Electronic Supplementary Material (ESI) for RSC Advances.

Impact of rare-earth metal oxide (Eu_2O_3) on the electrochemical properties of polypyrrole/CuO polymeric composite for supercapacitor application

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Galvanostatic charge-discharge (GCD) plots for the other two ternary nanocomposites viz. PPY/CuO/Eu_2O_3-1 (10 weight % of Eu_2O_3) and PPY/CuO/Eu_2O_3-3 (50 weight % of Eu_2O_3).

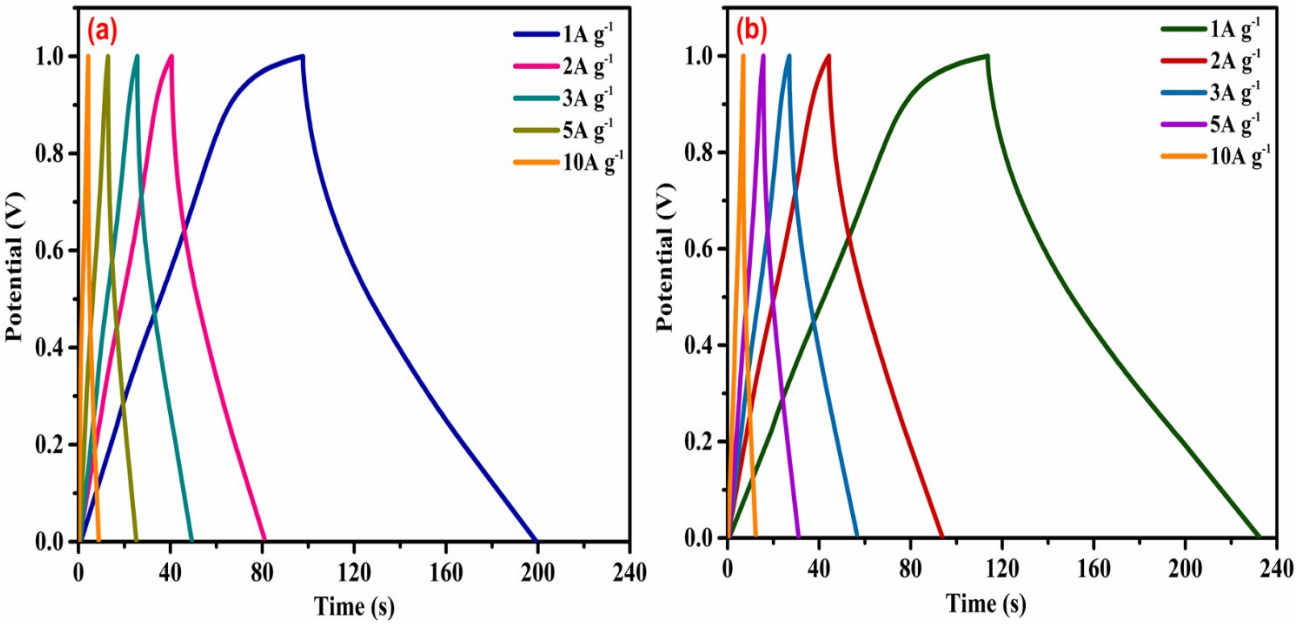

Fig. S1. GCD plots of (a) PPY/CuO/Eu_2O_3-1 ternary nanocomposite and (b) PPY/CuO/Eu_2O_3-3 ternary nanocomposite at the various current densities.

Fig. S1 shows the comparative GCD curves of PPY/CuO/Eu_2O_3 ternary nanocomposites with 10 % and 50 % Eu_2O_3 at various current densities denoted by PPY/CuO/Eu_2O_3-1 and PPY/CuO/Eu_2O_3-3 respectively. The specific capacitance PPY/CuO/Eu_2O_3-1 with 10 % Eu_2O_3 was obtained to be 201 F g^{-1}, and PPY/CuO/Eu_2O_3-3 with 50 % Eu_2O_3 exhibited a specific capacitance value of 238 F g^{-1}. Increasing the Eu_2O_3 content in the ternary nanocomposite from 10 % to 30 % resulted in the enhancement of the specific capacitance. However, further increase in the Eu_2O_3 content proved to be deteriorating the optimum synergy availed between the various components of the ternary nanocomposite. Excess addition of Eu_2O_3 results into jamming of the mesoporous conducting network which otherwise facilitated the charge transfer easily. This results into the increased charge transfer resistance (Rct) and eventually to a reduced capacitance value. Also, addition of Eu_2O_3 beyond a certain limit results into increased resistance of the active

material which leads to a decrease in the specific capacitance. Moreover, the charge transfer complex that could have been formed at an optimum amount of Eu_2O_3 inclusion may have been destroyed due to excessive presence of Eu_2O_3. This leads to reduction in the electron donating tendency of PPY and protonation of PPY, consequently decreasing the specific capacitance value [1,2].

