Waste-Lithium-Liquid (WLL) Flow Battery for Stationary Energy Storage Applications

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With using a multi-layer electrolyte that consists of one liquid electrolyte and one solid electrolyte, the choices for cathode will be dramatically widened to include solid, liquid, and gas phases. Applying this concept, gas and liquid phases have been used as cathodes to create different battery systems such as the Li-air, Li-sea water, and Li-aqueous liquid batteries. Based on these reports, we hypothesized that, by charging the cell, Li metal could be electrochemically collected from any material containing Li-ions. This idea extended to harvesting Li metal from waste Li-ion batteries, in both solid and liquid phases, that contain Li-ion sources such as the Li_xC_6 anode, Li_xFePO_4 cathode, and $LiPF_6$ in the EC:DEC electrolyte. The harvested Li metal could then be an energy source for Li-Liquid flow batteries by using water as the cathode.

This study demonstrates the feasibility of using waste Li-ion batteries and water for the electrodes in a Waste-Lithium-Liquid (WLL) flow battery that can be used in a stationary energy storage application. Li metal was collected electrochemically from a waste Li-ion battery containing Li-ion source materials from the battery's anode, cathode, and electrolyte, thereby recycling the Li contained in the waste battery. The harvested Li metal in the battery system was discharged to produce the electricity by using water as the cathode. The discharge voltage of the water showed 2.7 V at 0.1 mA/cm^2 versus Li metal harvested from waste Li-ion batteries, compared to 2.8 V versus fresh Li metal at the same current rate. Since the energy source for this proposed battery system is provided by waste Li-ion batteries and water, the cost of the battery dramatically decreases, which is an attractive strategy for a large size energy storage application