**Figure captions**

**Fig 1:** *J* – *V* characteristics of BHJ P3HT: PCBM – based devices of as cast and after thermal annealing from 50 - 175°C (in steps of 25°C, 10 min)

**Fig. 2:** Impedance spectra of P3HT: PCBM (1:1) solar cell (as cast): (a) at 0.0 V and under varied illumination intensities, (b) under 1 sun (100%) illumination intensity and varied bias.

**Fig. 3:** Equivalent circuit representing P3HT: PCBM BHJ solar cell.

**Fig. 4:** (a)Impedance response of P3HT: PCBM solar cell; as cast and thermally annealed at various temperatures, at a sample bias of 0.5 V (i.e., around *V*oc) and under 1 sun illumination. The solid lines represent the fits to equivalent circuit model, (b) Comparison between equivalent circuit model fittings to experimental impedance data.

**Fig. 5:** A plot of carrier lifetimes as a function of thermal annealing temperatures.

**Fig. 6:** Mott-Schottky curve of ITO/PEDOT: PSS/P3HT: PCBM/Al device; as cast and after thermal annealing at 150°C.

**Fig. 7:** A graphical schematic illustrating vertical segregation process following thermal annealing of P3HT: PCBM bulk heterojunction solar cell.