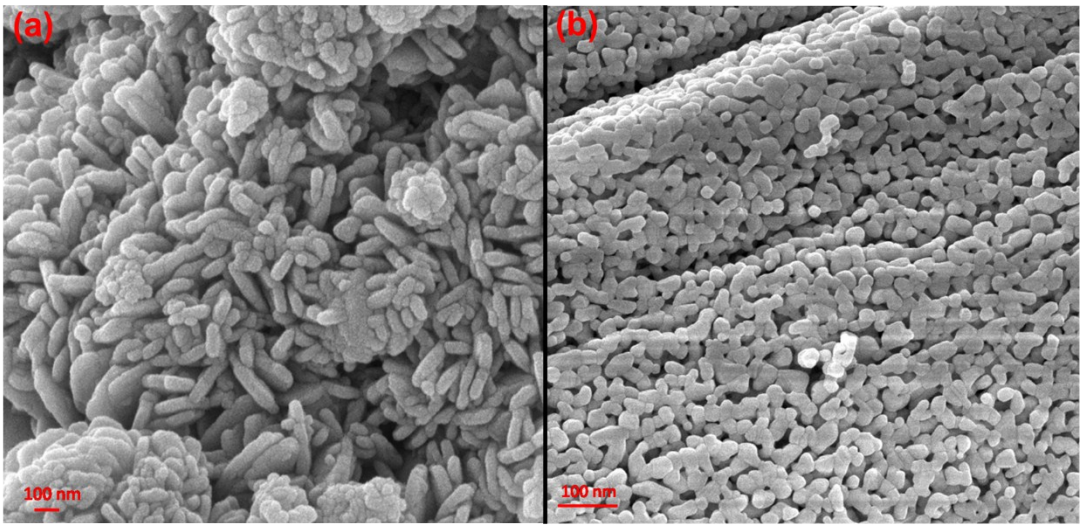

Fig. S2 (a) FE-SEM image of CuO particles and **(b)** Eu_2O_3 nanoparticles.

CV and GCD plots for the PPY, PPY/CuO, and PPY/CuO/Eu_2O_3-2 ternary nanocomposite in three-electrode system.

CV (at the scan rate of 200 mV s^{-1}) and GCD (at the current density of 1 A g^{-1}) of the PPY, PPY/CuO, and PPY/CuO/Eu_2O_3-2 ternary nanocomposite was performed as shown in Fig. S3. The CV was recorded in the potential -0.2 - 0.8 V and the GCD was recorded in the potential of 0 - 0.8 V. Pure PPY and PPY/CuO exhibited specific capacitance (as calculated from the GCD data) values of 130 and 223 F g^{-1}, respectively. PPY/CuO/Eu_2O_3 showed an enhancement in the specific capacitance value i. e. 380 F g^{-1}.

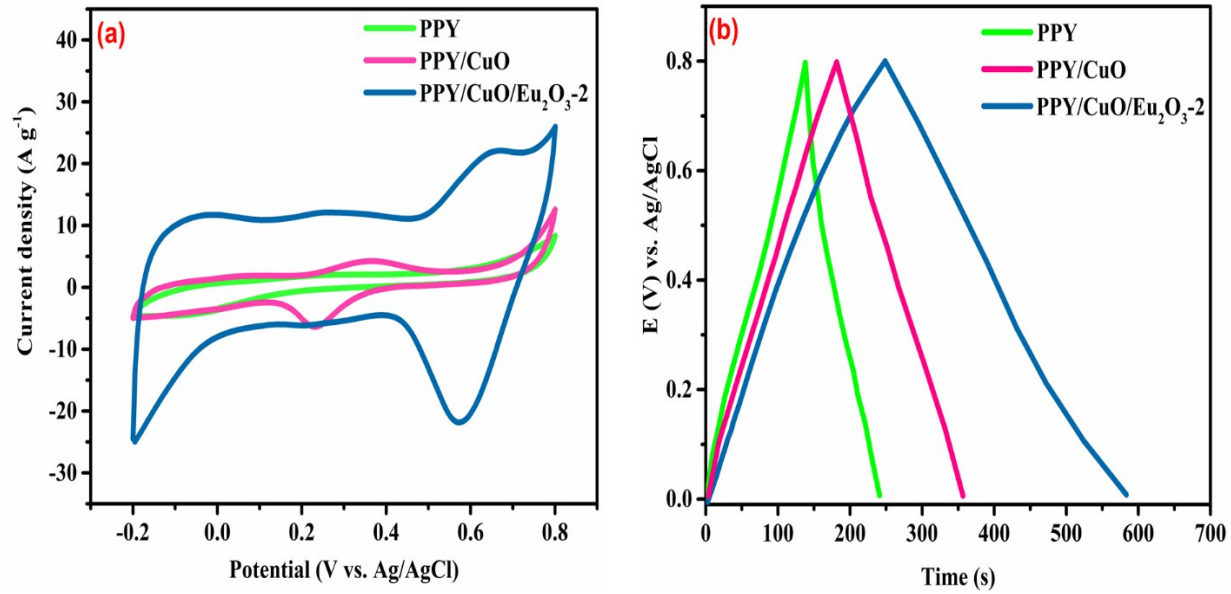

Fig. S3 The electrochemical performances of PPY, PPY/CuO, and PPY/CuO/Eu_2O_3 nanocomposites in a three-electrode system (a) CV curves @ 200 mV s^{-1} and (b) GCD plots at 1 A g^{-1}.

References

1. W. Sun and Z. Mo, *Mat. Sci. Eng. B*, 2013, **178**, 527-532.
2. H. M. Shiri and A. Ehsani, *J. Colloid and Interface Sci.*, 2016, **473**, 126-131.