

Electronic supplementary Information (ESI)

A study on electroactive PVDF/mica nanosheet composites with enhanced γ -phase for capacitive and piezoelectric force sensing

Mohammed Khalifa¹, Elisabeth Schoeffmann¹, Herfried Lammer¹, Arunjunairaj Mahendran¹, Guenter Wuzella^{1*}, S. Anandhan^{2*}

S1. Sensor setup

To prevent the nanogenerator from generating pseudo signals, great care was taken while preparing the setup. The cross sectional view of the PMNC-X nanogenerator is shown in **Fig. S1**, which confirmed that there was no gap between the electrodes and the PMNC-X, which significantly reduced pseudo signals and triboelectric effect.

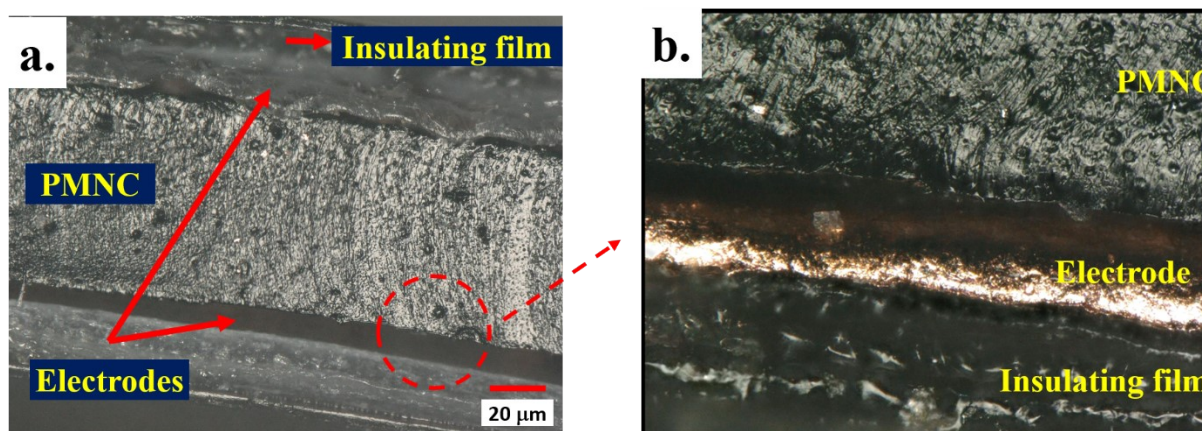


Fig. S1 a) and b) Microscopic images illustrating the cross section of PMNC-X based nanogenerator.

For the piezo-capacitance measurement of PMNC-X, copper electrodes were pasted onto the insulating plastic sheet. PMNC-X based nanogenerator was sandwiched between the electrodes. At the periphery of the electrode, a thin layer ($<10 \mu\text{m}$) of polyurethane film was attached to prevent the external effects and to provide the necessary cushioning effect (**Fig. S2a**). However,

it is important to note that the TPU film does not have any role in generating the piezo-capacitance output. A similar setup was built for studying the piezoelectric performance of the PMNC-X nanogenerator, but without the polyurethane film as shown in **Fig. S2b**. For the durability test, three layers of PMNC-1.0 were sandwiched between the electrodes **Fig. S2c**.

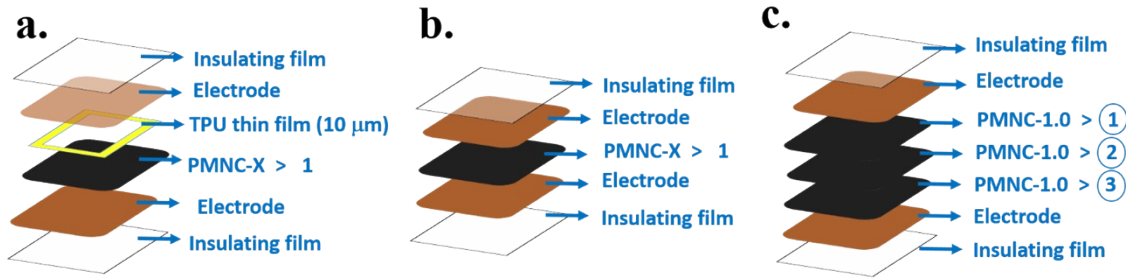


Fig. S2 Setup used for the evaluation of a) Piezo-capacitance based pressure sensor; b) Monolayer (PMNC-X) piezoelectric sensor; c) Three layers of PMNC-1.0 sandwiched between the copper electrodes for repeatability test.

