Cation ordering induced by F-doping of Ni-rich layered cathode enables ultra-long battery life

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Fluorine doping of a compositionally graded cathode with an average concentration of Li $[Ni_{0.80}Co_{0.05}Mn_{0.15}]O_2$ delivers a high discharge capacity of 216 $mAh{\cdot}g^{-1}$ with unprecedented cycling stability by retaining 78 % of its initial capacity after 8000 cycles. The cathode is cycled at 100 % depth of discharge (DOD) unlike currently deployed layered cathode whose DOD is limited to 60 % to preserve the required battery life[1,2]. The structural and chemical stability of the cathode was provided by the unique microstructure of the compositionally graded cathode combined with ordered site-intermixing of Li and transition metal (TM) ions discovered by TEM. F-doping induces formation of 2 $a_{hex} \times 2$ a_{hex} superlattice from ordered occupation of Li in TM slabs and vice versa and is proved to be essential in suppressing the microcrack formation in the deeply charge state and maintain the cathode's structural stability during extended cycling[3,4]. The proposed cathode also allows the used EV batteries to be recycled in energy storage systems.

1. *ACS Energy Lett.* **4**, 2995 (2019)
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