Supporting Information

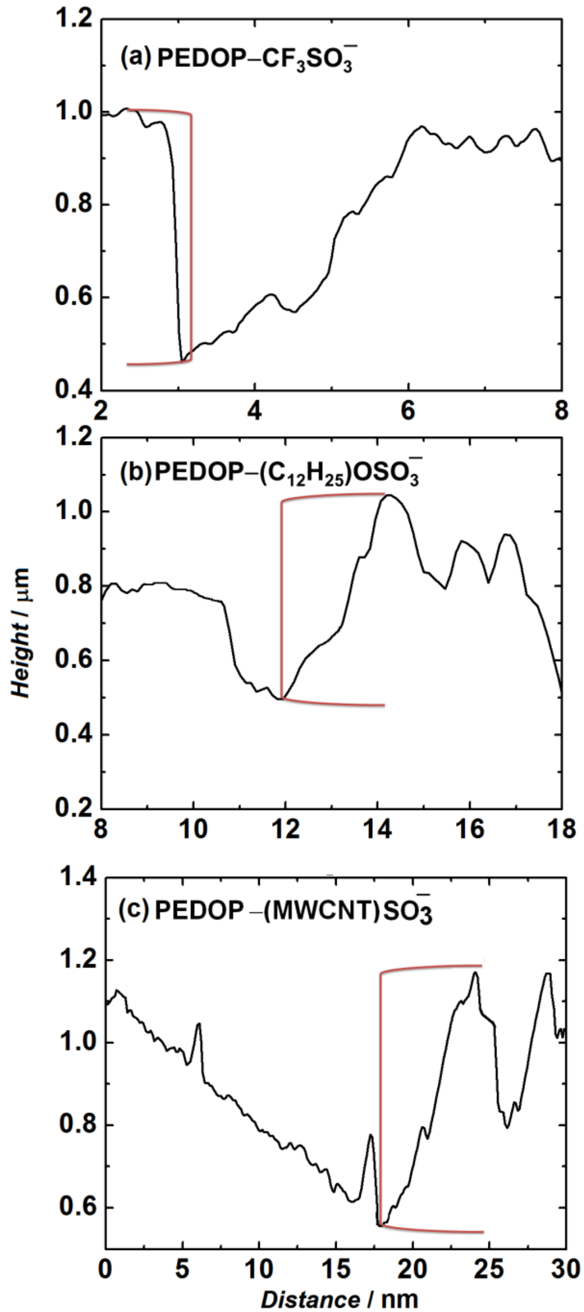

Figure S1 Section profiles of (a) PEDOP-$CF_3SO_3^-$, (b) PEDOP-$(C_{12}H_{25})OSO_3^-$ and (c) PEDOP-(MWCNT)SO_3^- films obtained from AFM. The vertical span enclosed in a half-bracket in each sample is the thickness of the film: 550, 570 and 620 nm for (a) PEDOP-$CF_3SO_3^-$, (b) PEDOP-$(C_{12}H_{25})OSO_3^-$ and (c) PEDOP-(MWCNT)SO_3^- films respectively.

