MRS Spring 2023

View Abstract

CONTROL ID: 3837430

PRESENTER: Francesca Soavi

AUTHOR PREFERRED PRESENTATION TYPE: Invited Speaker

SYMPOSIUM: EN01 Electrochemical Capacitors and Related Devices—Fundamental, Materials and Cell Design

KEYWORDS: Performance/Functionality/energy storage, Performance/Functionality/energy storage, Performance/Sustainability/environmental impact.

ABSTRACT

TITLE: Green Hybrid Supercapacitive Systems

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ABSTRACT BODY:

Abstract Body: Electrical double layer capacitors (EDLCs) are key energy storage systems for applications having frequent high peak-to-average power demand, from portable to stationary applications and e-mobility. They are also considered systems of choice to design different hybrid energy technologies, where they are connected to batteries, fuel cells or ambient energy harvesters to improve the overall power performance and reliability.

A unique feature of EDLCs is that, unlike batteries, they store energy electrostatically within a wide operational voltage range, limited only by the electrochemical stability window of the electrolyte. This dynamic response makes EDLCs easily connectable, at single cell level, with a wide range of energy harvesters/storage units including those operating at low and variable voltage, like solar cells, piezoelectric generators, and microbial fuel cells.

Depending on the defined end-use, the hybrid energy storage/conversion systems should be properly sized and designed with attention to the sustainability of materials and manufacturing processes. Specifically, the storage unit has to be tailored, both to meet the device design requirements (flexibility, thickness, size) and the electric behavior of the harvester. In addition, today, EDLCs cannot be considered as totally green. Greener component options are biochar electrodes obtained by the pyrolysis of bio-derived-waste that will enable the exploitation of ubiquitous and scalable raw materials within a circular economy approach. Electrode and membrane manufacturing by water-processable polymers is also a valuable approach, as well as novel electrolyte formulations, including ionic-liquids and water in salt electrolytes (WiSE) could solve most of the criticality of today EDLC organic solvent-based electrolytes.

Here, we report about different activities that target the design of hybrid systems, where EDLCs are designed taking into account the electric characteristics of the energy harvesters parallel connected and and manufactured by exploiting sustainable components. The main achievements obtained within the HyFLOW UE project, that targets the development of an environmentally friendly hybrid storage unit based on vanadium redox fow batteries and supercapacitors will be reported. We will discuss about the different approaches that should be followed for hybrid systems, based on different harvesters like solar cells, piezoelectric generators, or microbial fuel cells, where EDLCs play a key role in improving the output power quality and efficiency. We will also propose a semi-empirical method for proper supercapacitor sizing and component selection.

Acknowledgments

This work was supported by the European Union within the Horizon 2020 Research and Innovation Program 2020-2023 (Grant No. 963550 HyFlow project https://hyflow-h2020.eu/) and by NATO Science for Peace and Security Programme, under grant agreement G5772.

Attendance: I will attend in San Francisco and present in person between April 10-14, 2023