

# Bat448 - Advanced Electrolyte Supporting 500 Wh/kg Lithium-Carbon/Nickel Manganese Cobalt (NMC) Batteries

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## Project Objective

**Project goal** is to develop electrolytes that can form lithiophobic LiF-rich solid electrolyte interface (SEI) on Li anode surface and LiF-rich cathodic electrolyte interphase (CEI) on NMC cathode surface and enable Li/NMC batteries to achieve an energy density of 500 Wh/kg and a cycle life of 1000. The lithiophobic LiF SEI combining with lithiophilic carbon substrate significantly suppresses the Li dendrite and dead Li formation, which enables Li anode to achieve a recorded high Li plating/stripping coulombic efficiency of 99.8% at a current of 0.5 mA cm<sup>-2</sup> and a capacity of 1.0 mAh cm<sup>-2</sup>.

## Milestones

- 1) All fluorinated electrolytes allow LiNiO<sub>2</sub> to have Coulombic efficiency >99.9% for 1000 cycles. **(Completed)**
- 2) Cycle life of thick NMC 811, NMC622 and LiNiO<sub>2</sub> in all fluorinated and ionic liquid electrolytes. **(Completed)**
- 3) Bi@graphite for Li anode with high CE. **(Completed)**
- 4) Energy density of Li-C@NMC full cells or Li-C@LNO >500 Wh/kg, and cycle life of Li-C@NMC or Li-C@ cobalt free full cells >500 cycles. **(On Track)**
- 5) Li/LiNiO<sub>2</sub> or Li/NMC811 pouch full cell test. **(On Track)**

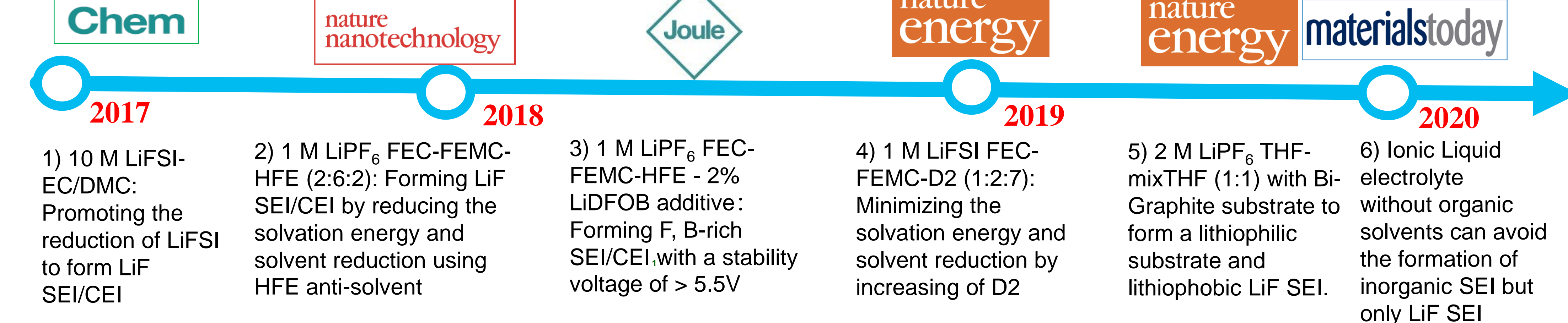
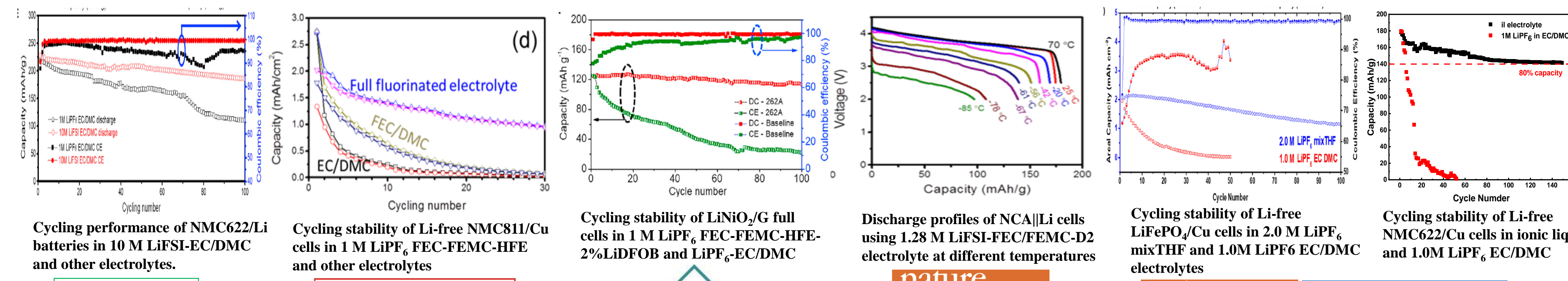
## 1. Electrolyte Design for High Capacity Electrodes

