Two-dimensional Hybrid nanocomposites for Ion-selective Faradic Capacitive Deionization

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Abstract

Rapid population growth, industrialization, and modern urbanization have all contributed to an increase in the demand for potable water globally. As a result, effective and sustainable desalination methods have evolved, producing potable water from a variety of sources, including brackish water. Capacitive deionization (CDI) systems are among the most promising methods for producing potable water from brackish water sources. Thus, the development of better electrode materials is critical in the development of a CDI system that consumes less energy. A variety of three-dimensional (3D) nanostructured composites, including metal oxide-decorated graphene/carbon nanotube hybrids[1,2] and bimetallic nanoparticle-embedded graphene frameworks[3], were produced using simple hydrothermal and thermal treatment procedures. These materials have distinct architectures that integrate both faradaic and non-faradaic mechanisms, resulting in effective ion capture, high specific capacitance, and improved charging efficiency (Fig.1). Specifically, redox-active electrodes showed improved sodium ion intercalation/deintercalation, resulting in high salt adsorption capacities and excellent cycling stability[1,2,3]. Furthermore, the use of nanoclay and conductive carbon networks improved hydrophilicity and structural resilience, resulting in a longer electrode lifespan and consistent performance[4]. The work emphasizes the possibility of tailored hybrid materials and asymmetric electrode topologies to promote next-generation CDI systems by increasing desalination efficiency, energy savings, and operational stability.

References

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Figures

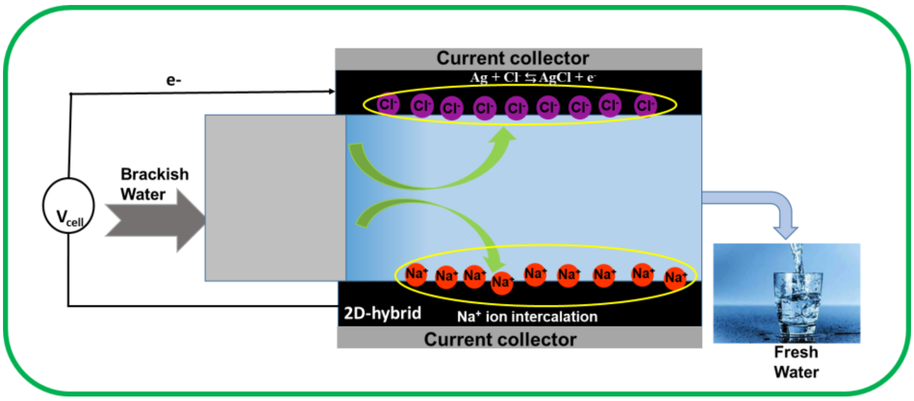

Figure 1: Schematic representation of a faradic capacitive deionization system with 2D hybrid electrode material