BIOMASS-BASED ACTIVATED CARBON ELECTRODES

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INTRODUCTION

The exhaustion of fossil fuels and climate change have led to global environmental demands that require researchers to explore developing renewable and sustainable energy sources. There is increasing interest in producing clean and green energy sources, typically wind and solar [1]. Further, efficient energy storage is becoming the focus for the majority of the scientific community, drawing attention to high-performance energy storage systems such as supercapacitors. Supercapacitor exhibits a high power density and thus offers promising potential to facilitate the development of energy storage. The supercapacitor is in demand among other energy storage devices as it is compatible with various applications such as electric vehicles, portable devices, and many other stationary energy storage systems [2]. This energy storage system offers high power density, excellent cycle performance, high cyclic stability, and rapid charge-discharge rates [3].

In supercapacitor application, high energy storage ability can be achieved with a highly porous structure of carbon materials that develop a high specific surface area, long-term cycle ability, and high conductivity [4]. Supercapacitors' most common electrode material is activated carbon under an electrochemical double-layer capacitor (EDLC). Porous carbon materials

are vastly implemented as electrode materials due to their amazing textural features, high porosity on the surface area, and well-developed pore size distribution. These features serve the porous carbon materials to easily adapt to electrolyte ions' sizes, high conductivity, and stability. Moreover, the electrochemically active site of the surface functionalities for the carbon-based materials can be fabricated to modify the capacitive behaviour in supercapacitor applications.

PRINCIPLE OF SUPERCAPACITOR

Theory

The electrode material is the most important component for charge storage in the supercapacitor, influencing the electrochemical performance. Generally, supercapacitors can be classified into electrical double-layer capacitors (EDLC) or pseudo-capacitors, whose electrochemical performance is evaluated through the physical and chemical properties of the electrode and electrolyte materials.

Types of Supercapacitors

A supercapacitor can be classified into three different types, which are electrochemical double layer capacitor (EDLC), pseudo capacitor, and hybrid capacitor [5]. The electrode material is the primary factor that contributes to excellent performance in supercapacitors. Carbon-based materials such as activated carbon and graphene, transition metal oxides (nickel (II) oxide and manganese dioxide), as well as conducting polymers are among the common electrode materials used in supercapacitors.

EDLC is an energy storage device that stores available electrical energy in the form of an electrochemical with a double layer between the anode-cathode electrode and the electrolyte solution. Commonly, the charge storage in EDLC is non-Faradaic and has zero presence of chemical reduction-oxidation reaction [4]. The electrode materials for EDLC are mainly from various carbon forms such as graphene, carbon nanotubes, and activated carbon [6]-[7]. Unlike EDLC, pseudo capacitor involves redox reaction and transports the electrolyte ions through Faradaic electron charge