Supporting Information

Fabrication of $CuCo_2O_4$/PANI nanocomposite as advanced Electrode for High Performance Supercapacitor

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1. Trasatti Method Analysis

In cyclic voltammetry (CV), the current response to an applied potential varies with the type of redox reaction taken place. i.e redox reaction is a diffusion-controlled or an adsorption-controlled process. The shape of the CV curves, used to predict whether the electrode material belongs to Supercapacitor, battery and hybrid type.

In hybrid type electrode material, both the battery type material and supercapacitor type materials were exhibited redox peaks only, it is not easy to differentiate between battery-like and supercapacitive behavior based on the shape of the CV. In order to analyze the contribution of battery and supercapacitor type from the CV, Trasatti et al. successfully proposed an approach to quantify the contributions from diffusion controlled and capacitive charge storage processes.[1]

1.1 Evaluation of total capacitance (C_T)

CV of $CuCo_2O_4$, PANI and $CuCo_2O_4$/PANI were recorded with different scan rates ranging from 5 mVs^{-1} to 100 mVs^{-1}. Then, corresponding capacities were evaluated based on the

equation (1). Further, the plot of reciprocal of the capacities (C^{-1}) and the square root of scan rates ($v^{1/2}$) should yield a linear correlation between them, to assume semi-infinite diffusion of ions[1, 2]. Specifically, the correlation can be described by the following equation (S1).

$$C^{-1} = \text{constant} \cdot v^{1/2} + C_T{}^{-1} \quad \text{..... (S1)}$$

where C, v and C_T represent calculated capacity (mAh g^{-1}), scan rate (mVs^{-1}) and total capacity, respectively. The "total capacitance (C_T)" is treated as the sum of battery-like and supercapacitive-like capacity. C_T equals the reciprocal of the y-intercept of the C^{-1} vs. $v^{1/2}$ plot (Fig.S1, left columns).

1.2 Evaluation of total supercapacitor and battery-like capacity

Plotting the calculated capacities (C) against the reciprocal of square root of scan rates ($v^{-1/2}$) should also give a linear correlation described by the following equation S2 (assuming a semi infinite diffusion pattern)[3-5]: (Fig.S1, right columns).

$$C = constant \,.\, v^{-1/2} + C_{\text{cap}} \quad \text{.....(S2)}$$

where C, v and $C_{cap.}$ is the calculated total capacity (mAh g^{-1}), scan rate (mVs^{-1}) and the maximum capacitive contribution in total capacity. Linear fit the plot and extrapolate the fitting line to y-axis gives the C_{cap} Subtraction of C_{cap} from C_T yields the maximum diffusion-controlled capacity contribution in total capacity ($C_{dif.}$).

1.3 Evaluation of the percentage of capacity contribution from supercapacitor-like and battery-like charge storage processes in the total stored charge

The capacity contribution can be evaluated based on the following equations S3 & S4.

$$C_{cap}\,\% = \frac{C_{Cap}}{C_T} \times 100\% \quad \text{..... ..... (S3)}$$

$$C_{dif}\,\% = \frac{C_{dif}}{C_T} \times 100\% \quad \text{..... ..... (S4)}$$

Where C_{cap} % and C_{dif} % stand for capacity percentage of Capacitive-like and diffusion-controlled-like capacities[6].

