Boosting the supercapacitive properties of polypyrrole with chitosan and hybrid silver nanoparticle/nanocluster

John Kevin Gan,1 Yee Seng Lim,1 Nay Ming Huang,1* Hong Ngee Lim2,3

1Low Dimensional Materials Research Centre, Department of Physics, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia
2Department of Chemistry, Faculty of Science, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
3Functional Device Laboratory, Institute of Advanced Technology, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
Corresponding author: huangnayming@um.edu.my (Huang N.M.)

Calculation

Three-electrode configuration

The specific capacitance was calculated from the galvanostatic charge/discharge (GCD) curves using equation (1).

\[ C_m = \frac{I \Delta t}{m \Delta V} \]  

where \( C_m \) is the specific capacitance in farads per gram, \( I \) is the discharge current, \( \Delta t \) is the discharge time, \( m \) is the mass of the active materials in the electrode and \( \Delta V \) is the potential window.

Two-electrode configuration

A symmetric supercapacitor cell was assembled using a Teflon Swagelok® construction with two equal Ag@PPy/CS electrodes. The separator is a piece of filter paper soaked with 1.0 M \( \text{H}_2\text{SO}_4 \) electrolyte. The specific capacitance was calculated according to equation (2)

Electronic Supplementary Material (ESI) for RSC Advances. This journal is © The Royal Society of Chemistry 2016
\[ C_m = 4C/m \]  
\[ (2) \]

where \( C \) is the experimental measured capacitance of the supercapacitor device, and \( m \) is total mass of the active materials in both electrodes. Electrochemical impedance spectroscopy (EIS) was carried out with a perturbation amplitude of 5 mV versus the open-circuit potential within a frequency range of 100 kHz to 0.1 Hz. The energy and power density of the symmetric supercapacitor were calculated from the GCD measurements by employing equations (3) and (4), respectively.

\[ E_{\text{cell}} = C_{\text{cell}} V^2/2 \]  
\[ (3) \]

\[ P_{\text{cell}} = E_{\text{cell}}/\Delta t \]  
\[ (4) \]

where \( E_{\text{cell}} \) is the energy density (W h kg\(^{-1}\)), \( C_{\text{cell}} \) is the specific capacitance of the cell, \( V \) is the working potential window, \( P_{\text{cell}} \) is the power density (W kg\(^{-1}\)), and \( \Delta t \) is the discharge time.

**Figure S1:** X-ray diffraction patterns of CS, PPy, PPy/CS, Ag@PPy and Ag@PPy/CS nanocomposites.