LITHIUM-ION BATTERIES

Deciphering electrolyte degradation

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The performance of Li-ion batteries deteriorates during operation. This is caused by undesired reactions that lead to the loss of active Li content, dissolution of transition metals and degradation of electrolytes. Both the solvent and salt components of electrolytes are prone to decomposition; a significant part of electrolytes is also consumed in the formation of electrode–electrolyte interphases during cycling. While battery degradation has been widely studied at the lab scale, investigations on batteries under realistic aging conditions, which differ significantly from the cycling procedures at labs, are rarely reported in the scientific literature. Now, Sascha Nowak and colleagues at the University of Münster and Helmholtz-Institute Münster take battery samples from used electric vehicle (EV) battery packs provided by five EV manufacturers and characterize their electrolyte compositions.

No information on the received battery samples was given to the researchers in advance, but by using a range of analytical techniques they quantify the electrolyte decomposition products and also decipher the pristine electrolyte formulation. Despite having varied electrolyte compositions in the samples, $LiPF_6$ is identified as the dominating conducting salt, and almost all samples contain cyclic ethylene carbonate (EC), linear dimethyl carbonate and ethyl methyl carbonate (EMC) solvents. Through hydrolysis and reaction with solvent molecules, $LiPF_6$ decomposes to many different products, among which those containing phosphorous are toxic. The degradation of solvents predominantly occurs via polymerization of EC and transesterification of EMC. Based on the low degree of transesterification, the researchers also suggest that at least one additive must be present in the pristine electrolytes to suppress this reaction. However, it could not be precisely detected in the aged electrolytes, possibly due to being consumed during the formation of electrode–electrolyte interphases.

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