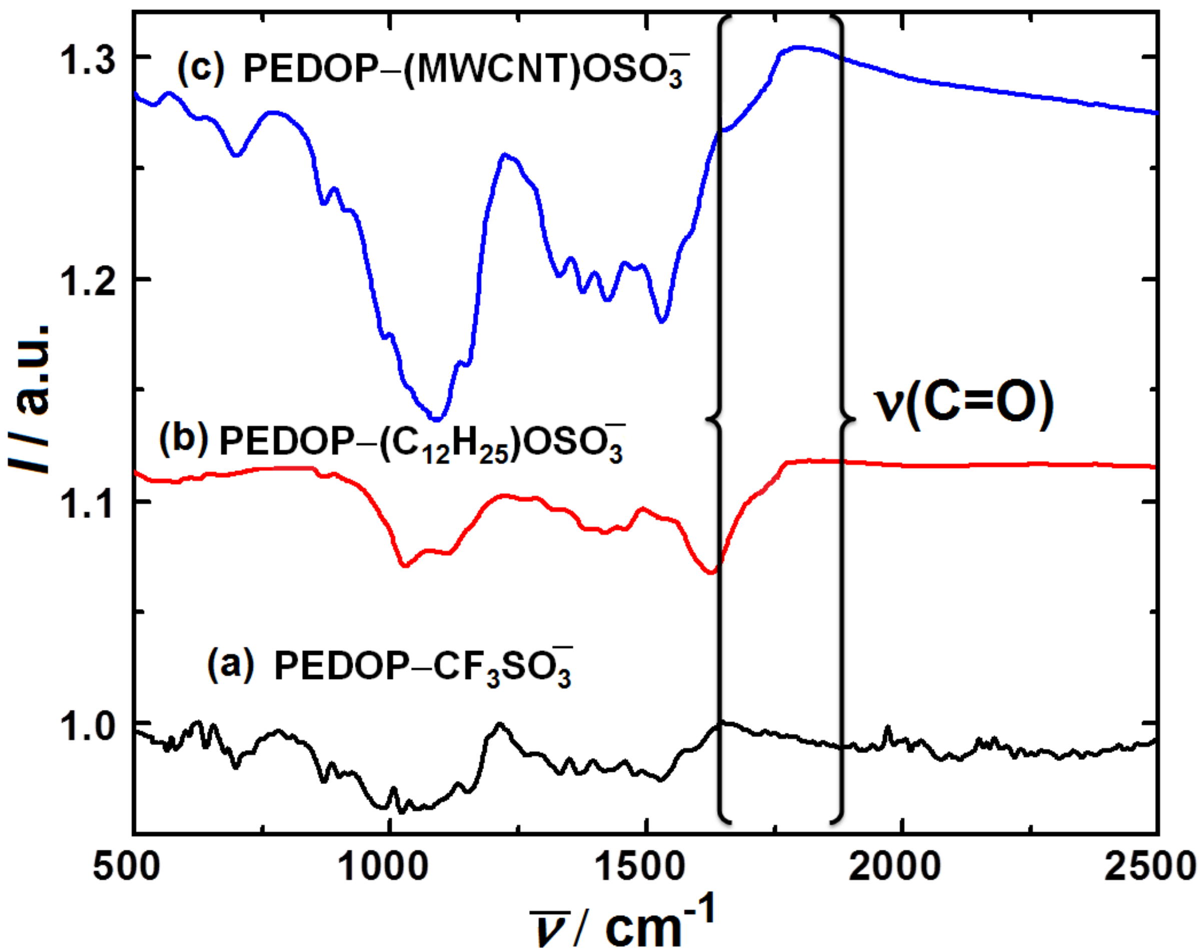

Figure S2 FTIR spectra of as-fabricated (a) PEDOP-$CF_3SO_3^–$, (b) PEDOP-$(C_{12}H_{25})OSO_3^–$ and (c) PEDOP-(MWCNT)$SO_3^–$ films recoded in the 500 to 2500 cm^{-1} region. The wavelength range of 1690 to 1900 cm^{-1}, enclosed in the curly bracket shows no peaks corresponding to ν(C=O) stretching frequency, indicating that all the three films are not over-oxidized during deposition.

The PEDOP-(MWCNT)SO_3^- film shows Mott-Gurney dependence (bottom inset of Figure 5i), According to the Mott-Gurney Law,

$$j = 9/8\ (\varepsilon_r \varepsilon_o \mu_{eff}\ V^2/L^3) \qquad (1)$$

where ε_r is the dielectric constant of the film, μ_{eff} is the carrier mobility, ε_o is the permittivity of vacuum and L is the film thickness.

