Facile synthesis of O/N co-doped hierarchical porous carbon: For high performance supercapacitor and electromagnetic interference shielding

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1. Electrochemical measurements

To prepare the working electrode, the carbon material (80wt%), acetylene black (representing 10wt%), and polytetrafluoroethylene (PTFE, 10wt%) slurries were thoroughly mixed. Subsequently, the mixture was uniformly coated onto a nickel foam with dimensions of 1.3×1.3cm^2 and subjected to a continuous pressure of 10 MPa for 30 seconds. The coated sample was then dried in an oven at 105°C for 12 hours. The electrochemical performance of the work electrode was analyzed using a CHI660e electrochemical workstation, which involved cyclic voltammetry (CV), galvanostatic charge/discharge (GCD) measurements and electrochemical impedance spectroscopy (EIS). The specific capacitance (C_s) of the electrode can be calculated using Eq. (S1).

* MERGEFORMAT $$C_s = \frac{I_d \times \Delta t}{m_1 \times a \times \Delta V_1} \quad \text{(S1)}$$

Here, C_s represents the specific capacitance of electrode, F g^{-1}; I_{d1} denotes the discharge current, A; Δt_1 represents the discharge time, s; m_1 represents the loading mass in the single electrode, g; a is the mass percentage of the active substance, wt%; ΔV_1 represents the discharge voltage window, V.

The total mass loading of SC-90, SC-120, and SC-150 electrodes is shown in Table S2. The total mass loading consisted the binder (PTFE, 10wt%), conductive agent (acetylene black, 10wt%), and O/N co-doped hierarchical porous carbon (80wt%) in the electrode. The total mass loading of SC-90, SC-120, and SC-150 electrodes is 4.2, 4.0 and 3.5 mg, respectively.

A symmetric supercapacitor (S-SSC) was prepared using SC-120 as the electrode and the cellulose membrane as the separator. The electrochemical performance of the work electrode was analyzed using a CHI660e electrochemical workstation. Moreover, the long-term stability of S-SSC was evaluated by subjecting it to a rigorous cycling test consisting of 7500 charge-discharge cycles using the Land testing system (CT3002A). Eq. (S2) - (S4) were used to calculate the energy densities and power densities of S-SSC.

$$C_m = \frac{I_{d2} \times \Delta t_2}{m_2 \times a \times \Delta V_2} \quad \text{(S2)}$$

$$E = \frac{1}{2} \times \frac{C_{\mathrm{m}} \times \Delta V_2^{\,2}}{3.6} \quad \text{(S3)}$$

$$P = \frac{E}{\Delta t} \times 3600 \quad \text{(S4)}$$

Here, C_m represents the specific capacitance of S-SSC, F g^{-1}; I_{d2} denotes the discharge current, A; Δt_2 represents the discharge time, s; m_2 represents the total loading mass in the two electrodes, g;

a is the mass percentage of the active substance, wt%; ΔV_2 represents the discharge voltage window, V; E represents the energy densities, W h kg^{-1}; P represents the power densities W kg^{-1}.

2. EMI shielding measurements

The electromagnetic interference shielding performance of SC-120 within the frequency range of 8.2-12.4 GHz was measured using a vector network analyzer (E5071C, Agilent) through coaxial method. A coaxial ring with SC-120 mixed with paraffin at a mass ratio of 5:5 was prepared, and the thickness of the coaxial ring was 1.984mm. SER, SEA, and SET correspond to the reflection effectiveness, absorption effectiveness, and total EMI shielding effectiveness of the material. The calculation process of SE_R, SE_A, and SE_T is shown in Eq. (S5) - (S7).

Here, S_{11} represents the reflection coefficient, and S_{21} represents the transmission coefficient.

$$SE_R = 10 \times \log(\frac{1}{1-|S_{11}|^2}) \quad (S5)$$

$$SE_A = 10 \times \log(\frac{1-|S_{11}|^2}{|S_{21}|^2}) \quad (S6)$$

$$SE_T = SE_R + SE_A \quad (S7)$$

The electromagnetic shielding efficiency (%) refers to the percentage representation of the electromagnetic shielding capability. It indicates the extent to which materials reduce the effects of blocking, reflecting, or absorbing electromagnetic waves relative to the incident electromagnetic waves. The electromagnetic shielding efficiency (%) was calculated by Eq. (S8).

$$\textit{Electromagnetic shielding efficiency (\%)} = 100 - (\frac{1}{10^{\frac{SE_T}{10}}}) * 100 \quad (S8)$$

Table S1 The production yield of sesame meal coke, SC-90, SC-120, and SC-150

Sample	esame meal coke	SC-90	SC-120	SC-150
production yield (%)	32.96	8.67	8.26	7.93

Table S2 The total mass loading and carbon mass loading of SC-90, SC-120, and SC-150 electrodes

Sample	SC-90	SC-120	SC-150
Total mass loading (mg)	4.2	4.0	3.5