Electrochemical characterization and calculation methods of supercapacitors

4

Ellie Yi Lih Teo[1,2,*] *and Kwok Feng Chong*[3,4]
[1]Department of Science & Technology, Faculty of Humanities, Management and Science, Putra University Malaysia, Bintulu, Sarawak, Malaysia, [2]Institute of Ecosystem Science Borneo, Putra University Malaysia, Bintulu, Sarawak, Malaysia, [3]Faculty of Industrial Sciences and Technology, Universiti Malaysia Pahang Sultan Al-Abdullah, Kuantan, Pahang Darul Makmur, Malaysia, [4]Center for Advanced Intelligent Materials, Universiti Malaysia Pahang Sultan Al-Abdullah, Kuantan, Pahang Darul Makmur, Malaysia
*Corresponding author. e-mail address: ellie_teo@upm.edu.my

4.1 Introduction

Supercapacitors, also known as electrochemical capacitors, are well known to be energy storage devices that can store electrical energy harvested from alternative sources. Supercapacitors can be categorized into electric double-layer capacitors, which store charges through the formation of electric double layers, and pseudocapacitors (PCs), which accomplish charge storage via reversible redox reactions. They are well known for their intrinsic properties such as high power density (>10 kW/kg), long life cycle ($\sim 10^6$), fast charge−discharge, and low maintenance. This has led to significant research interest in the development of supercapacitors such as novel materials for electrodes, new electrolytes, and material and type of separators.

As the electrode stores bulk of the charges, new 2D materials like graphene and Mxene have been introduced as potential electrode material due to their high specific surface area, which means higher electrostatic charge storage [1]. Various research studies have also been conducted on the formation of composites between carbon-based materials (activated carbon [AC], carbon nanotubes, graphene, etc.) and metal oxides (manganese, nickel, cobalt, etc.) or conducting polymers (polyaniline [PANI], polypyrrole, etc.) to yield the synergistic effect of both materials [2,3]. To overcome the charge transport limit in 2D electrodes, 3D forms of the electrode such as in the form of aerogel, hydrogel, and 3D self-assembly are also being explored. In terms of electrolytes, aqueous electrolytes are preferred, as they are benign and easily available. However, they have a smaller operating potential window (PW) compared to nonaqueous electrolytes. Nonaqueous electrolytes have a large operating PW, but they are expensive and nonenvironmentally friendly. Therefore the focus for supercapacitor electrolytes is on the development of the "perfect" electrolyte, which has high ionic conductivity, large PW, and a wide operating temperature range [4].

Supercapacitors. DOI: https://doi.org/10.1016/B978-0-443-15478-2.00008-5