A Highly Conductive Halospinel Cathode for All-Solid-State Batteries

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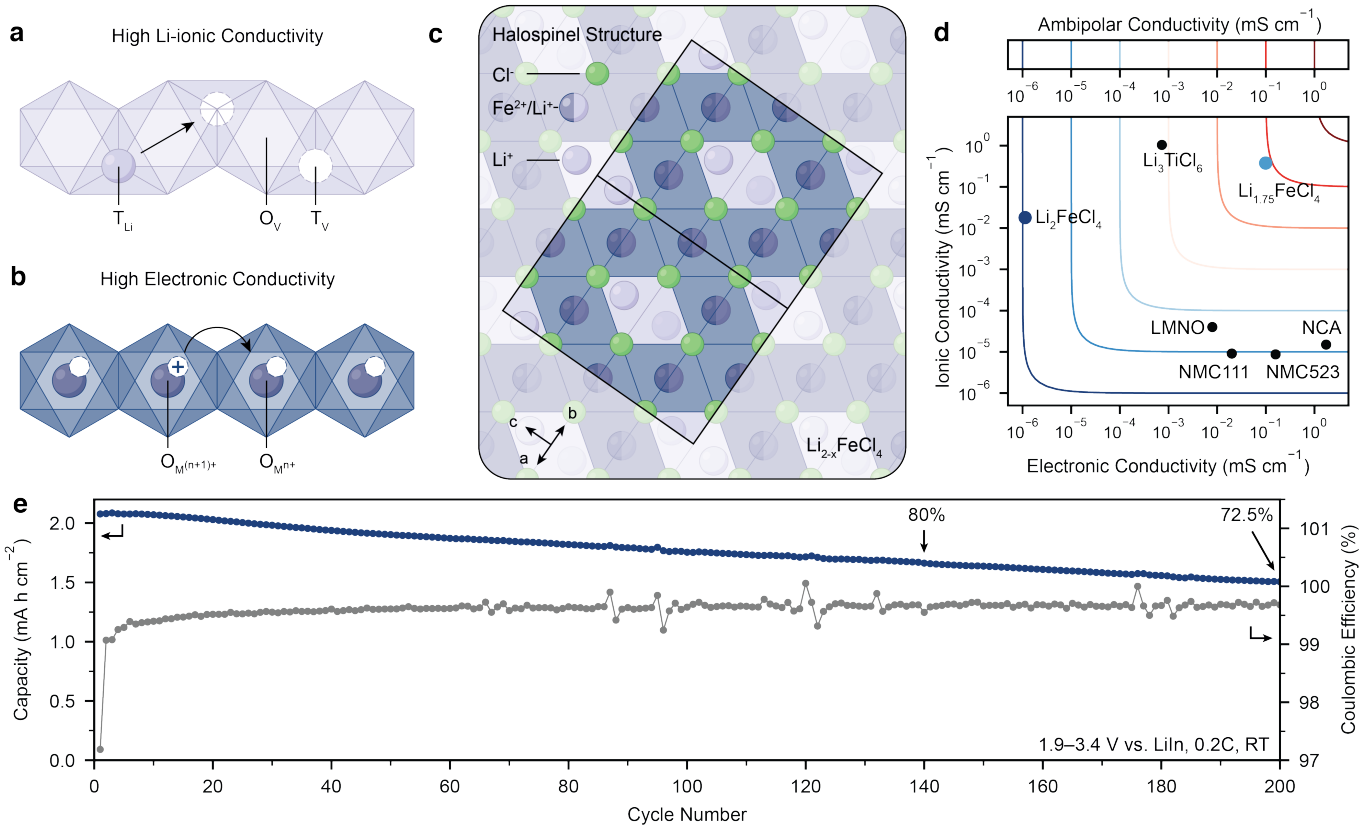
To meet the growing demands of modern energy storage, cathode active materials (CAMs) in Li-ion batteries (LIBs) not only need to offer high energy density, but also enable fast charge and discharge.[1] To this end, CAMs must facilitate both rapid electronic and ionic transport at the lattice scale, since chemical diffusion will be rate-limited by the slower species (Figure a, b). While oxospinels meet these criteria and are therefore widely employed in state-of-the-art LIBs, we demonstrate that halospinels offer greatly enhanced transport properties and enable the incorporation of earth-abundant transition metals such as iron(Figure c, d).[2] Using $Li_{2-x}FeCl_4$ ($0<x\leq1$, LFC) as a model system, we show that its intrinsically high ionic-electronic conductivity allows for all-solid-state batteries (ASSBs) with micron-sized CAM particles, achieving exceptional areal capacity (>2 mA h cm^{-2}) at practical current densities (0.5 mA cm^{-2}) and extended cycle life of 200 cycles (Figure e). Our findings position LFC as a commercially viable CAM, paving the way for cost-effective, high-performance ASSBs.



[1] Y. Liu, Y. Zhu, Y. Cui, *Nat. Energy* **2019**, 4, 540.
[2] J. F. Baumgärtner, D. Isler, Q. H. Nguyen, M. Klimpel, C. Černe, J. Šivavec, D. Chernyshov, W. van Beek, D. Rettenwander, K. V. Kravchyk, M. V. Kovalenko, *in Review* **2025**.