Modification of Carbon Xerogels for Negative Electrode in a Capacitive Deionization Cell

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The concept of capacitive deionization (CDI) cell is straightforward – by control of electrostatic force, ions dissolved in an aqueous liquid can be trapped on a polarized surface, and regenerated back to a concentrated stream. Therefore, CDI is an alternative technology for wastewater treatment, competing with other current technologies. In contrast to the membrane and thermal treatments (*e.g.*, reverse osmosis and mechanical vapor compression), CDI offers the advantages of low-pressure operation and less-cost maintenance.[1]

Various carbon materials have been extensively studied as electrodes in CDI cells as shown in a recent review.[2] To improve the deionization performance of a CDI cell, attempts to modify and develop carbon materials have been experimentally performed, including the improvement of porosity and surface area by varying synthesis conditions, increases of ion-accessible pores by forming surface groups, change of surface polarity by coating with metal-oxide particles, use of membrane-assisted methods to reduce co-ion repulsion, and the design of novel carbon-based materials. These modifications and developments have shown a significant increase in the electrosorption capacity in CDI studies.

A typical CDI cell employs the same carbon materials at both the positive and negative electrodes (*i.e.*, same thickness and porosity), which is often called symmetric CDI operation in the literature.[3] However, this physically symmetric CDI operation may actually be electrochemically asymmetric, as the same type of carbon material could have a substantially different behavior for cation and anion adsorption. Under such conditions, the total deionization performance for a CDI cell is always restricted by the electrode with weaker ion adsorption. Furthermore, as discussed recently from an electrochemical aspect, the deionization efficiency depends on the location of the potential of zero charge (PZC) and discharging potential (E_o, when two electrodes are shorted) with respect to the electrode working domain.[4] As a result, after determining the behavior of each electrode for ion adsorption within the working domain, modification of one electrode (*i.e.*, an asymmetric CDI operation) is an alternative way to improve the deionization performance.

In this study, we modify the CX electrode surface by forming negatively polarized surface species. These modifications for the negative electrode can significantly improve deionization performance for a CDI cell.

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References

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