Supplementary information

Dielectric constant enhancement of Poly 4-Vinylphenol (PVPh) via Graphene flakes incorporation through electrospray atomization for Energy Storage

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1. Electrospray Atomization Set-up:

In thin film fabrication techniques, electrospray atomization is one of the most cost-effective technique in which the liquid flow out of a nozzle with control flow rate is brought under the influence of a high potential electric field at desired temperature.[1-4] A cone is developed at the nozzle orifice by gradually increasing the applied potential and a stable jet forms at the tip of the cone. Due to coulombic forces, the stable jet breaks down further into extremely-tiny droplets, carrying nanoparticles/functional material. The electrospraying droplets are deposited on a substrate to form a homogenous film of the solute which is present as precursor in the solvent.

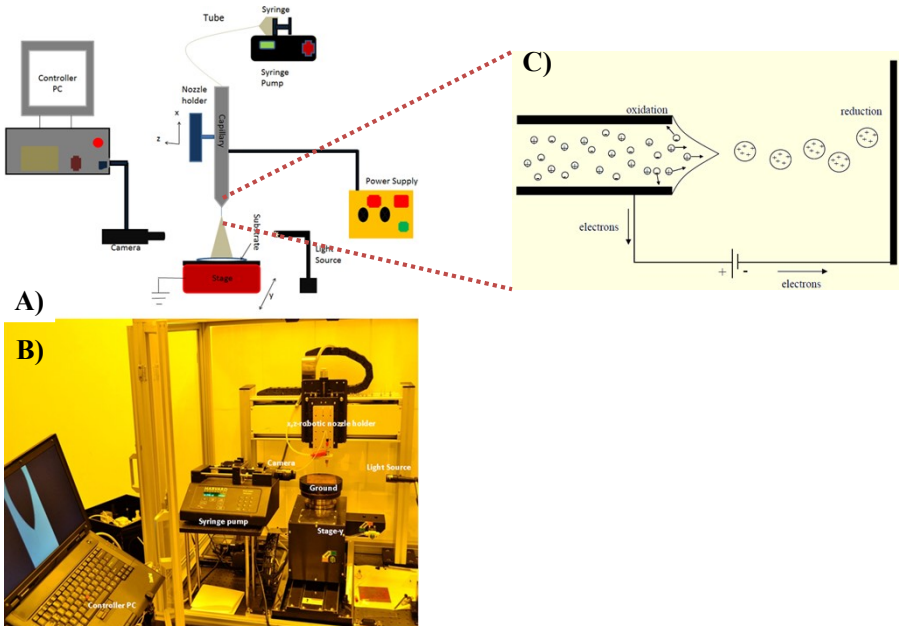

Fig. S1. A & B) Electrospray Atomization set-up, C) Electrospray Atomization deposition mechanism.

2. Potentials comparison for atomization modes of PVPh, Graphene and PVPh/Graphene dispersion

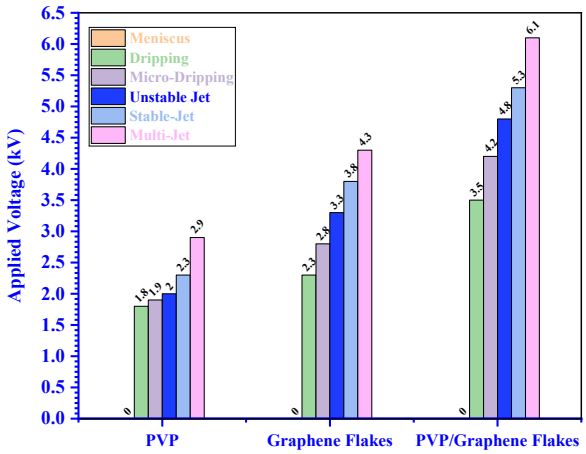

Fig. S2. Potential required for different electrospray modes at 300 µl/hr flow rate of PVPh, Graphene and PVPh/graphene dispersions.

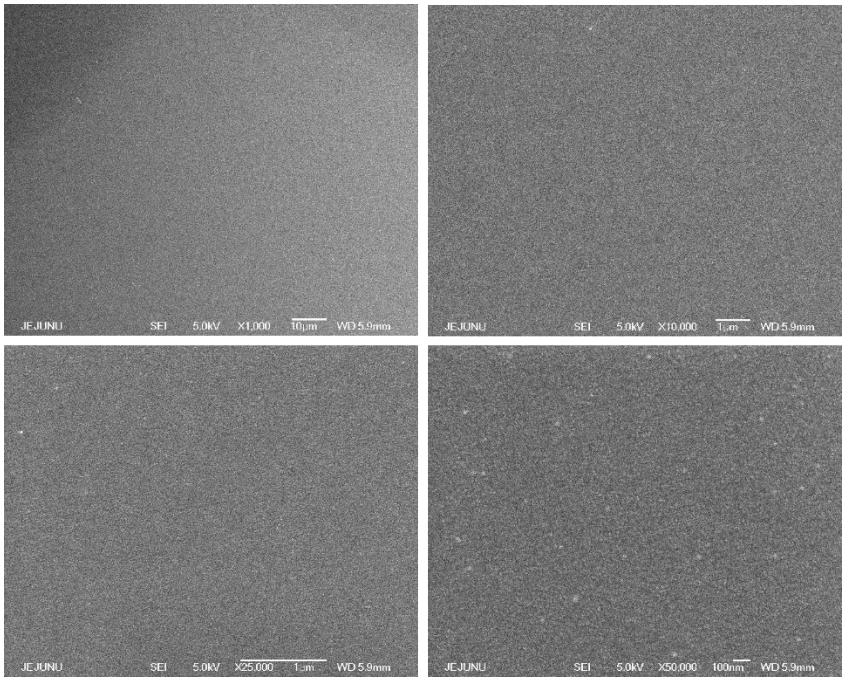

Fig. S3. Lower to higher magnification FESEM surface morphology analysis of PVPh thin films

