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Development of Ion-Exchange Fiber-Reinforced Concrete Batteries for Energy Storage Applications

Abstract

This study examines the development of ion-exchange fiber-reinforced concrete batteries designed to balance energy storage functionality with structural durability. By investigating innovative materials and methods for bifunctional infrastructures, this research addresses the global need for sustainable energy solutions. Incorporating ion-doped fibers into concrete matrices is a novel approach to improving mechanical and electrochemical properties. The principal methodology includes the design of optimized concrete composites and experimental studies such as electrochemical impedance spectroscopy, cyclic voltammetry, charge/discharge cycling, and compressive strength assessment. The battery performance was evaluated, and the preliminary results indicate the stability of cement-based rechargeable batteries in terms of discharge capacity, efficiency, and energy density. Significant progress has also been made in terms of durability under environmental stress. Efforts will also be made to integrate these versatile materials into innovative infrastructure systems such as energy-efficient buildings and self-powered roads. This work highlights the potential of rechargeable cement-based batteries for scalable applications in buildings and roads, contributing to the sustainability and multifunctionality of future infrastructure development.