Sustainable carbon anode materials derived from polypropylene via eco-friendly pretreatment and carbonization

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Waste polypropylene (PP) poses significant environmental challenges due to its non-degradability and common disposal methods such as incineration or landfilling [1]. Converting PP into carbon materials for lithium-ion battery (LIB) anodes offers a sustainable alternative [2] but typically involves harsh chemical treatments to improve thermal stability and carbon yield. This study introduces a novel, eco-friendly method that utilizes a bio-derived additive—composed of chitosan, montmorillonite, and sodium phytate—to enhance the thermal resistance of PP during carbonization. The additive, incorporated at 5 wt% through ball milling, effectively suppresses PP decomposition above 400 °C and increases residual carbon retention. The resulting carbon materials were characterized by Fourier-transform infrared spectroscopy (FTIR), thermogravimetric analysis (TGA), X-ray diffraction (XRD), Raman spectroscopy, scanning electron microscopy (SEM), and transmission electron microscopy (TEM) to investigate their structural and morphological features. Electrochemical performance was evaluated using galvanostatic charge–discharge, cyclic voltammetry, and electrochemical impedance spectroscopy, demonstrating the material's potential as a viable anode in LIBs. These findings highlight a promising pathway for sustainable plastic waste valorization through green chemistry and energy storage innovation.

Keywords: Waste polypropylene, lithium-ion batteries, anode material, upcycling, plastic recycling, sustainable energy storage, carbonization.

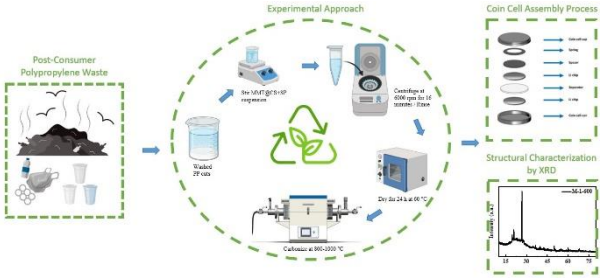

Figure 1. A schematic representation of the eco-friendly upcycling process that converts polypropylene (PP) waste into carbon anode material for lithium-ion batteries.

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References

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