LITHIUM-ION BATTERIES

High-voltage electrolytes

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The amount of energy stored in a battery can be improved through increasing the operating voltage or the capacity of its electrodes and, in particular, the cathode. For Li-ion batteries, cathode capacities are approaching their limit. This has prompted researchers to turn their attention to the development of high-performance electrolytes that can enable high-voltage battery operations. Unfortunately, existing electrolytes are prone to undesired decomposition at high operating voltages (typically ~5.0 V), leading to poor cycling stability and a deterioration in efficiency. Now, Chunsheng Wang and colleagues at the University of Maryland and Brookhaven National Laboratory develop an all-fluorinated electrolyte with high stability above 5.3 V, which, when coupled with a high-voltage cathode ($LiCoMnO_4$), delivers an exceptionally high energy density of 480 Wh kg^{-1} for 100 cycles.

Their electrolyte consists of $LiPF_6$ salts in solutions of fluoroethylene carbonate (FEC), bis(2,2,2-trifluoroethyl) carbonate (FDEC), hydrofluoroether (HFE), and a Li difluoro(oxalate)borate (LiDFOB) additive. These components all have important roles in the operation of the battery: FEC, FDEC and especially HFE have high oxidation potentials due to the strong electron-withdrawing effect of their F atoms, which helps to maintain their oxidative stability at the cathode; FEC, FDEC, HFE and LiDFOB all contribute to producing F-containing species that are key in the formation of the stable cathode–electrolyte interface; FEC helps dissolve the Li salts; and FDEC decreases the viscosity of the electrolyte solution and improves the ion transport. Furthermore, the $LiCoMnO_4$ cathode is also carefully prepared so that there is no presence of Mn^{3+} ions, whose redox occurs at a low voltage and would therefore lead to a low energy density.

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