Electrochimica Acta
Volume 334, 20 February 2020, 135587

An ultrafast battery performing as a supercapacitor: Electrode tuning for high power performance

Jon Ajuria [a], Frederic Aguesse [a]

[a] Research on Alternative Energies (CIC energiGUNE), Basque Research and Technology Alliance (BRTA), Alava Technology Park, Albert Einstein 48, 01510 Vitoria-Gasteiz, Spain

Received 6 September 2019, Revised 13 December 2019, Accepted 28 December 2019, Available online 30 December 2019.

https://doi.org/10.1016/j.electacta.2019.135587

Abstract

In this work we present an ultrafast battery (UFB) based on olive pit derived hard carbon (HC) and $LiNi_{1/3}Mn_{1/3}Co_{1/3}O_2$ (NMC111). In view of the faradaic nature of the active materials, the system should be catalogued as a battery. Nevertheless, the quadratic shape of the voltammograms demonstrates that the system can mimic supercapacitor performance, being able to respond to peak power demands in few seconds. Electrode engineering, by merely tailoring mass loading and mass balance, enabled such duality. On the one hand, at an operating voltage window of 2.9–3.75 V, the system is able to deliver 212 $Wh \cdot cm^{-3}$ at 1000 $W \cdot cm^{-3}$ (respect to the active mass) within a discharge time of 10 min. On the other hand, the system can deliver 87 $Wh \cdot cm^{-3}$ at 6000 $W \cdot cm^{-3}$ within a discharge time of 32 s. In addition, the system shows capacity retention over 90% after 30 000 cycles at a current density of 1 $A \cdot g^{-1}$ ($t_{discharge}$ = 32 s). This innovative design covers the existing gap between batteries and supercapacitors, resulting in an astonishing energy-to-power device that can rule out the electrochemical energy device scene.

Graphical abstract