High-rate Li-ion batteries demonstrate superior safety

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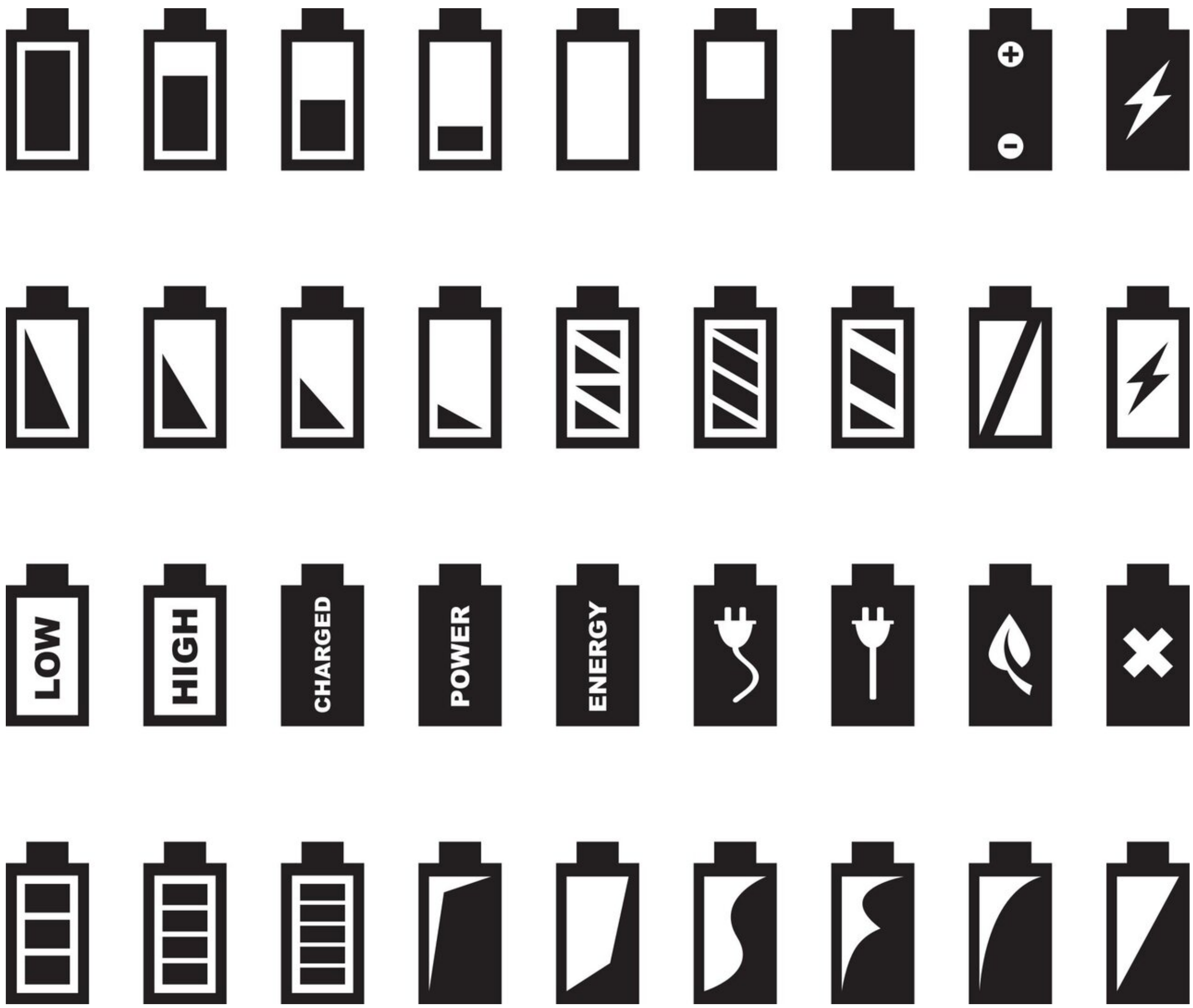

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As the inevitable growth of transport electrification continues, the types of batteries that will be used in such vehicles, their charging parameters, infrastructure and timeframes are key considerations that will speed up the transition to electrification.

In the paper,"Determining the Limits and Effects of High-Rate Cycling on Lithium Iron Phosphate Cylindrical Cells'published in and on the cover of the JournalBatteries,researchers from WMG, University of Warwick investigated the impacts on battery cell aging from high current operation using commercial cells.

They used two tests to establish the maximum current limits before cell failure and applied this maximum current until cell failure. Testing was performed to determine how far cycling parameters could progress beyond the manufacturer's recommendations.

During testing, current fluxes were increased up to 100 C cycling conditions. Charge and discharge current capabilities were possible at magnitudes of 1.38 and 4.4 times, respectively, more than that specified by the manufacturers' claims. This increased current was applied for 500 charge-discharge.

However, the application of these currents resulted in a rapid decrease in capacity in the first 60 cycles as well as an increase in resistance. Furthermore, the application of such currents resulted in the increase of cell temperature, during both charge and discharge with natural convection during the rest step cooling the cell. Batteries operate in an optimum temperature range, and any deviations outside this can cause components and chemicals to start decomposing inside them.

They also identified deformation of the "jelly roll" (coiled electrodes and separator) with formation of lithium plating from testing and aging. These deformations emanate from the center of the cell in an axial direction towards the outside of the cell, suggesting the core of the cell was the hottest.

Lead Engineer, Justin Holloway, from WMG, University of Warwick comments:

"The testing showed there is a window for operating batteries above manufacturer stated current limits, however, whilst maintaining manufacturer stated voltage limits. We need to ensure that batteries operate in as the safest manner possible, and for an appropriate practical lifetime, which is why the manufacturers have these limits.

"We also identified thermal fatigue as the driving mechanism for jelly roll deformation. With each cycle of charge and discharge, the cell experienced thermal stresses causing deformation of its components. These deformations grew progressively with cycle number, while the jelly roll was constrained mechanically by the rigid outer can and center pin.

"If convection cooling could be applied to the center of the cell where the cell was the hottest, these deformations could be mitigated and controlled, allowing the cell to maintain capacity and resistance criteria for longer."

The researchers would like to thank all involved in this work, including WMG's High Value Manufacturing Catapult and The Faraday Institution. WMG's Battery Forensic Group, led by Dr. Mel Loveridge is keen to engage with industry and academia alike to grow advances in understanding new materials, battery performance and degradation modes.

More information: Justin Holloway et al. Determining the Limits and Effects of High-Rate Cycling on Lithium Iron Phosphate Cylindrical

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