Extraordinary enhancement in piezoelectric response in electrospun PVDF fibers containing fluoro doped graphene derivatives

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Abstract

Graphene oxide (GO) was suitably functionalized to obtain carboxylated and fluorinated graphene oxide (GOCOOH and GOF) derivatives respectively via Hunsdiecker reaction. Electrospun mats of PVDF/GO, PVDF/GOCOOH and PVDF/GOF fibers were then prepared by electrospinning. The piezoelectric coefficient (d_{33}) as measured using piezoelectric force measurement (PFM) enhanced by more than two folds with respect to control PVDF spun mat. The piezoelectric coefficient though enhanced upon addition of GO and GOCOOH however it enhanced significantly in case of GOF. For instance, a drastic increase in piezoelectric response from 30 pm V^{-1}(electrospun neat PVDF) to 63 pm V^{-1} (for electrospun PVDF/GOF) was observed as revealed from PFM result. The phase transformation in these fibers were systematically investigated by various techniques like Fourier transform infrared spectroscopy (FTIR), wide angle X-ray diffraction (XRD), Raman spectroscopy and PFM. FTIR and XRD results revealed that the electrospun fiber mats showed predominantly β PVDF. Interestingly, the highest β content was obtained in the presence of GOF. The drastic enhancement in β phase is due to the presence of highly electronegative fluorine. The addition of GOCOOH and GOF in PVDF not only increases the polar β phase, but also changes the piezoelectric response significantly. More interestingly, PVDF/GOF films exhibited higher energy density and dielectric permittivity when compared with the control samples. These findings will help guide the researchers working in this field from both theoretical understanding and practical view point for energy storing device and charge storage electronics.

Keywords: PVDF, GO, electrospinning; β-phase; piezoelectric coefficient, dielectric properties, energy density.

References

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Figures

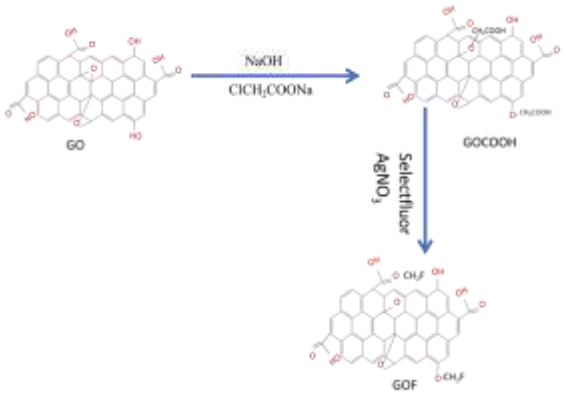

Figure 1. Schematic presentation of the synthesis of fluorine doped graphene oxide via the Hunsdiecker reaction.

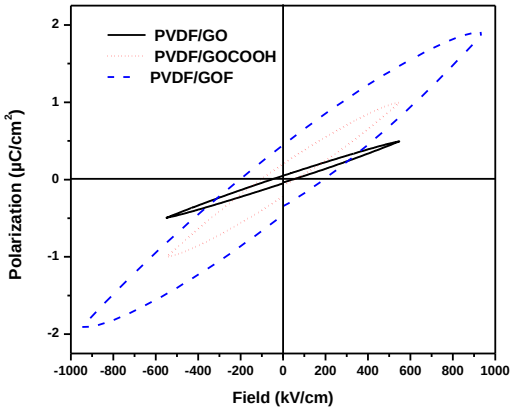

Figure 2: P–E loops for PVDF/GO, PVDF/GOCOOH and PVDF/GOF at room temperature.