

Mapping potential electrode for lithium-ion supercapacitors

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Abstract

Many of the available renewable sources (solar and wind) are intermittent and the energy supply may not match the energy demand. Hence, storage is needed to enable energy to be stored for use when it is needed later. Diminishing fossil fuels and increasing oil prices have created the need to derive energy from sustainable sources. The energy storage device from alternative and inexpensive sources, such as bio-waste chicken eggshells, has a niche in storing and releasing the energy. The research is the first of its kind in the world and tested whether eggshells can provide an alternative to the traditional reliance on fossil fuels in assist to power lithium-ion batteries used in households.

Mapping new materials for renewable energy storage is critical to our planet's future. Chicken eggs are used worldwide in large quantities in the food, pharmaceutical, and manufacturing industries, and household purposes. However, after using the egg, the shells are discarded as solid waste. The shell is a composite made of CaCO_3 and a protein-rich fibrous membrane. This bio-waste is commonly disposed of in landfills, which attracts a cost. In order to achieve sustainable development, reusing waste streams can provide both economic and environmental returns.

The fine eggshell powders are used as an electrode against a metallic lithium anode in a non-aqueous electrolyte. The initial discharge capacitance of the eggshell system was found to be 232 F g^{-1} , while the reversible capacitance was 120 F g^{-1} . From thereon, the cell maintained an excellent capacitance retention of 92% over 1000 cycles. The electrochemical performance obtained is comparable to that of commercially available classical activated carbon (AC) material. The CaCO_3 showed a non-faradaic behaviour and the shape of the electrochemical curves resemble that of the AC electrode. The preliminary findings suggest that CaCO_3 from eggshells can be used as the electrode in lithium supercapacitors to store and release charges effectively over a wide electrochemical stability window of 4 V.

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