Electronic Supplementary Material (ESI) for Inorganic Chemistry Frontiers.


## *Electronic Supplementary Information*

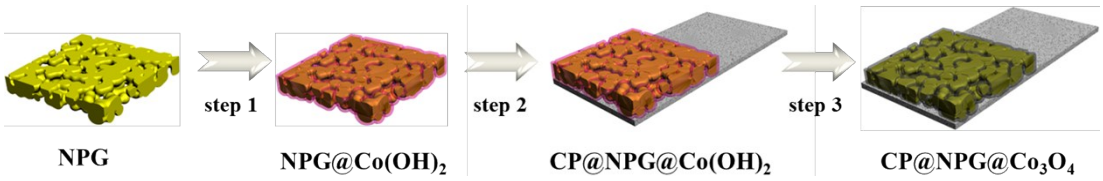


**Figure S1.** Schematic diagram of the preparation procedure of the CP@NPG@$Co_3O_4$ composites.

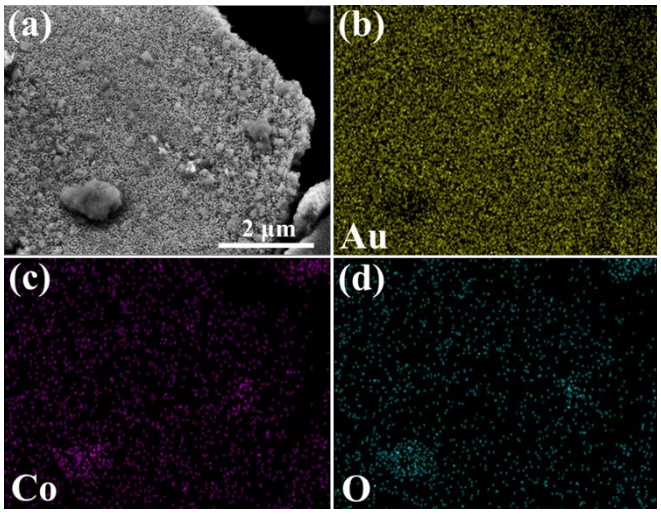


**Figure S2.** (a) SEM image and (b, c, d) the corresponding elemental mapping of the NPG@$Co_3O_4$ composites.

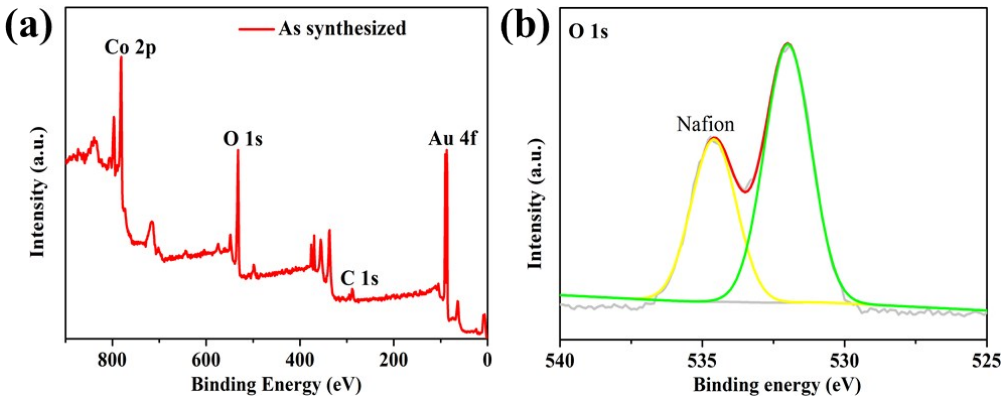


**Figure S3.** (a) survey and (b) O 1s XPS spectra of NPG@$Co_3O_4$ composites.

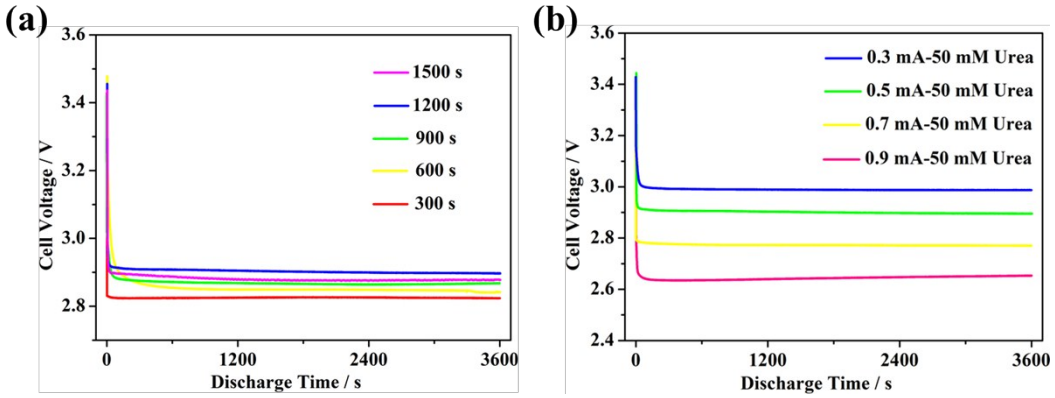


**Figure S4. The discharge time was set to 1h.** (a) Discharge curves in different electrochemical deposition time (seconds) at 0.5 mA $cm^{-2}$. (b) Discharge curves at current densities ranging from 0.3 to 0.9 mA $cm^{-2}$.