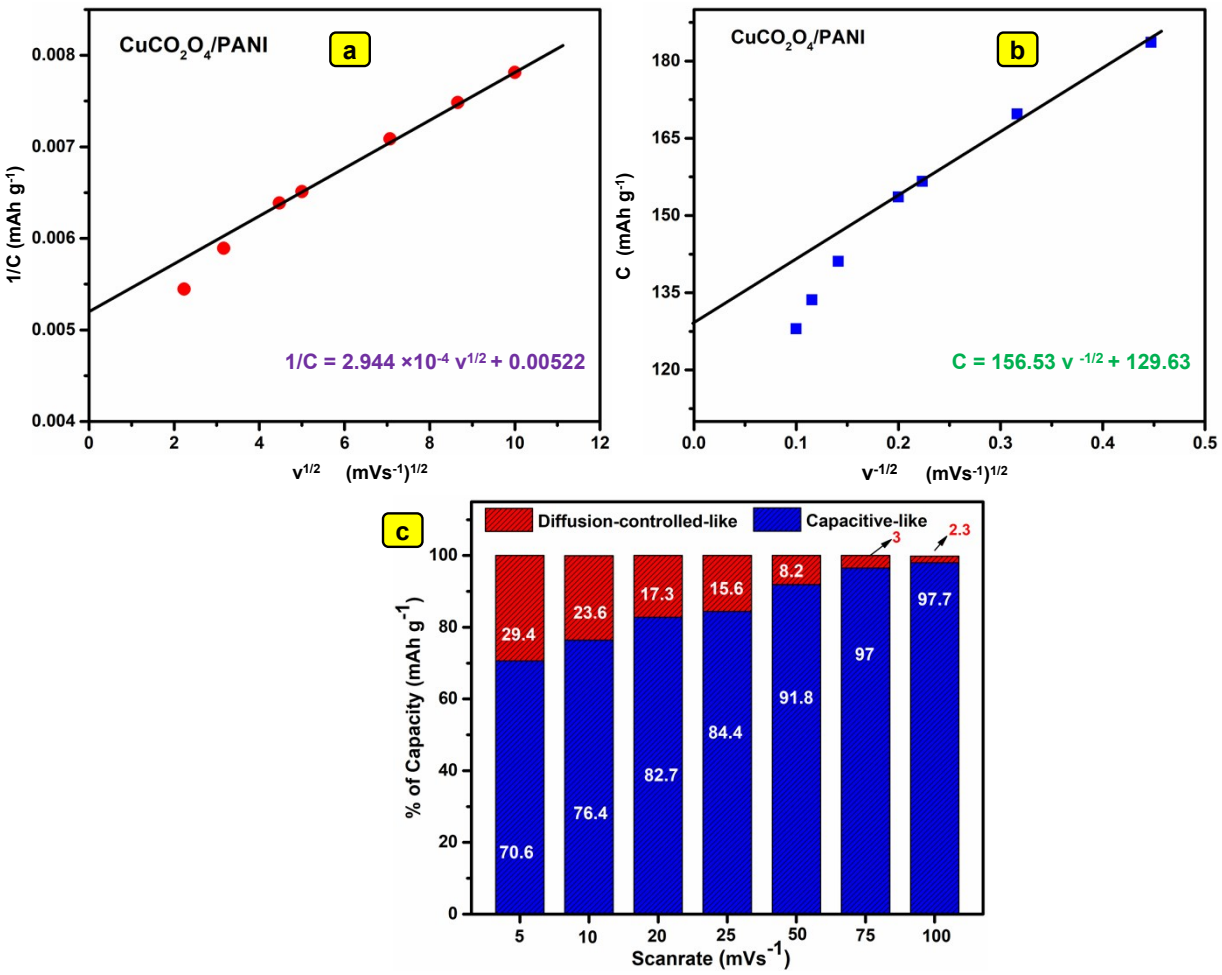

Fig.S1: a) Plots of reciprocal of Capacities (C^{-1}) vs. square root of scan rate ($v^{1/2}$) for $CuCo_2O_4$/PANI NC
b) Plots of Capacities (C) vs. reciprocal of square root of scan rate ($v^{-1/2}$) for $CuCo_2O_4$/PANI NC. The solid lines are linear fitting lines of data points
c) Percentage of Capacity contribution evaluated for $CuCo_2O_4$/PANI NC at different scan rates (5 mVs^{-1} to 100 mVs^{-1}).

References

1. S. Ardizzone, G. Fregonara and S. Trasatti, *Electrochimica Acta*, 1990, **35**, 263-267.
2. J. Shao, X. Zhou, Q. Liu, R. Zou, W. Li, J. Yang and J. Hu, *Journal of Materials Chemistry A*, 2015, **3**, 6168-6176.
3. J. Duay, S. A. Sherrill, Z. Gui, E. Gillette and S. B. Lee, *Acs Nano*, 2013, **7**, 1200-1214.

4. V. Augustyn, P. Simon and B. Dunn, *Energy & Environmental Science*, 2014, **7**, 1597-1614.
5. P. Yang, P. Sun, L. Du, Z. Liang, W. Xie, X. Cai, L. Huang, S. Tan and W. Mai, *The Journal of Physical Chemistry C*, 2015, **119**, 16483-16489.
6. Z.-H. Huang, T.-Y. Liu, Y. Song, Y. Li and X.-X. Liu, *Nanoscale*, 2017, **9**, 13119-13127.