

Supplementary Information

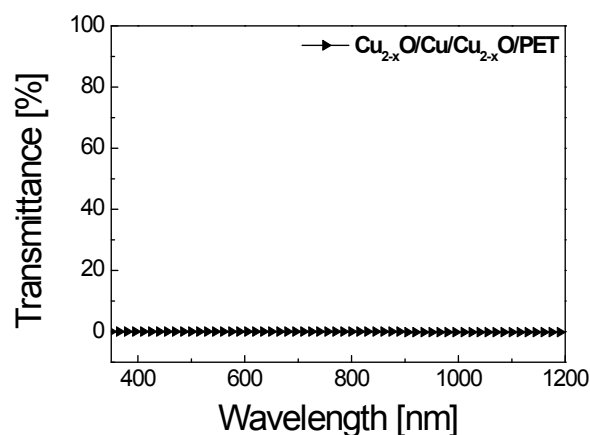


Fig. S1. Optical transmittance of as-deposited $\text{Cu}_{2-x}\text{O}/\text{Cu}/\text{Cu}_{2-x}\text{O}$ multilayer before grid patterning.

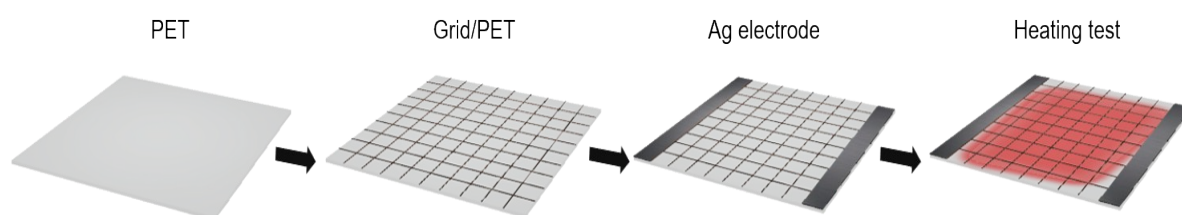


Fig. S2. Schematic of the TFH fabrication process using the RTR-sputtered $\text{Cu}_{2-x}\text{O}/\text{Cu}/\text{Cu}_{2-x}\text{O}$ multilayer grid. Two terminal-side Ag contact electrodes were fabricated on the $\text{Cu}_{2-x}\text{O}/\text{Cu}/\text{Cu}_{2-x}\text{O}$ multilayer grid films.

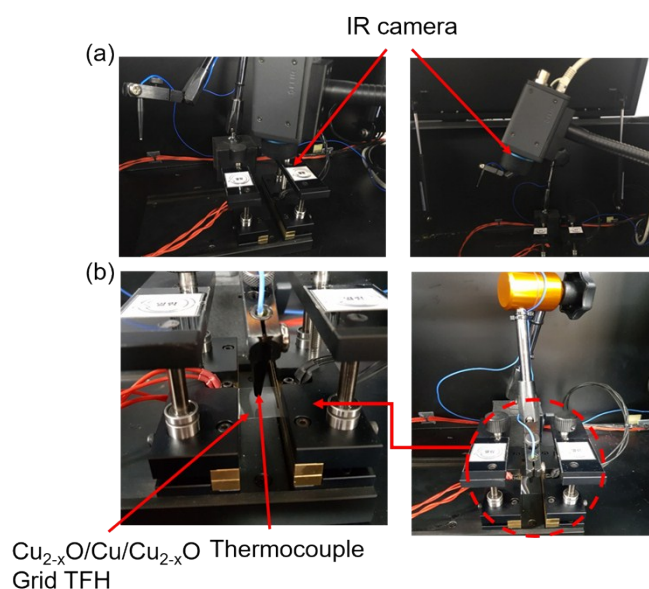


Fig. S3. Pictures of temperature measurement system for the TFHs, with (a) an IR image camera and

(b) a thermocouple.

