In recent decades, one of the major challenges is to provide highly efficient, low-cost, and environmentally friendly energy storage/conversion devices in order to address the increasing concern of environmental issues and the depletion of fossil fuels. Among of the various power source devices, electrochemical capacitors, also known as supercapacitors (SCs), as electrochemical energy-storage devices have attracted much interest due to a number of desirable properties, including rapid charging-discharging rate, long cycle life, and the ability to deliver up to ten times more power than the conventional batteries.\(^1\)

Herein, the novel polyaniline (PANI)/polypyrrole (PPy) double-walled nanotube arrays (DNTAs) are designed to exploit the synergetic effects and shape effects for SCs. The PPy and PANI both are polymers and they are promising pseudocapitive materials because of their good electrical conductivity, high energy storage capacity, low-cost synthesis, and environment-friendness, and they have the special complemental performance and can co-contribute to the enhancement of pseudocapacitive performance of electrode.

The aims of designing such PPy/PANI DNTAs are listed as following: (i) The DNTAs as a smart nanoarchitecture would substantially reduce the resistance of electrolyte penetration/diffusion and obviously enhance the utilization rate of electrodes because of the large surface area and arrayed, hollow nanostructures; (ii) The PPy and PANI layers would provide electron “highways” for charge storage and delivery because of its high electrical conductivity; (iii) The PPy/PANI DNTAs grown on conductive substrate have an excellent electrical contact with current collector, and accordingly each DNTA will effectively participate in electrochemical reactions and almost no “dead” volume.\(^4\)

The PPy/PANI DNTAs (40/20 nm) at scan rate of 5 mV/s show specific capacitance \(C_s\) of 693 F/g. The PPy/PANI DNTAs exhibited excellent rate capability and showed a decay of 47% in \(C_s\) with scan rate increasing from 5 to 250 mV/s. The PPy/PANI DNTAs also exhibited superior long-term cycle stability, and loss 8% of the maximum specific capacitance after 1000 cycles. Here the layer thicknesses of PPy and PANI can affect the performance of PPy/PANI DNTAs. The long-term cycle stability for five different PPy/PANI DNTAs are shown in Figure 1 (40 nm PPy layer and differing by the thick-ness of PANI layer (10, 20, 30, 40, and 50 nm)). With increasing thickness of PANI, the \(C_s\) of PPy/PANI DNTAs also increase from 575 to 780 F/g at 10 mV/s. The PPy/PANI DNTAs with PANI layers of 50 nm show the highest \(C_s\) of 780 F/g among these samples. Clearly, the PPy/PANI DNTAs with 40 nm PPy and PANI layers show the best supercapacitive performance with large \(C_s\) and high cycle stability. The synergetic effects between PPy and PANI, the shape effects of nanotube arrays and double-walled nanostructures, and high utilization rate of electrode are crucial for the outstanding performance of PPy/PANI DNTAs. The large \(C_s\), good rate capability, and excellent long-term cycle stability offered by the PPy/PANI DNTAs make them promising candidate electrodes for high-performance supercapacitors.

**Figure 1.** Long-term cycle stability at 10 mV/s for PPy/PANI DNTAs with different PANI thickness of 10, 20, 30, 40, and 50 nm (PPy layers are 40 nm).

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