

Polypyrrole Nanotubes/Graphene nanocomposites for printed flexible asymmetric supercapacitors

Bhawna Nagar

Deepak P. Dubal, Arben Merkoçi, Pedro Gomez-Romero

Novel energy oriented Materials group Catalan Institute of Nanoscience and Nanotechnology (ICN2), CSIC and The Barcelona Institute of Science and Technology, Campus UAB, Bellaterra, 08193 Barcelona, Spain

bhawna.nagar@icn2.cat
pedro.gomez@icn2.cat

In this work we combined highly capacitive graphene with pseudocapacitive polypyrrole nanotubes (PPyNTs) that were produced by chemical oxidation of pyrrole monomers by soft template directed route [1, 2]. We have tested the composite separately over a flexible cotton cloth using a three electrode cell. We aim to design a flexible asymmetric supercapacitor device over plastic substrate using inkjet or wax printing techniques for making patterns on plastic substrates in the future.

The composite preparation was confirmed using TEM (Figure 1(a) and (b)) while the electrochemical properties were tested using cyclic voltammetry (Figure 1(c) and (d)). Fig.1 c) shows an increase in current and capacitance with the composite compared to only rGO and PPyNTs. Also, there are different working voltages of rGO (-0.85 to +0.1V) and the composite (-0.3 to +0.8V). This can be taken advantage of by using the voltage window of rGO and the composite together in a two electrode cell to make an asymmetric flexible supercapacitor device, with a total of 1.6 V working voltage. Also, there is a change in the shape of the curves from typical rectangular of rGO to distorted rectangular shape with a prominent peak confirming pseudocapacitance from redox active polypyrrole. Preliminary electrochemical tests of the three-electrode cell, led to

capacitance values of 176, 310.5 and 324 F/cm³ for rGO, PPyNT and Gr/PPyNTs respectively.

The next steps include fabrication of a low-cost flexible asymmetric supercapacitor device harnessing the large potential window which in turn will provide high energy density.

References

- [1] Franciele Wolfart, Deepak P. Dubal, Marcio Vidotti and Pedro Gomez-Romero, *The Royal Society of Chemistry Adv.*, 6 (2016) 15062–15070
- [2] Dubal D.P., Chodankar N.R., Caban-Huertas Z, Wolfart F, Vidotti M, Holze R, Lokhande C.D., Gomez-Romero, P. *J.Power Sources*, 308 (2016)158-165.
- [3] Dubal D.P., Ayyad O., Ruiz V., Gómez-Romero P. *Chemical Society Reviews*, 44 (7) (2015) 1777 - 1790.

Figures

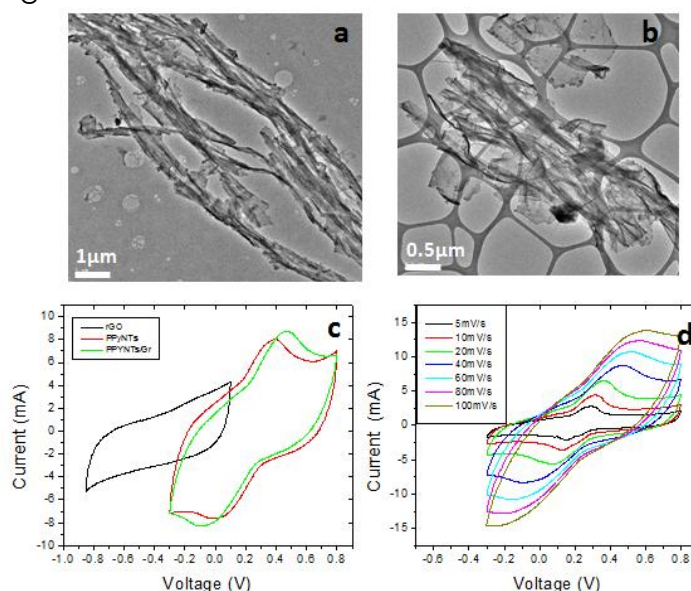


Figure 1: (a) and (b) TEM images of the composite (c)Cyclic Voltammograms of rGO, PPyNTs and Gr/PPyNTs at 40mV/s versus Ag/AgCl (d) CV curves of G/PPyNTs at different scan rates (5 to 100mV/s).