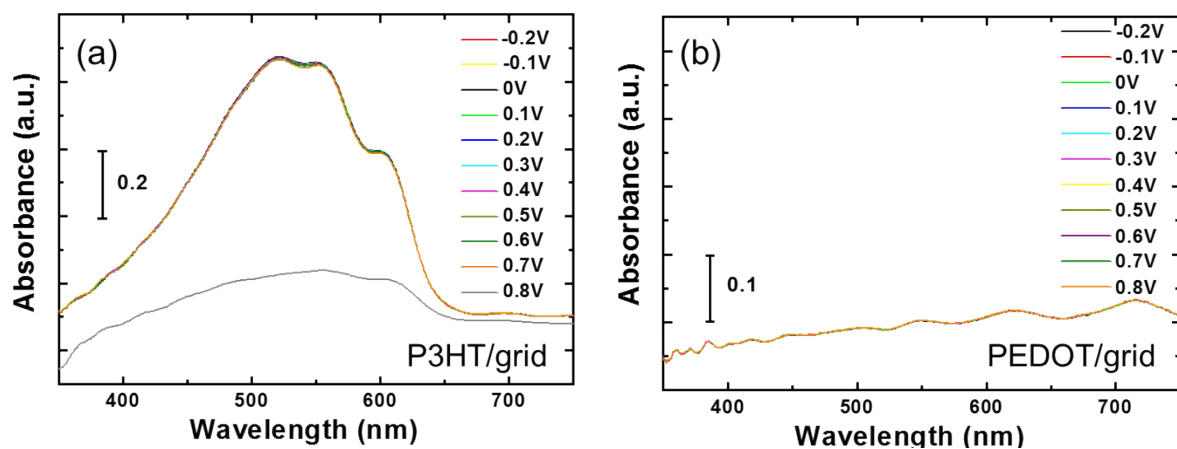


Fig. S4. Absorbance spectra obtained at potentials from -0.2 V to 0.8 V for (a) the P3HT and (b) PEDOT:PSS films spin-coated on $\text{Cu}_{2-x}\text{O}/\text{Cu}/\text{Cu}_{2-x}\text{O}$ multilayer grid electrodes.

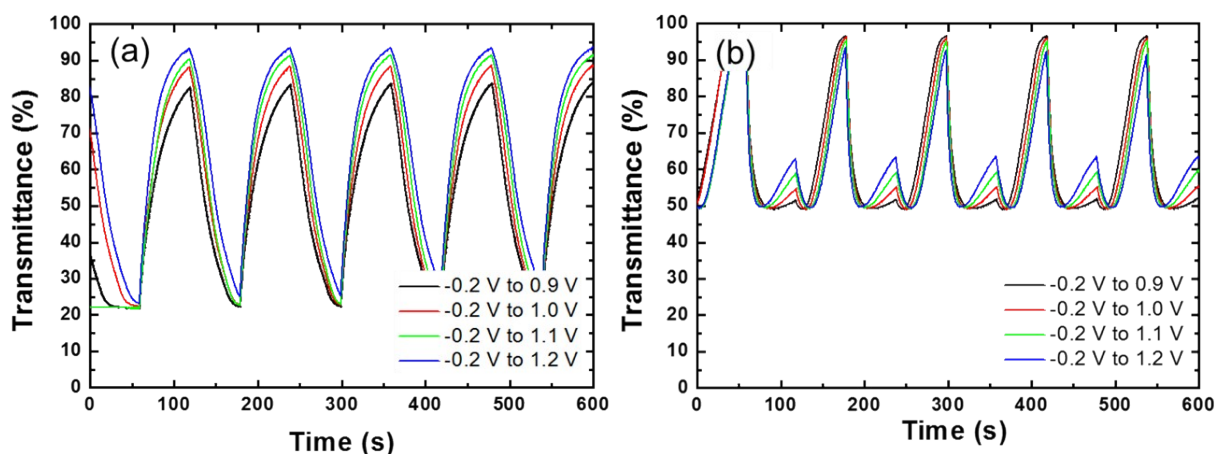


Fig. S5. *In situ* transmittance spectra for P3HT/PEDOT:PSS film measured (a) at 520 nm and (b) 720 nm when different voltage pulses were applied for an interval of 60 s.