

## Supplementary Information

To exclude the influence of rinsing and followed thermal annealing on the Seebeck coefficient of DMSO/EMIMBF<sub>4</sub> mixture post treated films, DMSO post treated samples with rinsing and thermal annealing steps were prepared.

### Experiments:

Pristine polymer films were dropped with 150  $\mu$ L DMSO to cover their film surface and left inside the fume hood for 30 min. Afterwards films were thoroughly washed with DI water and dried on a hot plate in ambient atmosphere at 120°C for 10 min. These samples are named as P\_DMSO”.

### Results and Discussions:

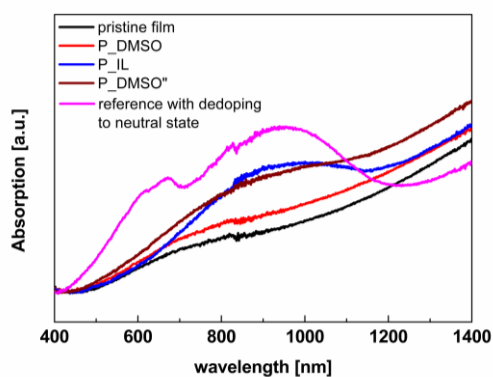


Figure SI-1 Influence of rinsing and thermal annealing step on the UV-Vis spectra of PEDOT:PSS thin films.

Compared to sample P\_DMSO, as it is shown in Figure SI-1, sample P\_DMSO” displays slight modification in the UV-Vis spectra. However, no polaron absorption peak at 900nm is observed as that of EMIMBF<sub>4</sub> treated films, indicating that the transition of PEDOT chains from bipolaron to polaron state is due to the presence of EMIMBF<sub>4</sub> during the post treatment. In addition, the influence of rinsing and thermal annealing on the thermoelectric properties of PEDOT:PSS films are shown in Figure SI-2. The Seebeck coefficient of P\_DMSO” is similar as that of P\_DMSO, confirming that the rinsing and thermal annealing steps are not responsible for the improvement of Seebeck coefficient for DMSO/EMIMBF<sub>4</sub> mixture post treated films.

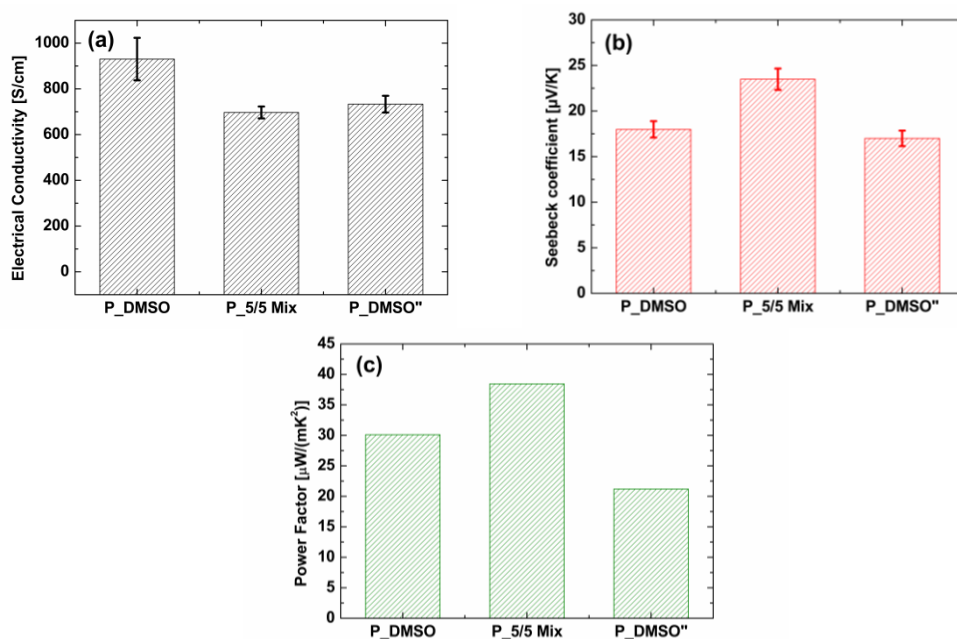


Figure SI-2: Influence of rinsing and thermal annealing on the thermoelectric properties of PEDOT:PSS thin films.