Innovative Rechargeable Cement-Based Solid-State Batteries for Self-Powered Intelligent Transportation Infrastructure

Innovative developments in intelligent transportation systems (ITS) necessitate reliable and sustainable power sources for operation. Traditional energy supplies exhibit limitations regarding sustainability and continuous power availability. Cement-based batteries present a promising solution by embedding energy storage capabilities within infrastructure components such as roads, bridges, and buildings. This paper introduces rechargeable cement-based solid-state batteries, leveraging the ubiquitous nature of cementitious materials to power ITS components such as sensors, lighting, and communication devices. Nickel-iron electrodes and cement-based electrolytes were fabricated and analyzed for microstructure and ionic conductivity. The inclusion of polyacrylic acid (PAA) enhanced performance, achieving a maximum energy density of 13.1 Wh/m^2. Findings demonstrate these batteries' potential to autonomously power ITS components, reduce traditional energy reliance, and minimize environmental impact. This approach offers a sustainable path for developing self-powered, intelligent infrastructure, contributing to smart city initiatives and resilient urban planning.