# Development of self-poled PVDF/MWNTs flexible nanocomposite with boosted electroactive β-phase

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## S1 Porosity analysis

For porosity calculation, the sample were cut into $10\ mm \times 10\ mm$ square and thickness we about ~ 0.007 cm and weighed using an analytical balance. Further, each sample were repeated for 3 times to give an average porosity and calculated using the following equation.[1]

$$P\ (\%) = \left(1 - \frac{\rho_1}{\rho_0}\right) \times 100\% \tag{1}$$

Where $P$ is the porosity, $\rho_0$ and $\rho_1$ are the densities of the dense polymer (PVDF~$1.78\ g/cm^3$) and the porous film, respectively. Porosity must be measured over an appropriately sized volume, so that localized homogeneities in the porous structure do not affect the results. The porosity of the prepared film are calculated and depicted in Fig. S1

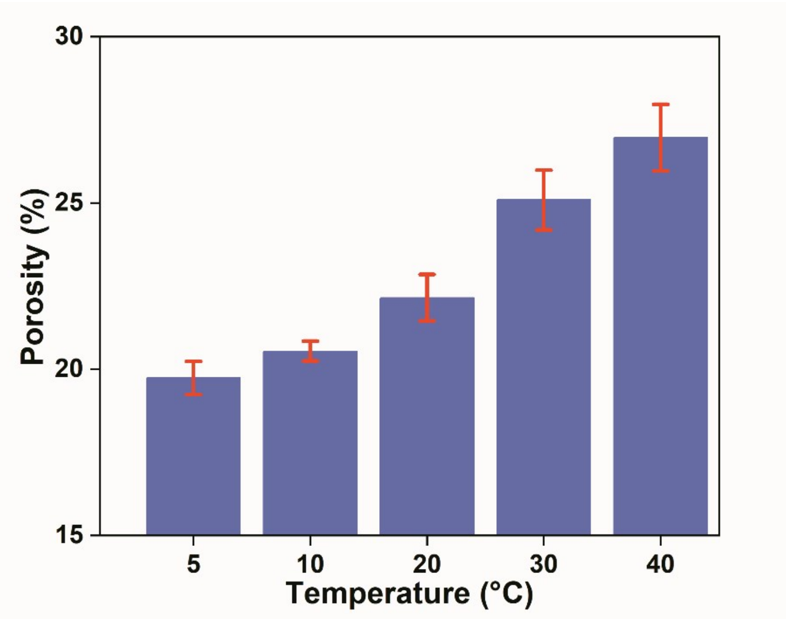


**Fig. S1** Porosity (P %) of PVDF film prepared at various quenching temperature.

It is evident from Fig. S1 that PVDF film prepared at 5 °C is having low porosity ca. ~ 20 % and subsequently increases for higher temperature. The decrease in the porosity for film are due to low temperature phase inversion, which reduce the diffusion coefficient and slowdown liquid–liquid demixing. Buonomenna et al.[2] has studied the effect of coagulation condition on morphology and crystal structure of PVDF membrane. They observed that casting solution temperature play a vital role in membrane morphology. The overall porosity increased for increase in casting solution temperature. Similarly, Zhang et al.[3] has studied the polymorphism of poly (vinylidene fluoride) membranes by controlling the phase inversion temperature and concentration of PVDF polymer in casting solution. It was observed that phase inversion/precipitation at high temperature leads to accelerate the liquid–liquid demixing process, which leads larger average pore size and finger-like voids in the cross-section. Further, Soin et al.[4] has studied the effect low temperature phase inversion on the β–phase of PVDF film and also investigated the morphology of the prepared film. It was observed that low temperature phase inversion has self-aligned the β–phase and the porosity of the films decreases with the decrease in the quenching temperature.

## S2. Force calculation via finger tapping

The force exerted during finger tapping was quantified using previously reported works.[5] Pusty et al.[5] has fabricated a PVDF base piezoelectric nanogenerator. They have measured the Piezoresponse using human finger tapping and the force was quantified using digital weighing balance. Hence, the finger tapping test was carried out on digital weighing machine to calculate the force exerted on the device and same force was maintained consistently throughout the all test sample for fair comparison. When the object (human finger) hits the device a momentum is generated which leads to charge generation. Based on the kinetic energy and momentum theorem the imparted force and stress was quantified using the following equations.

$$mgh = \frac{1}{2}mv^2 \qquad (2)$$

$$(F - mg) \times \Delta t = mv \quad (3)$$

$$\Delta\sigma = \frac{F}{A} \quad (4)$$

Where m is the average estimated mass of the object ~ 0.38 kg as measured from digital balance, $g$ is the acceleration due to gravity 9.8 N/Kg, $h$ is the falling height ca. ~ 0.05 m, v is the velocity; A is approximated area over which the pressure was applied ~ 900 $mm^2$ and $\Delta t$ ~ 0.05 time span between two hits. Putting the values in the above equations, we get an approximate force (F) ~ 3.7 N and applied stress $\Delta\sigma = {\sim}4.13\ KPa$. These calculated forces of ~3.7 N was maintained consistently throughout the all test sample for fair comparison of voltage response of piezoelectric device.

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