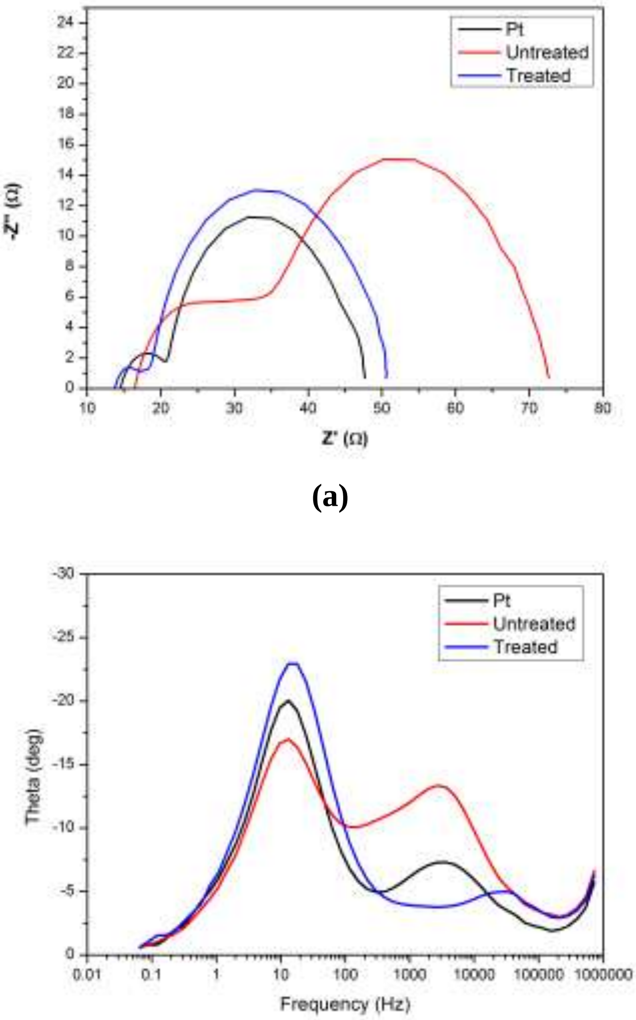
SUPPORTING INFORMATION

Ultrathin polypyrrole nanosheets doped with HCl as counter electrodes in dye-sensitized solar cells



(a)

(b)

Figure S1. EIS spectra under illumination of AM 1.5G simulated sunlight of DSSCs fabricated with UPNS CEs and Pt CEs. (a) Nyquist plots and (b) Bode plots.

Assuming that the catalytic counter-electrode materials are not stable; *i.e.*, they are detached from the underlying substrate, they may diffuse toward the working electrode and adsorb onto or interact with the TiO_2 surface, acting as an electron-loss catalyst. In general, this facilitated electron loss can reduce V_{OC} and eventually reduce η. For clarity, EIS measurements were performed using full cells. Other than the Nyquist plot obtained using symmetrical dummy cells, another semicircle on the TiO_2/dye/electrolyte interface was observed in the middle frequency region when one of the full cells was evaluated (Fig. S1a). Electron loss was evaluated in terms of electron lifetime in both he Nyquist and Bode plots. In particular, by using the peak (f_{max}) at ~10 Hz in the Bode plot, and the relation of $1/(2\pi f_{max})$, electron lifetime could be calculated. The Bode plots shown in Fig. S1b suggest that f_{max} was identical for all of the cells, implying the same electron lifetime in each case. Therefore, any instability of the UNPSs was not monitored. However, the reasons behind the decrease in V_{OC} in the UPNS cells remain unclear. It is plausible that the loss of V_{OC} may be due to mass-transfer overpotential associated with the high absolute Z_d values observed for the UPNS samples (Fig. 8a).[3]