- The great success of graphite/LiCoO<sub>2</sub> batteries in carbonate electrolytes is attributed to the formation of organic-inorganic solid electrolyte interphase (SEI) on graphite and organic-inorganic cathodic electrolyte interphase (CEI) on LiCoO<sub>2</sub> cathodes. The organic-inorganic SEI and CEI with strong bonding to the active materials tolerate small volume change of graphite and LiCoO<sub>2</sub> cathode.
- For Li and Si anodes and Ni-rich cathodes with a large capacity, a LiF SEI and a CEI with weak bonding to the electrodes are desired, so LiF layer will not deform along with the large volume change of these high-capacity electrodes, thus enabling the electrode to achieve a high Coulombic efficiency.
- LiF SEI on anode and CEI on cathode can be formed by promoting the reduction of fluorinated inorganic salts, but suppressing the reduction/oxidation of organic solvents through addition of highly fluorinated anti-solvents.

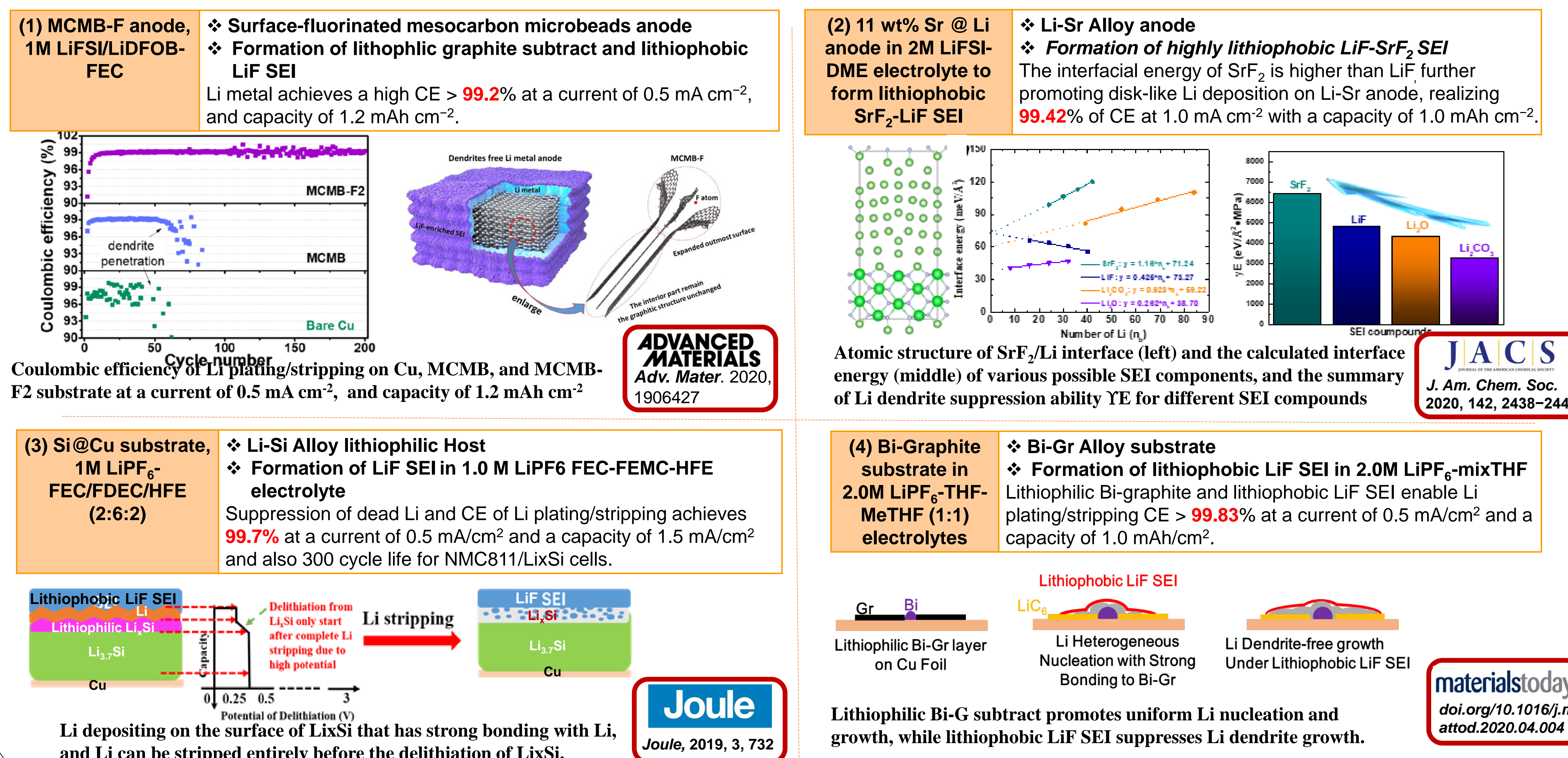
## 2. Research Progress of Advanced Electrolytes

