Nickel foam and carbon fiber as current collector for alkaline nickel-iron rechargeable cement-based batteries

This paper investigates the development and optimization of alkaline nickel-iron rechargeable batteries for integration into cement-based structures, introducing an innovative approach to enhance energy storage within construction materials. Foam nickel mesh and carbon fiber mesh are employed as current collectors for the nickel-iron electrodes. Performance tests were conducted on the integrated nickel-iron rechargeable batteries within cement.Compared to batteries using carbon fiber mesh (CF-Cell), batteries using foam nickel mesh current collectors (NF-Cell) exhibited higher capacity retention and better cycling stability. The initial capacity of NF-Cell was 11.92 Wh/m^2, and after 30 charge-discharge cycles at a current density of 0.12 mAh/cm^2, it retained 10.38 mAh/cm^2. Additionally, foam nickel batteries demonstrated superior rate capability, maintaining 25% of their initial capacity when the current density was increased fivefold, representing a 12.1% improvement over carbon fiber-based batteries. Further electrochemical analysis through scanning electron microscopy (SEM), cyclic voltammetry (CV), and electrochemical impedance spectroscopy (EIS) revealed that the electroplated foam nickel electrode possesses a three-dimensional interconnected porous structure. This structure enhances contact with the active material and promotes ion transport. Consequently, NF-Cell exhibits lower impedance and excellent ion diffusion characteristics, thereby enhancing charge retention capabilities and exhibiting slow self-discharge.This study emphasizes the potential of alkaline nickel-iron rechargeable cement-based batteries as a viable energy storage solution. Foam nickel, as a promising, efficient, and cost-effective battery current collector, holds the promise of effectively harnessing and storing renewable energy, thus meeting the energy needs of remote areas.

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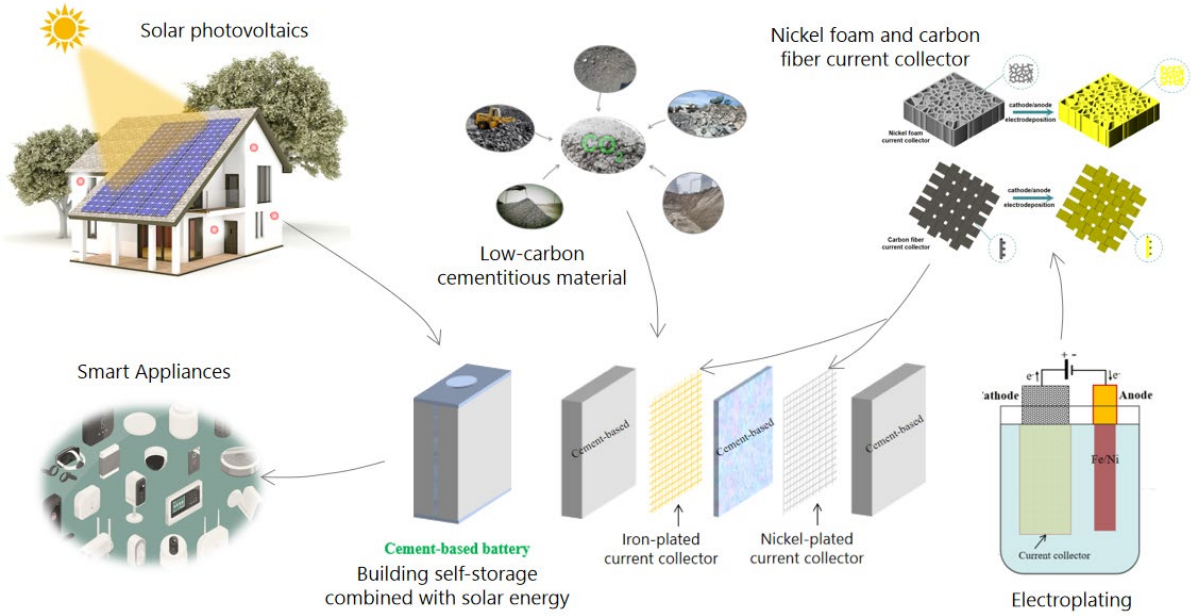
Solar photovoltaics
Low-carbon
cementitious material
Nickel foam and carbon
fiber current collector
Smart Appliances
Cement-based battery
Building self-storage
combined with solar energy
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Iron-plated
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