Increased Charge Rate and Capacity for Olivine Li-Ion Batteries via Efficient, Upcycled Nanoscale Electrodes

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Lithium-ion batteries are used as the power source for a myriad of devices, from smartphones to electric vehicles. The main issues preventing further growth and development of these batteries are safety and capacity - both of these must be addressed in order to secure the future of the Li-ion energy market. A possible solution to these limitations may lie in adaptation of silicon anodes; Si's specific capacity can reach 4.2 Ah g-1, 12x that of the most commonly used anode, graphite. To date, however, Si anode technology remains untapped due to its massive volume change and instability during Li cycling. Concurrently, Li-ion electrode technology can be improved using lithium iron phosphate (LiFePO4) in place of LiCoO2. LiFePO4 possesses increased thermal and chemical stability, charge stability for over 2000 cycles, and decreased environmental impact when discarded. In this research, Si-anode and LiFePO4 technologies were simultaneously adapted to design an improved Li-ion battery. To prepare silicon for use as an anode material, Si wafers were first (metal-assisted) chemically etched, to create nanoscale channels on the surface. These channels provide space for the crystal to safely expand and contract without damage to its structure. Lithium-ion batteries, including etched, nanostructured Si-anodes, were assembled, and compared to a standard CR2032 cell at low-load conditions (10ohm resistance). The new Si-LiFePO4 design demonstrated 48% higher specific capacity, and exhibited 250X improvement in consistent output, suggesting that they are better-suited than the CR2032 for long-term applications such as pacemakers, emergency lighting, and devices which require consistent power.

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