Waste chicken bone-derived porous carbon materials as high performance electrode for supercapacitor applications

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Supporting information

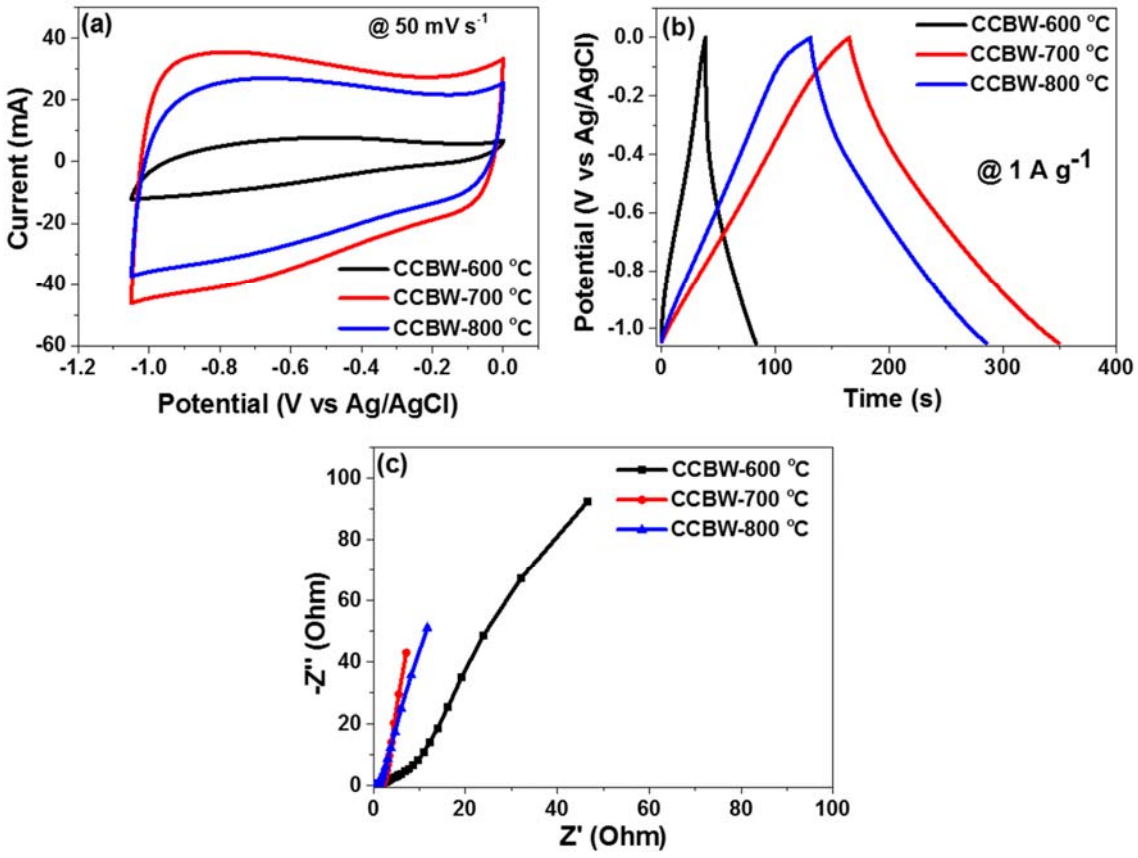

Fig. S1: (a) CV curves at 50 mV s^{-1} in a negative potential window, (b) GCD curves at 1 A g^{-1} in a negative potential window, (c) EIS Nyquist plot of CCBW (weight ratio of 1-1) at 600 °C, 700 °C and 800 °C, respectively.

For two-electrode evaluation using 3 M KOH basic aqueous electrolyte whereby the CCBW-1 electrode display Faradic behavior in the positive potential window and EDLC in the negative potential window (figure S2 (a)), the mass on each electrode was estimated via a charge balance equation, as presented below [1,2]:

$$Q_{+} = Q_{-} \Longrightarrow m_{+} \times Q_{s+} = m_{-} \times \Delta V_{-} \times C_{s-} \Longrightarrow \frac{m_{-}}{m_{+}} = \frac{Q_{s+}}{\Delta V_{-} \times C_{s-}} \quad \text{(S1)}$$

where; Q_{+} and Q_{-} are charge for positive and negative electrode, Q_{s+} present specific capacity for positive electrode, C_{s-} stand for specific capacitance for the negative electrode, ΔV_{-} indicate potential window for the negative electrode, while m_{+} and m_{-} stands for masses (mg) for the positive and negative electrodes, respectively.

The specific capacity (Q_s) and specific energy (E_d) of the CCBW-1//CCBW-1 symmetric device using 3 M KOH basic aqueous electrolyte was calculated using the following equations [3]:

$$Q_s = \frac{I_d \times \Delta t}{3.6} \quad \text{(S2)}$$

$$E_d = \frac{I}{3.6 * m} \int V dt \text{ [Wh kg}^{-1}\text{]} \quad \text{(S3)}$$

where $\int V dt$ is the area under the discharge curve of the device, m (mg) is the total mass of the active electrode and Δt is electrode discharge time in seconds.