Equation (1) can be rewritten as:

$$Log\ j = log\ (9/8\ \varepsilon_r \varepsilon_o \mu_{eff} /L^3) + 2\ log\ V \quad (2)$$

The y-axis intercept of the inset of Figure 5i can equated to the first part of equation (2) and μ_{eff} which is the carrier mobility can be determined.

However, in the equation (2), ε_r is unknown, and it was determined by recording an impedance spectrum of the same film using two gold coated spring contacts by applying an ac amplitude of 10 mV over a frequency range of 1MHz to 0.01 Hz. No dc bias was applied to the assembly, during the measurement. By equating equations (3) and (4), ε_r was determined.

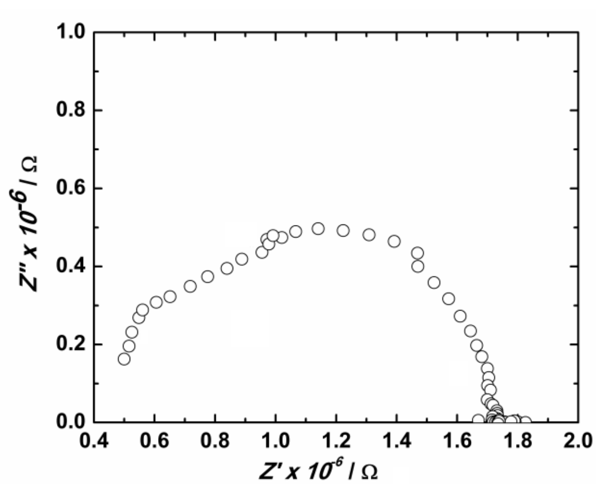

Figure S3 Nyqvist plot of PEDOP-(MWCNT)SO_3^- film between two gold contacts.

At the maximum of the semi-circle in the Z" versus Z' response,

$C = 1/2\pi f Z'$ (3)

where C is the capacitance of the film, f is the frequency and Z' the real component of impedance. Capacitance is also given by:

$C = A\varepsilon_r\varepsilon_o / d$ (4), where A and d are the surface area and thickness of the film respectively.

$\varepsilon_r = d/A2\pi f Z'\varepsilon_o$ (5)

By substituting equation (5) in equation (2),

$log(9/16A\pi f Z'L^2) + log(\mu_{eff})$ = y-axis intercept ($log\ j$) (6)

The Z' value was 1.14×10^{-6} Ω, frequency at the maximum of the semi-circle was 4738 Hz, thickness of the film (L *or* d) was 620×10^{-7} cm, and by solving equation (6) we deduced the charge carrier mobility to be 1.6×10^{-8} $cm^2\ V^{-1}\ s^{-1}$.

