Investigation of various aqueous electrolytes on the electrochemical characteristics of supercapacitors based on activated carbon

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Supercapacitors (SCs), also known as electrochemical capacitors (ECs), are recognized as a major device for energy storage and are also attracting increasing interest due to their continuous practical use in mobile electronic devices, electric vehicles and fuel cells [1,2]. SCs also include pseudocapacitors and electrical double layer capacitors (EDLCs). In particular, EDLCs have a physical charge accumulation mechanism that creates an electrical double layer (EDL) on the surfaces of both electrodes [3].
Electrolytes play a vital role, and there are two forms of electrolytes: aqueous electrolytes and organic electrolytes. Aqueous electrolytes have obvious advantages over organic electrolytes, such as high conductivity, high safety and low cost. In addition, compared to organic electrolytes, aqueous electrolytes have a resistivity that is at least 20 times lower than that of organic electrolytes, which means that the power density of a supercapacitor using aqueous electrolytes is very high. In addition, the ionic conductivity and electrochemical potential window of the electrolytes also affect the efficiency of SCs [4]. In this study, the advantages of aqueous electrolytes prompted us to use and compare such as electrolytes 6M KOH, 1M Li_2SO_4 and 1 M Li_2SO_4 + 0.5 M KI.
For preparation of composite electrodes, we used synthesized carbon material based on walnut shells and commercial carbon of Cabot Norit Nederand B.V. (producer Netherlands) (mass 85%) with addition of PVDF, "Kynar HSV900" (mass 10%) as binder and acetylene carbon black (mass 5%), "C-65, Timcal C-NERGY Imerys" as conductive additive.
Various characterization tools such as SEM/EDX, BET and X-ray Diffraction Analysis, Thermogravimetry (TG/DTA), and Raman spectroscopy were used to evaluate the carbon materials. The electron microscopic images shown in Figure 1 show the openwork morphology typical of activated carbon (AC) based walnut shells and internal porosity.
Electrochemical tests were performed using an Elins P-45X multi-channel potentiostat-galvanostat instrument. The obtained activated carbon electrodes were used as supercapacitor electrodes using cyclic voltammetry (CV), galvanostatic charge-discharge (GCD) and electrochemical impedance spectroscopy (EIS) techniques in aqueous electrolytes. In the potential range from 0 to 1 V, CV measurements were recorded at various scanning speeds ranging from 20 to 160 mV/s. GCD was performed at specific currents of 100, 500, 1000, and 2000 mA/g with a voltage range of 0 to 1 V. EIS measurements were evaluated in the frequency range (0.01 Hz to 100 kHz) at a sine potential amplitude of 10 mV.

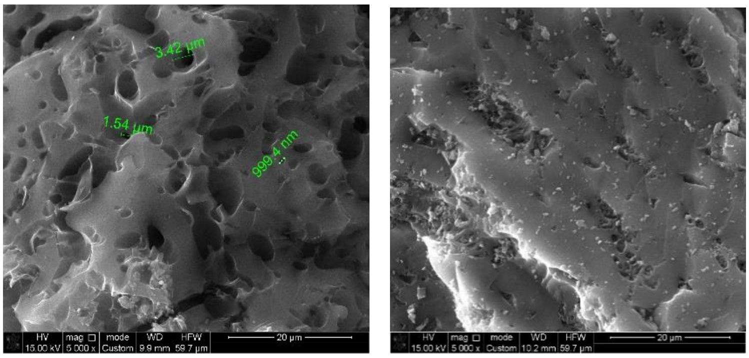

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Figure 1. Scanning electron microscopy images of porous carbon materials (1-walnut shells and 2-commercial carbon).

Synthesized carbon material based on walnut shells calculated capacitance values of 266 F/g for 1 mol/L Li_2SO_4 and 273 F/g for 6 mol/L KOH, respectively. Evaluation of the electrochemical characteristics showed that the porous walnut shell-derived carbons were characterized by outstanding charge propagation and gravimetric capacitance comparable or even much higher than that of commercially available AC.

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