Supplementary Information

To exclude the influence of rinsing and followed thermal annealing on the Seebeck coefficient of DMSO/EMIMBF$_4$ mixture post treated films, DMSO post treated samples with rinsing and thermal annealing steps were prepared.

Experiments:

Pristine polymer films were dropped with 150 µL 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$_4$ treated films, indicating that the transition of PEDOT chains from bipolaron to polaron state is due to the presence of EMIMBF$_4$ 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$_4$ mixture post treated films.

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