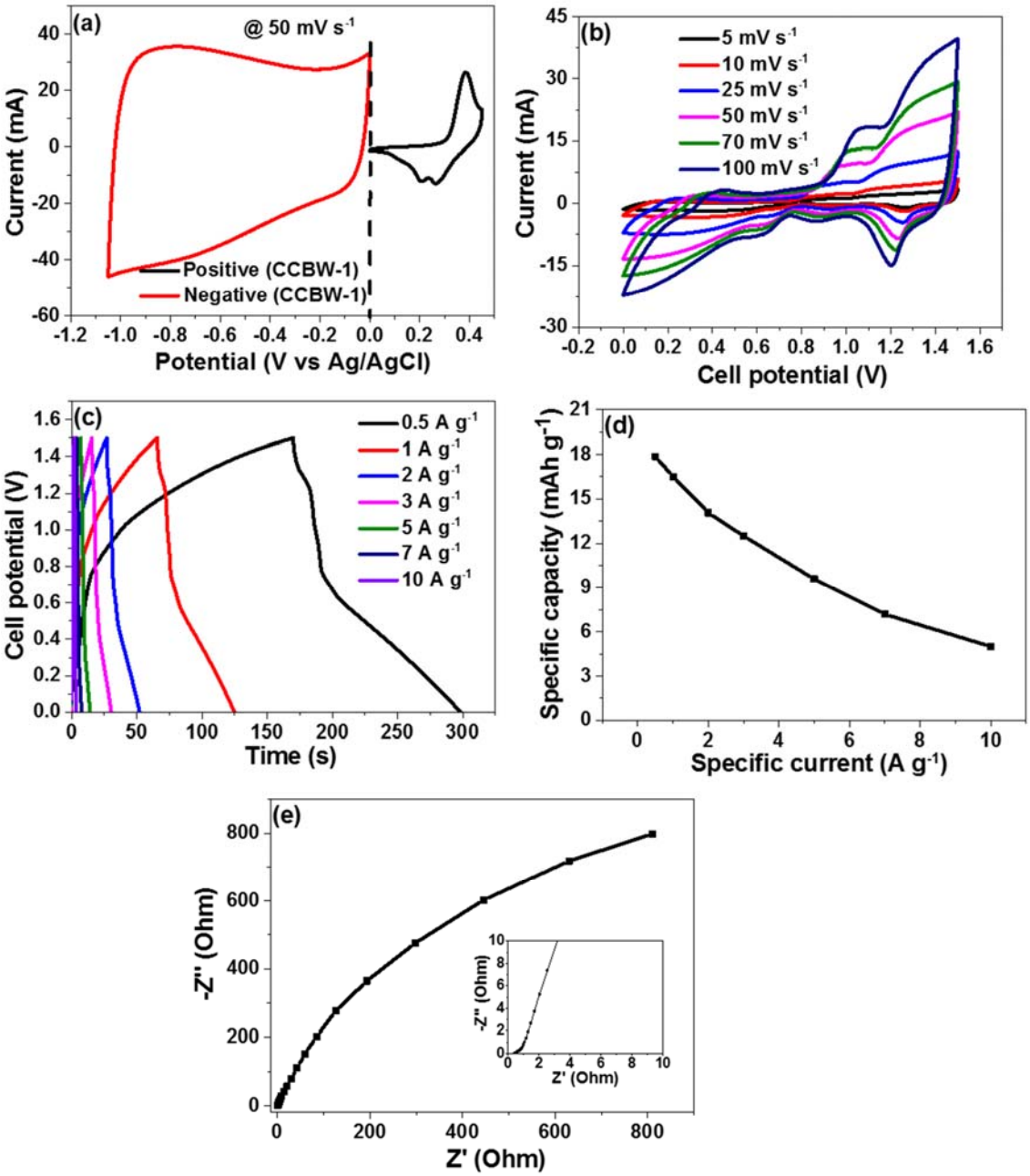

Fig. S2: Electrochemical performance of the symmetric device CBW-1//CCBW-1 at 700 ºC using 3 M KOH electrolyte: (a) CV curves at 50 mV s^{-1} in a positive and negative potential window, (b) CV curves at different scan rates, (c) GCD curves at different specific current, (c) Specific capacity versus specific current and (d) EIS Nyquist plot, respectively.

