Electrochemical behavior of biomass-derived activated carbons for electrochemical capacitors

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Recently, concerns about the global environment have increased, and the interest in new energy devices that can replace petroleum has also increased. Energy storage devices with high energy densities, such as Li-ion batteries (LiBs) and fuel cells, are key to developing this technology but are limited by low power densities, making it challenging for vehicles to adapt to varying power demands. Electric double-layer capacitors (EDLC) are characterized by high power densities and semi-permanent life characteristics. Therefore, EDLC is suitable for use as auxiliary power to compensate for low power density of LIB or fuel cells. The electrochemical properties of the EDLC are determined by three factors: the electrolyte, current collector, and active electrode material, the last of which has the greatest influence. Thus, the active electrode material of the EDLC should have a large specific surface area and outstanding electrical conductivity to facilitate the storage of many ions. For this reason, porous carbon materials have been widely used. Notably, among the various porous carbon materials for EDLC, activated carbon (AC) shows numerous advantages from outstanding electrical conductivity to physical and chemical stability, large specific surface area, and low cost, such that it has been used as the main active electrode material for the EDLC. In the past, EDLC studies have focused on improving energy density, and as a result, most studies on the development of high specific surface area AC with micropore-rich pore structure have been conducted. However, EDLC required in the market is demanded not only for high energy density but also for high power density. Therefore, it is necessary to study AC having a high specific surface area (for high energy density) and a high mesopore ratio (for high power density).

In this study, a mesoporous kenaf-derived AC (KAC) was prepared to enhance the performance of an EDLC. Specifically, the effect of the stabilization agent on the pore development mechanism was studied by observing the textural properties and crystal structure analysis. And their electrochemical performance was studied focusing on the textural properties. As a result, the specific surface area and mesopore volume ratio 1490-1940 m^2/g and 69.5-88.1%, respectively. It was also observed that pore structure was found to be dependent on the activation temperature. The mesopore structure of KAC resulted in a substantial decrease in the Warburg impedance as the ion diffusion resistance decreased. Finally, the KAC developed through chemical stabilization and steam activation exhibited more outstanding pore characteristics and electrochemical performance than commercial AC (YP-50F), as well as the potential to enhance the performance of EDLC as an active electrode material.