3. Raman Spectroscopy Analysis of Graphene Flakes

Raman spectroscopy of the deposited graphene flakes film is carried out by using the LabRam HR800 microRaman spectroscope. The Raman system is operated at the 10 mW laser power and an excitation wavelength of 514 nm with Ar^{+} ion laser. **Fig. S4.** shows the Raman spectrum of the deposited graphene flakes film. The major signature peaks, commonly observed in all chemically processed graphene are D band at 1,354/cm, G band at 1,580/cm and 2D band at 2,725/cm. The G band at 1,580/cm corresponds to E_{2g} mode which is related to the sp^2-bonded carbon atoms vibration in a 2D hexagonal lattice. And the D band at 1,354/cm arises from a breathing mode of k-point phonons of A1g symmetry. The high intensity of D band indicates the presence of sp^2 C with defects. It is also reported that the D band arises from the reduction in size of in-plane sp^2 domains as well as the larger surface-to-volume ratio. Deposited graphene flakes film has strong in-plane sp^2 bonds in two-dimensional system.

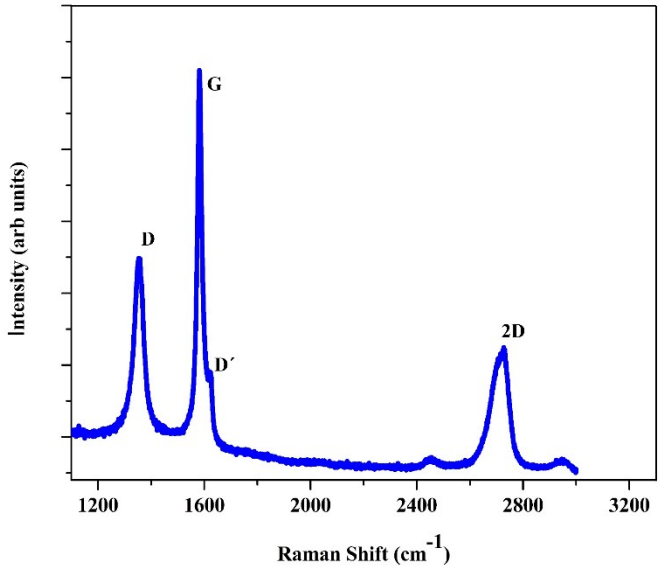

Fig. S4. Graphene Flakes Raman spectroscopy analysis**,** showing corresponding signature peaks of few layers graphene.

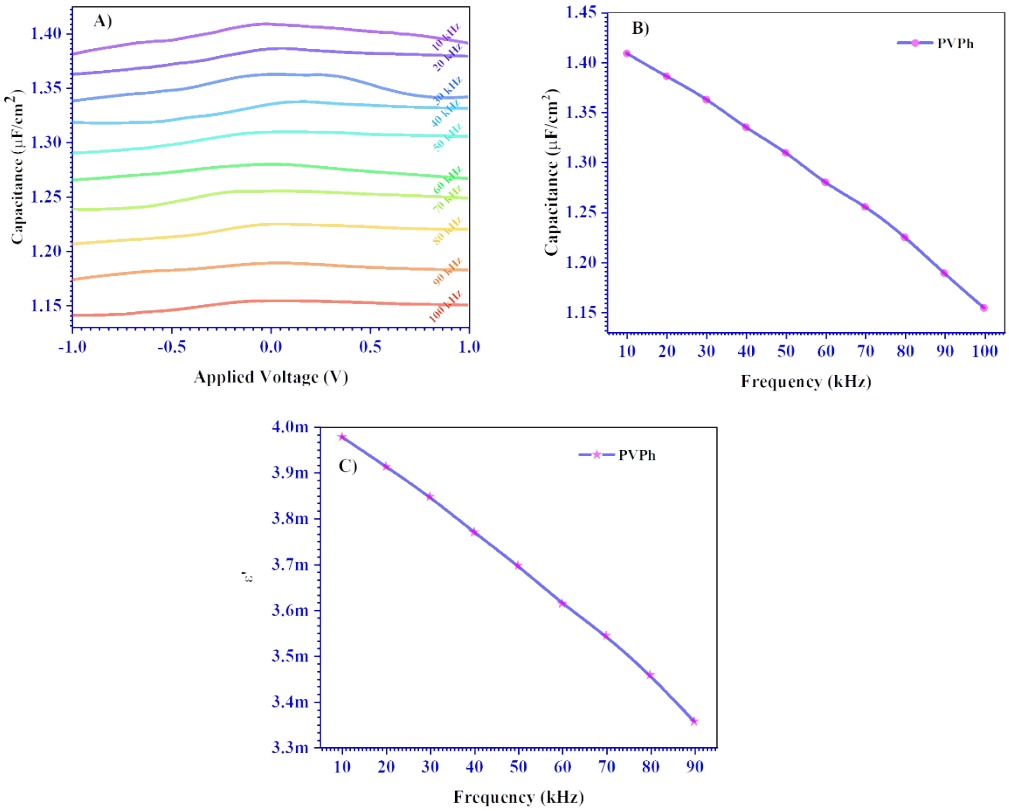

Fig. S5. A) Capacitance vs applied voltage (CV) at frequencies ranging 10 kHz to 100 kHz, B) Frequency dependent capacitance (Cf) and C) Frequency dependent dielectric constant (ɛf), characterization of PVPh applied as dielectric layer in the MIS capacitor.

References

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