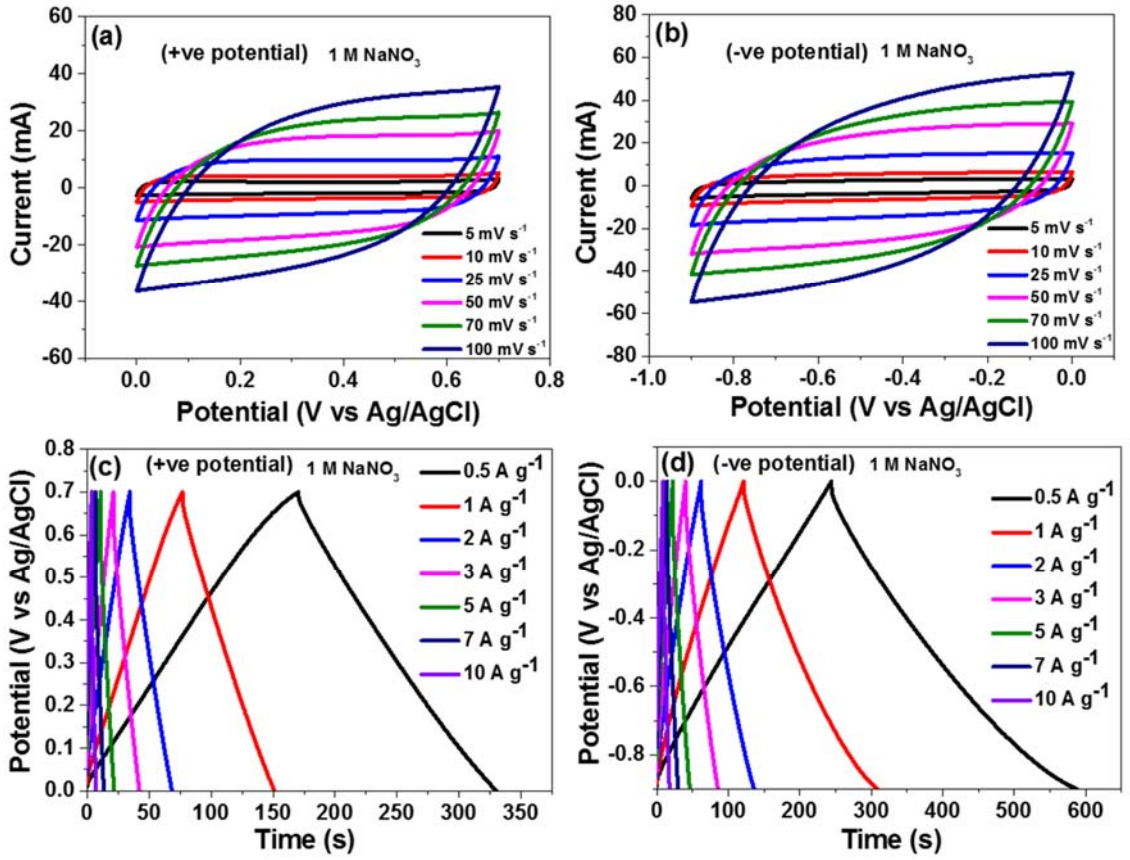

Fig. S3: (a, b) CV curves at different scan rates in both positive and negative potential windows, (c, d) GCD curves at different specific currents in both positive and negative potential windows for CBW-1 in 1 M $NaNO_3$, respectively.

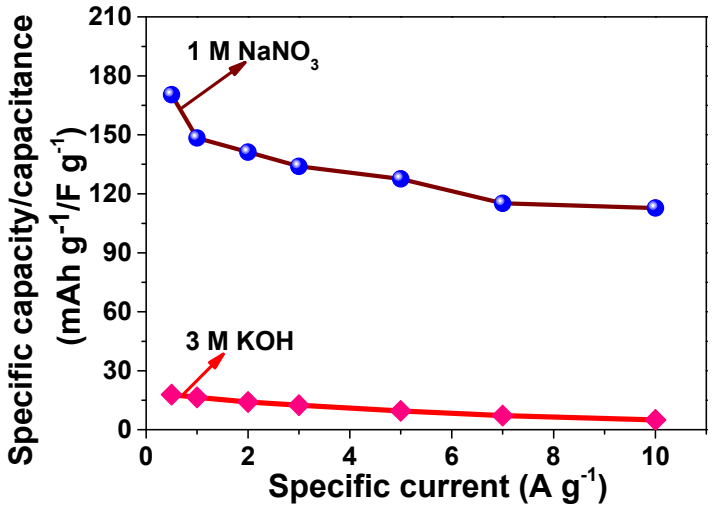

Fig. S4: Comparison of the rate capability/stability of the CBW-1//CCBW-1 symmetric device obtained using specific capacity/capacitance versus specific current in 3 M KOH and 1 M $NaNO_3$ electrolyte.

References

[1] D.J. Tarimo, K.O. Oyedotun, A.A. Mirghni, B. Mutuma, N.F. Sylla, P. Murovhi, N. Manyala, Enhanced electrochemical performance of supercapattery derived from sulphur-reduced graphene oxide/cobalt oxide composite and activated carbon from peanut shells, Int. J. Hydrogen Energy. (2020). https://doi.org/10.1016/j.ijhydene.2020.09.142.

[2] A. Noori, M.F. El-Kady, M.S. Rahmanifar, R.B. Kaner, M.F. Mousavi, Towards establishing standard performance metrics for batteries, supercapacitors and beyond, Chem. Soc. Rev. 48 (2019) 1272–1341. https://doi.org/10.1039/c8cs00581h.

[3] K.O. Oyedotun, M.J. Madito, D.Y. Momodu, A.A. Mirghni, T.M. Masikhwa, N. Manyala, Synthesis of ternary NiCo-MnO2 nanocomposite and its application as a novel high energy supercapattery device, Chem. Eng. J. 335 (2018) 416–433. https://doi.org/10.1016/j.cej.2017.10.169.