### Increasing LiF content in SEI and CEI, and improving cycling Coulombic efficiency

### Enhancing electrochemical performance

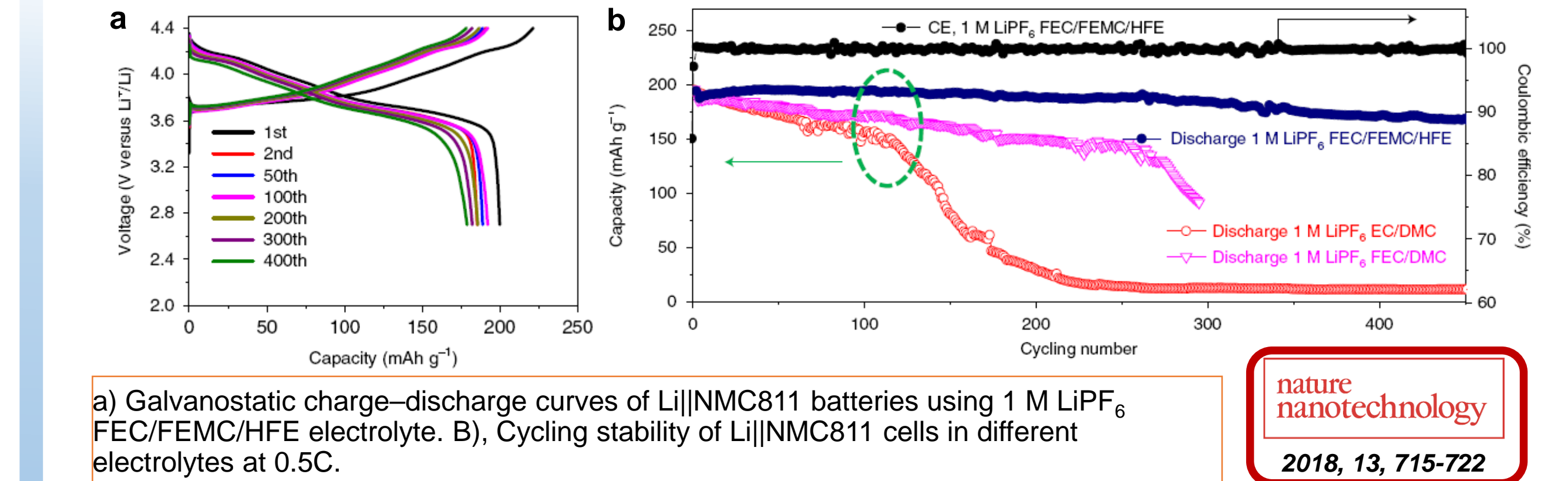


### 3. Design of Lithiophilic Substrates and Lithiophobic LiF SEI on Lithium Anode

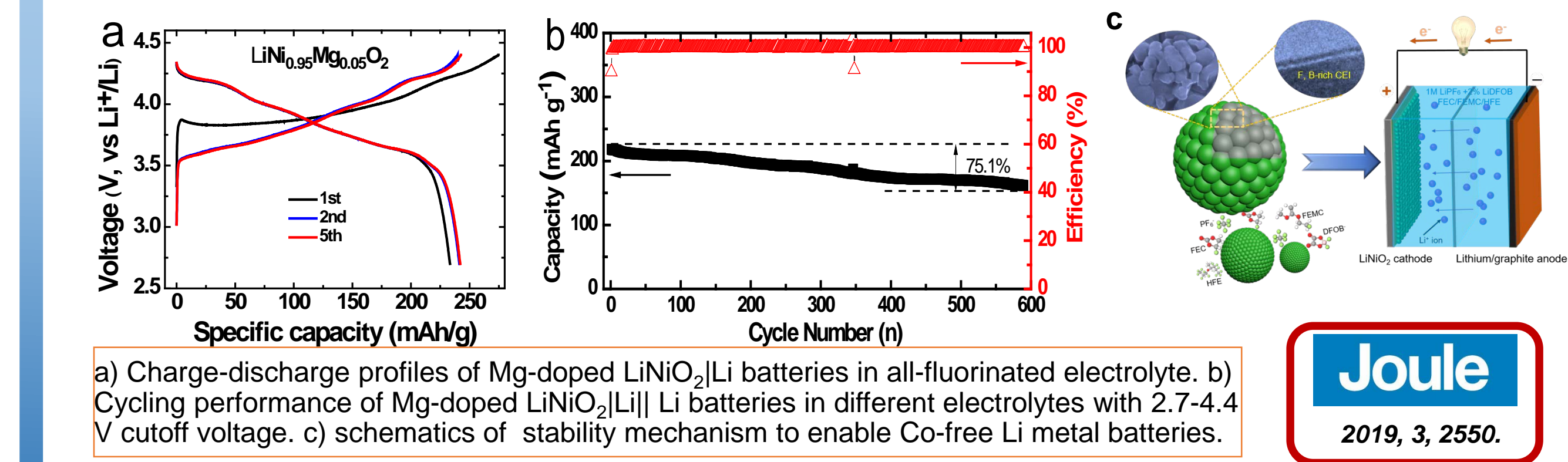


## 3. High Performance Ni-rich Cathodes

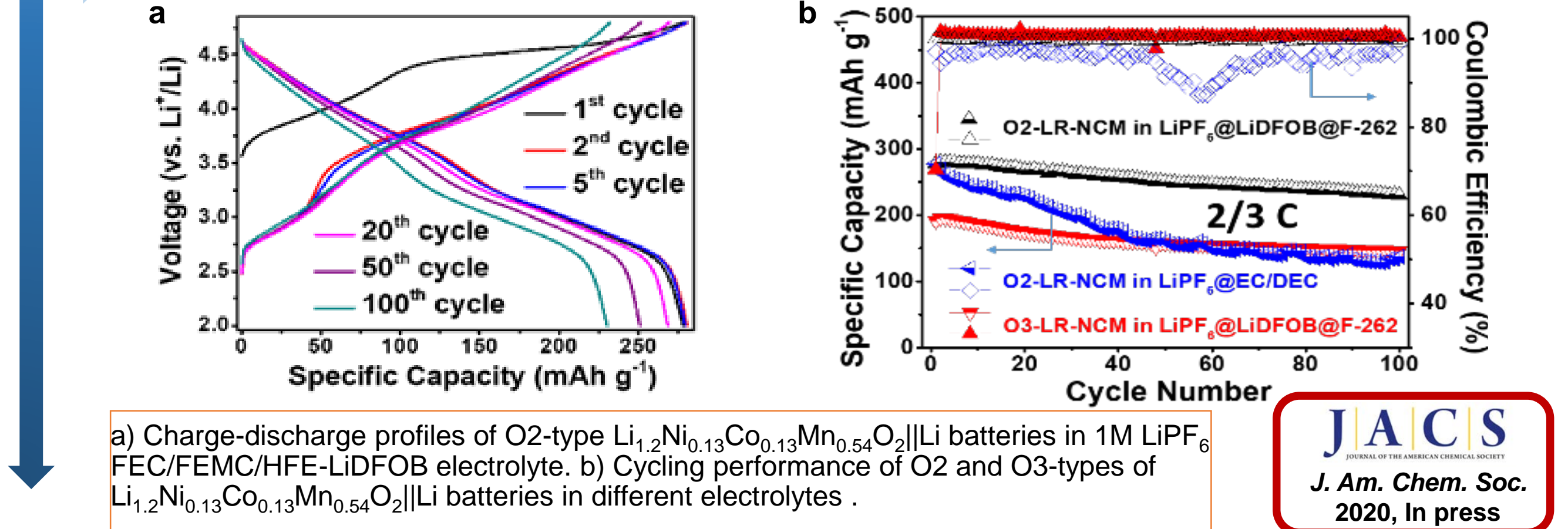
### NMC811/Li pouch cell with 1M LiPF<sub>6</sub> FEC/FEMC/HFE + 2% LiDFOB



### Co-free LiNiO<sub>2</sub> with 1M LiPF<sub>6</sub> FEC/FEMC/HFE + 2% LiDFOB



### O2-Li rich NCM with 1M LiPF<sub>6</sub> FEC/FEMC/HFE + 2% LiDFOB



## 4. References & Acknowledgement

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