Advancing solid state and electrochemical science and technology

Journal of The Electrochemical Society

Graphene as Vehicle for Ultrafast Lithium Ion Capacitor Development Based on Recycled Olive Pit Derived Carbons

Jon Ajuria,[1,z] Maider Zarrabeitia,[2,a] María Arnaiz,[1,2] Oxel Urra,[1] Teófilo Rojo,[1,2] and Eider Goikolea[2,z]

[1] *CIC Energigune, Albert Einstein 48, Technology Park of Alava, 01510, Vitoria-Gasteiz, Spain*
[2] *Inorganic Chemistry Department, University of the Basque Country UPV/EHU, 48080 Bilbao, Spain*

Herein we report a series of lithium ion capacitors (LICs) with extraordinary energy-to-power ratios based on olive pit recycled carbons and supported on graphene as a conducting matrix. LICs typically present limited energy densities at high power densities due to the sluggish kinetics of the battery-type electrode. To circumvent this limitation, the hard carbon (HC) was embedded in a reduced graphene oxide (rGO) matrix. The addition of rGO into the negative electrode not only forms a 3D interpenetrating carbon network but also wraps HC particles, facilitating ion diffusion and enhancing the electronic conductivity notably at high power densities. Electrochemical impedance spectroscopy (EIS) analysis reveals that charge-transfer resistance at electrode-electrolyte interphase and the charge-transport resistance within the electrode are considerably lower in the presence of rGO. In addition, charge-transport resistance remains constant upon cycling even at increasing current densities. Capacity gain at high current densities, owing to the reduction of the electrode resistance, triggers the overall LIC performance, allowing for the assembly of an ultrafast LIC delivering up to 200 Wh kg^{-1}_{AM} at low power rates and 100 Wh kg^{-1}_{AM} at a power of 10 kW kg^{-1}_{AM}.
 [DOI: 10.1149/2.0361913jes]

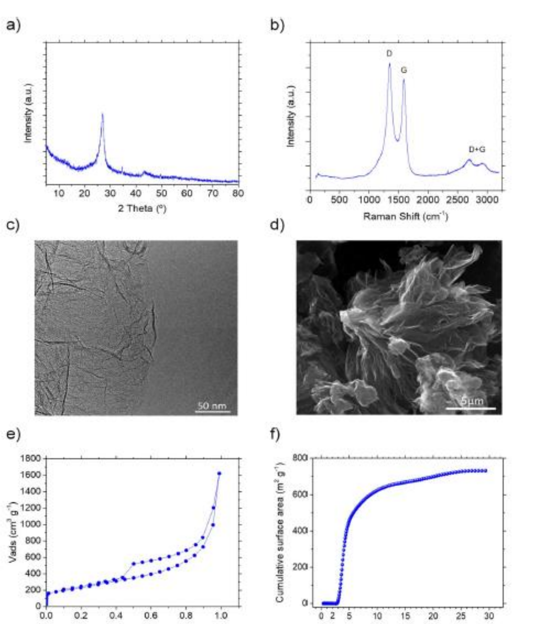

Figure 1. Physicochemical characterization of rGO: a) XRD pattern, b) Raman Spectrum, c) TEM micrograph, d) SEM micrograph, e) N_2 adsorption/deso isotherm and f) Cumulative surface area calculated using 2D-NLDFT.

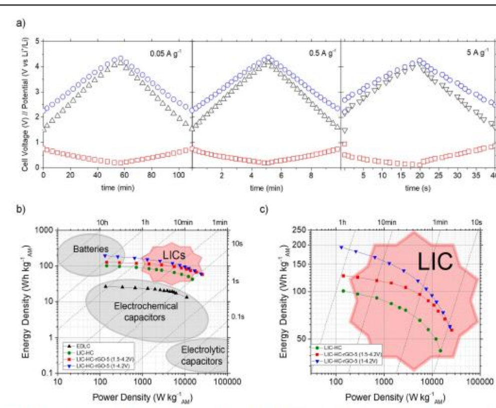

Figure 6. a) GA charge/discharge voltage profiles of HC-rGO-5:AC based LIC (black triangles) at applied 0.05, 0.5 and 5 A g^{-1} current densities and their respective HC-rGO electrode (red squares) and AC electrode (blue circles) potentials vs. Li^+/Li. b) Ragone Plot and c) Magnification of LICs region in the Ragone Plot.

Acknowledgments

We thank the European Union (Graphene Flagship, Core 2, grant number 785219), the Spanish Ministry of Science and Innovation (MICINN/FEDER) (RTI2018-096199-B-I00) and the Basque Government (Elkartek 2018) for the financial support of this work. M. Arnaiz thanks the Spanish Ministry of Science, Innovation and Universities for her FPU pre-doctoral fellowship (FPU15/04876).