Development of high-capacity electrodes for capacitive deionization

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Capacitive deionization (CDI) is a technology for desalination and water treatment in which salts and minerals are removed from water by applying an electric field between two porous electrodes. When an electric potential is applied to an electrode, ionic compounds are attracted to and electrostatically adsorbed onto the surface of the charged electrode. For desorption, the electrical potential is removed, and the adsorbed ions are quickly released back into the bulk solution [1-3].

The CDI process has increasingly become utilized as a desalination technology, and is regarded as an energy-efficient process because it operates is regarded as a relatively low voltage (approximately 1.2 V), one at which no electrolysis reactions occur. Shortening the CDI circuit or reversing the polarity of the electrodes is able to make adsorption and desorption of ionic substances from aqueous phases [4]. In other words, a main operating principle of CDI is that ions are adsorbed from a solution onto the electrostatic double layers formed at the electrode/solution interface inside of two porous electrodes. Because it is important to increase the ion adsorption capacity of the electrode surface for better CDI performance, properties of electrodes such as surface area, hydrophilicity, functional groups on the surface, and so on play a crucial role in determining the performance of CDI processes.

In this study, we fabricated carbon electrodes through mixed two different carbon powders with different sizes to investigate the effect of electrochemical properties of the electrodes fabricated with various combination of two carbon powders in weight. The characteristics of adsorption, desorption and electrode reactions were investigated by measuring conductivity, effluent pH, and the current passed through the cell under different mixing ratio. Moreover, electrochemical methods such as cyclic voltammetry (CV), chronoamperometry (CA), and electrochemical impedance spectroscopy (EIS) were applied to characterize the electrochemical properties of the electrodes in terms of capacitance, current efficiency, resistance and so on. As a result, it was confirmed that inclusion of smaller carbon particles inside the pores formed by bigger carbon particles is attributed to an increase in meso-size pores to enhance the adsorption as well as better electrical connectivity.

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