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Recycling Broken Photovoltaic Cells into Anodes for Lithium-Ion Batteries Using Open-Source 3D Printing

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Abstract : The increasing volume of end-of-life photovoltaic (PV) cells presents a significant environmental challenge and offers an opportunity for resource recovery. This work explores the use of broken silicon PV cells as a sustainable source of silicon for the fabrication of anodes in lithium-ion (Li-ion) batteries. An open-source toolchain provides a low-cost and accessible method for 3D printing anode composites. The silicon used in PV cells has already undergone energy-intensive purification and processing, which enhances its reuse in batteries as a more resource-efficient approach. While silicon is abundant and offers potential for high-capacity anodes, it faces challenges such as low conductivity and significant volume changes during cycling, which can lead to mechanical degradation and reduced battery performance. In this work, silicon PV waste is first ground into particles smaller than 50 microns using an open-source ball mill. The silicon particles mix with a UV-curable resin through an open-source bottle roller to form a printable slurry. This slurry is used to fabricate an acrylate-silicon composite via stereolithography (SLA) 3D printing. SLA 3D printing offers the advantage of high precision and the ability to create complex geometries, which can enhance the performance of the anode. The printed parts are then pyrolyzed in an inert nitrogen atmosphere, which burns away the volatile components of the resin and leaves behind a carbon residue that enhances conductivity and helps alleviate silicon volume expansion during cycling. The results demonstrate the feasibility of using broken solar cell anodes in batteries. This approach is a promising candidate for advancing recycling solutions. Additionally, the use of open-source toolchain promotes resource recovery and shows potential for future developments in circular economy within energy storage.

Keywords : recycling, silicon anode, Li-ion battery, 3D printing
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