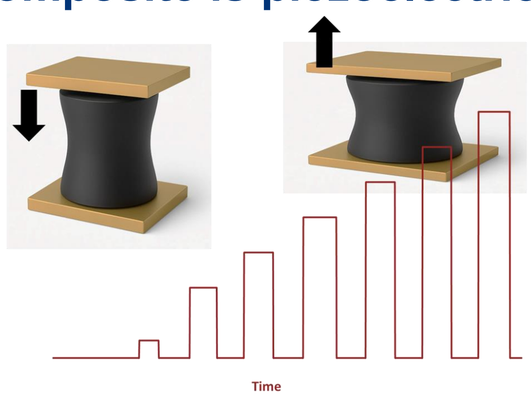
- **Mechanical characterization was performed under compression and tension to evaluate elasticity, hysteresis, and strain recovery.**
- **Electrical measurements (I–V sweeps, open-circuit voltage, short-circuit current) under dynamic strain to assess energy harvesting potential.**
- **We have measured both short-circuit current (I_{SC}) and open circuit voltage (V_{OC}) with deformation, at very low strain.**

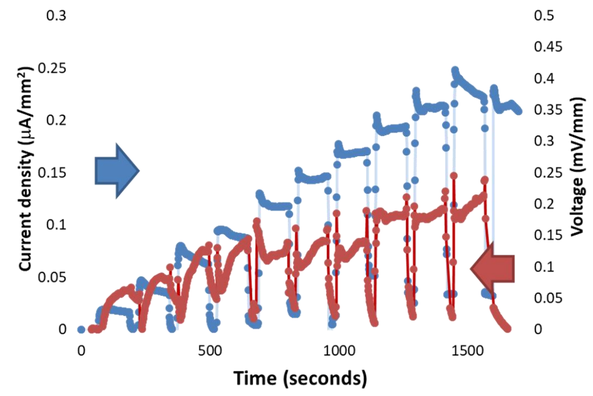
RESULTS & DISCUSSION

We have obtained a moldable and stretchable PVA/PANi composite material, with a compressive and tensile Young's moduli of ~0.69 MPa and ~0.89 Mpa.

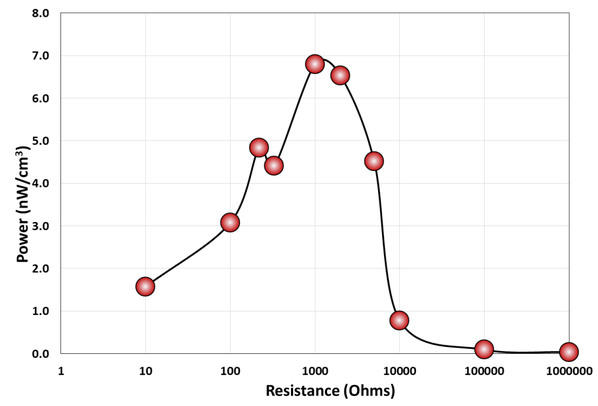


The strong I_{SC} and V_{OC} responses measured upon an oscillatory mechanical compression (up to 4.6% strain) and decompression cycles indicate that the composite is piezoelectric.

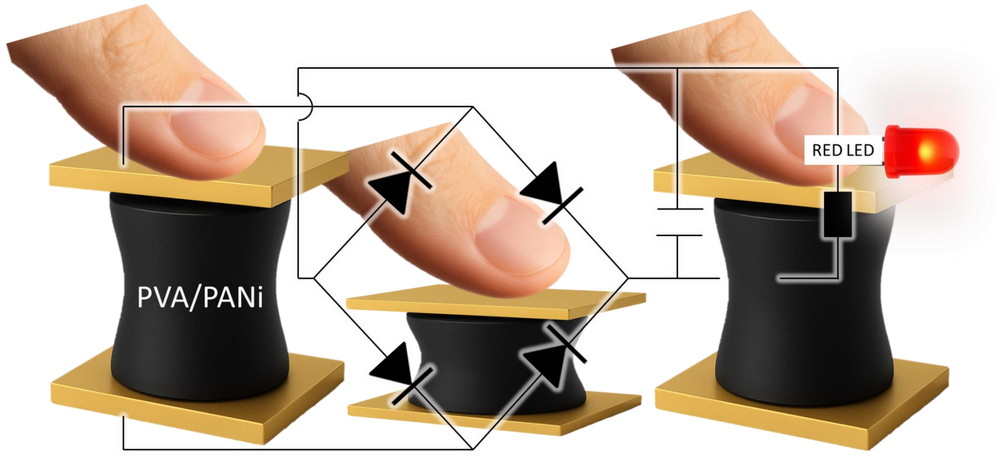




The maximum power density extracted under periodic strain and matched load conditions reached ~7 nW/cm³ at 1 kΩ [1].



Charge storage and energy harvesting were demonstrated by repetitive pressing cycles on the PVA/PANi composite, integrated in a rectifier circuit, capacitor charging and LED lightning.



CONCLUSION

PVA/PANi composite is a viable candidate for low-frequency, low-power mechanical energy harvesting and sensing, especially suitable in soft, flexible, and biocompatible wearable electronic components. Its facile synthesis, moldability, and piezoelectric response offer a promising platform for next-generation soft electronic materials [1,2].

REFERENCES

1. Honciuc, A.; Honciuc, M.; Solonaru, A.-M. ACS Appl. Electron. Mater. 2025, 7, 7776–7790, doi:10.1021/acsaelm.5c01140.

2. Honciuc, A.; Honciuc, M.; Solonaru, A.-M. Journal of Colloid and Interface Science 2024, 668, 37–49, doi:10.1016/j.jcis.2024.04.147.