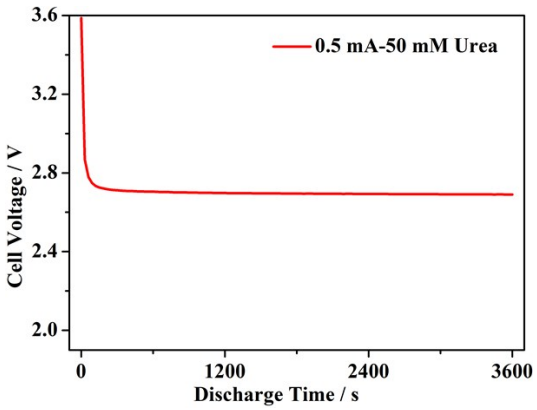

**Figure S5.** Discharge curve of pure NPG film in 50 mM urea + 50 mM $Li_2SO_4$ aqueous solution at 0.5 mA $cm^{-2}$.

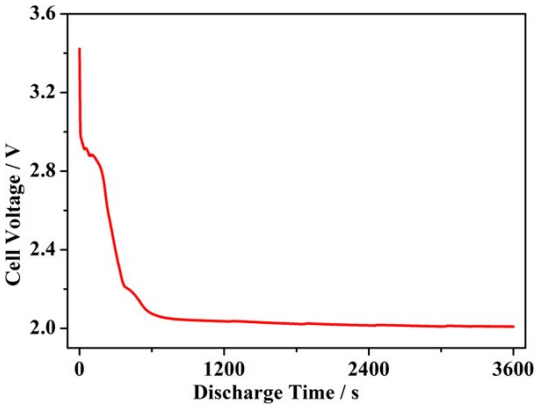


**Figure S6.** Discharge curve of CP@NPG@$Co_3O_4$ composites in 0.5 M $Li_2SO_4$ aqueous solution at 0.5 mA $cm^{-2}$.

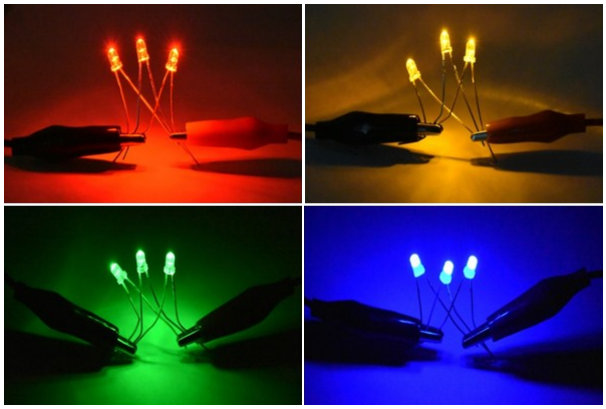

**Figure S7.** Digital graphs of red, yellow, green and blue LEDs in parallel being driven by a CP@NPG@$Co_3O_4$ based LFB (simulated urine), respectively.

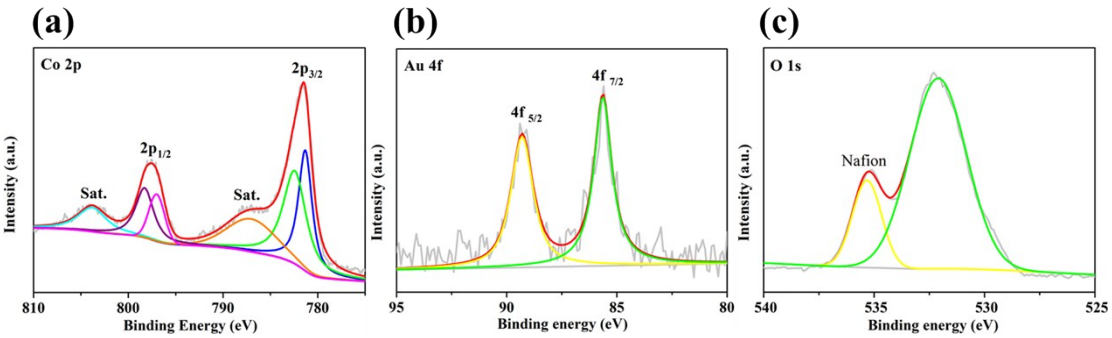


**Figure S8.** (a) Co 2p ; (b) Au 4f ; (c) O 1s XPS spectra of NPG@$Co_3O_4$ composites after discharged 5 days.

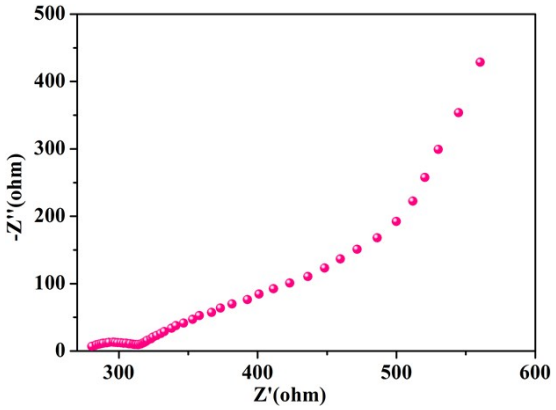


**Figure S9.** EIS (presented in scatterplot) curves of the LFB.

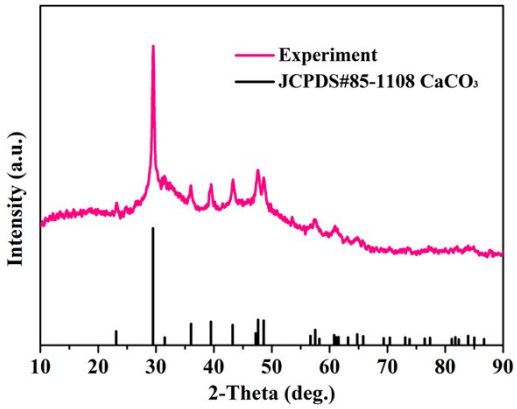

**Figure S10.** XRD patterns of JCPDS card of $CaCO_3$ phases and experiment (Precipitates collected from adding $CaCl_2$ solution to the catholyte after discharge 5 days).