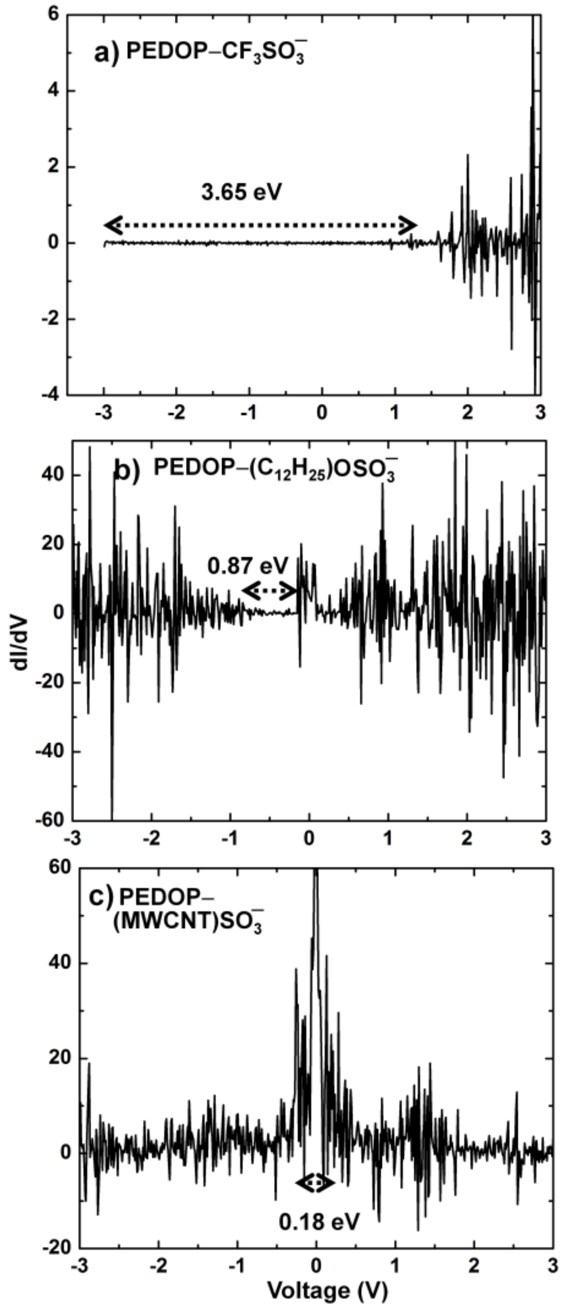

Figure S4 *dI/dV* versus applied bias (V) plots of (a) PEDOP-$CF_3SO_3^-$, (b) PEDOP-$(C_{12}H_{25})OSO_3^-$ and (c) PEDOP-(MWCNT)SO_3^- films derived from the point contact I-V curves averaged over 15 spots (inclusive of both bright and dark ones) in the current images shown in Figure 5.

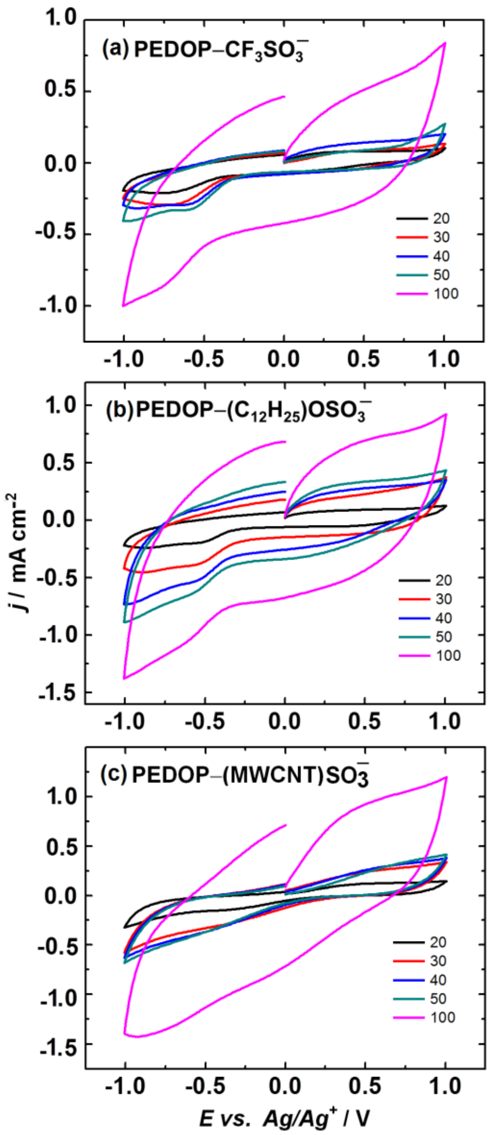

Figure S5 Cyclic voltammograms of (a) PEDOP-$CF_3SO_3^-$, (b) PEDOP-$(C_{12}H_{25})OSO_3^-$ and (c) PEDOP-(MWCNT)SO_3^- films recorded in a 0.5 M $LiCF_3SO_3$/PC electrolyte at scan speeds of 20, 30 40, 50 and 100 mV s^{-1}. The CV curve acquires a capacitive character at high scan rates (especially 100 mV s^{-1}) for all the three films.