S2. FTIR analysis

Fig. S3 shows the influence of fast cooling of PVDF films on the γ -phase of PVDF. PVDF films were heated above its curie temperature and rapidly cooled down at $-20\text{ }^{\circ}\text{C}$. The sudden cooling of PVDF films restricts the growth of α -crystals. As a result, the electroactive phase of PVDF was increased to $\sim 45\%$, whereas slow cooled PVDF film showed 21.9% of electroactive phase.

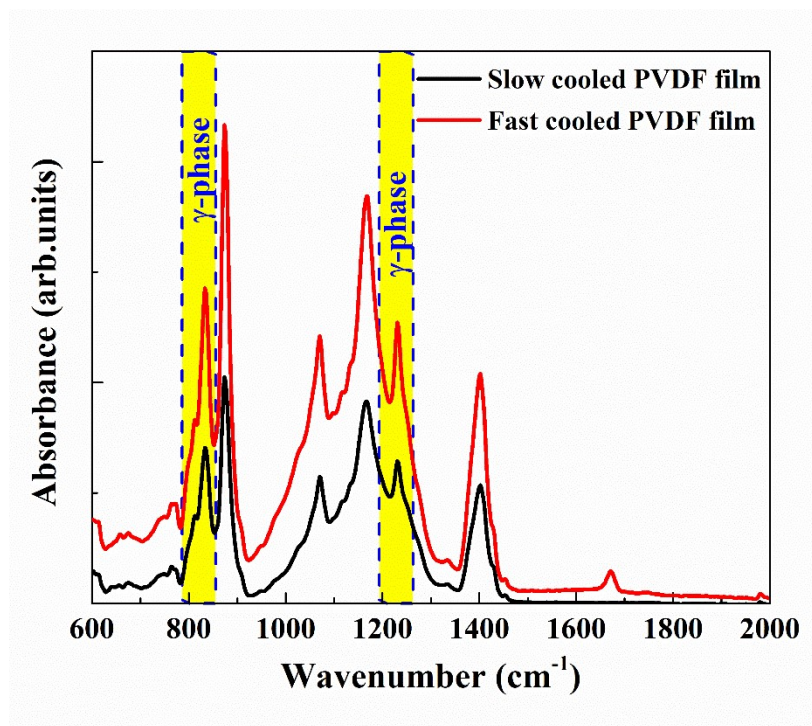


Fig.S3 FTIR spectra showing the influence of slow and fast cooling of PVDF films.

S3. Piezoelectric performance of PMNC-X

Prior to the piezoelectric test, switching polarity test was carried out as described elsewhere [1–3], to confirm that the voltage output generated was solely due to the piezoelectric effect and there was no influence of static charges, pseudo signals or triboelectric effect. **Fig. S3** shows the voltage output of PMNC-X in forward and reverse connection. Upon reversing the connection, the generated voltage output of PMNC-X was the same confirming that the voltage output was exclusively due to the piezoelectric effect.

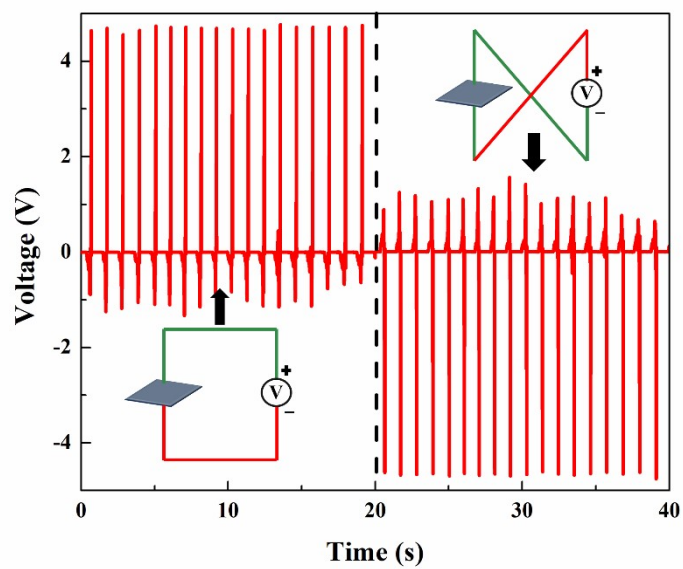


Fig. S3 Voltage output of PMNC-X in forward and reverse connection.

1. M. Khalifa and S. Anandhan, *J. Polym. Res.*, 2019, **26**, 1–13.
2. Z. Pi, J. Zhang, C. Wen, Z. bin Zhang and D. Wu, *Nano Energy*, 2014, **7**, 33–41.
3. K. Shi, B. Sun, X. Huang and P. Jiang, *Nano Energy*, 2018, **52**, 153–162.