Improved performance of a polymer nanogenerator based on silver nanoparticles doped electrospun P(VDF-HFP) nanofibers†

Dipankar Mandal, Karsten Henkel, Dieter Schmeißer

Organic Nano-Piezoelectric Device Laboratory, Department of Physics, Jadavpur University, Kolkata 700032, India

Brandenburgische Technische Universität Cottbus - Senftenberg, Angewandte Physik-Sensorik, K.-Wachsmann-Allee 17, 03046 Cottbus, Germany

Experimental: In this work we have used three (0.5, 1.0, 1.5) different w/v % of AgNO₃ with respect to the polymer solution in order to achieve the optimum device performance.

Reference solvent casting free-standing films were prepared to understand the difference in crystalline phase modifications introduced by the electrospinning procedure.

Chemical reaction involved in Ag-NPs formation:

HCON(CH₃)₂ + 2AgNO₃ + H₂O = 2Ag° + (CH₃)₂NCOOH + 2HNO₃ ........................................(S1)

Eq.S1 describes the formation of Ag-NPs, where the solvent DMF [HCON(CH₃)₂] is acting as a reducing agent, which is also a good solvent of P(VDF-HFP). This is one of the tricks of the present study where unwanted external additives and multiple steps in Ag-NPs synthesis can be avoided.
Fig. S1 Fiber morphology (FE-SEM image: left panel) of electrospun neat P(VDF-HFP) nanofibers consisting of large number of bead defects and the corresponding fiber diameters distribution (right panel).

Fig. S2 FT-IR spectra of electrospun (ES) fibers and thick film (N-ES) of neat P(VDF-HFP).
Fig. S3 The output signal from the PNG, when pressure is imparted on the surface of (i) fibers-air interface and (ii) fibers-collector interface.

Fig. S4 The preferential alignment of the dipoles is shown in the electrospun nanofibers collected on the Ni-coated flexible substrate (right panel diagram). The direction of the dipoles is parallel to the applied electric field ($\vec{E}$) utilized in electrospinning set-up, shown in the left panel image.
**Fig. S5** The generated output voltage of the PNGs fabricated with Ag-NPs doped electrospun P(VDF-HFP) fibers, where different w/v % of AgNO$_3$ was used. The corresponding FT-IR spectra of the electrospun samples are illustrated in Fig. S6. The output voltage decreases when AgNO$_3$ is 1.5 w/v % due to the reduction of the β-phase content and the appearance of the semi-polar γ-phase with little co-existence of the non-polar α-phase (Fig. S6, sample: HFP-Ag1.5).

**Fig. S6** FT-IR spectra of the electrospun neat P(VDF-HFP) fibers [sample: HFP-Ag0.0] and Ag-NPs doped P(VDF-HFP) nanofibers [sample: HFP-Ag#, where # indicates the w/v % of AgNO$_3$ and the solvent used]. The ‘*’ mark the samples presented in the main article and labeled as ‘neat-HFP’ and ‘HFP-Ag’.