Electronic and Ionic Transport in NCA and NMC Cathodes

Scientific Achievement

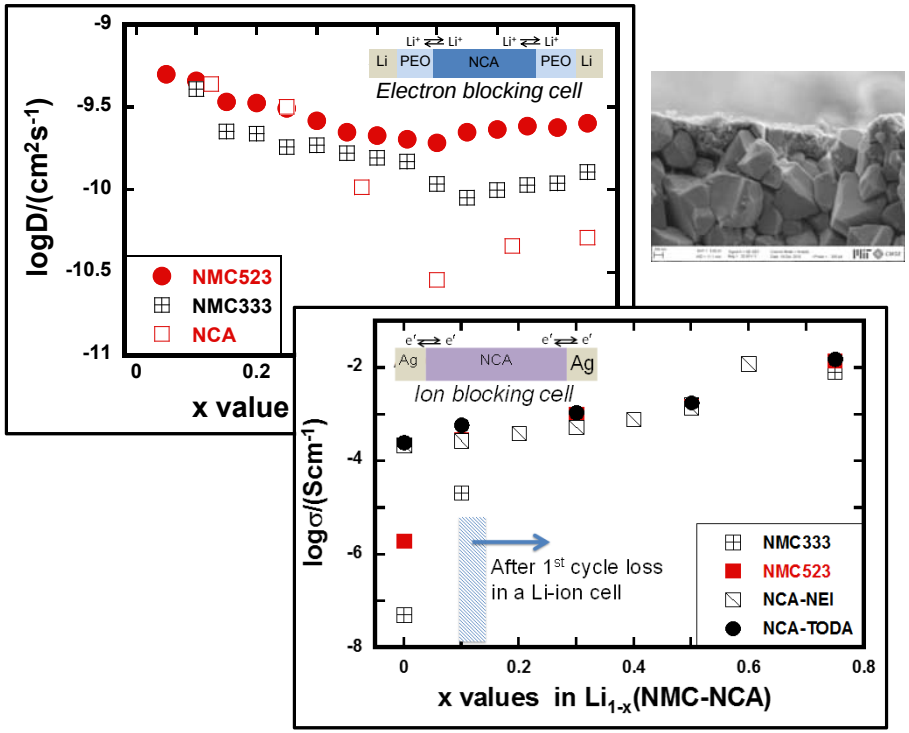
First measurements of bulk electronic and ionic transport across the entire state-of-charge range relevant to energy storage in NCA and NMCs, the most widely studied classes of Li-ion cathodes

Significance and Impact

Allows rate-limiting transport species and paths to be understood up to high charge voltage necessary to realize near-theoretical capacities of layered oxide cathodes

Research Details

- Prepared pure-phase polycrystals with controlled residual porosity allowing electrochemical titration
- Excluded typical electrode additives that interfere with mechanistic determination
- Used ion-blocking and electron-blocking cell configurations to isolate electronic and ionic transport
- Used both ac and dc-relaxation techniques on same samples for independent corroboration of results



Findings: Across the entire Li concentration range relevant to energy storage, electronic conductivity is ~10^4 higher than ionic conductivity. Ion transport *decreases* with increasing Li vacancy concentration, until electrochemical shock creates rapid transport paths through microcracking

1. R. Amin, D.B. Ravnsbaek, Y.-M. Chiang, *J. Electrochem. Soc.* 162(7), A1163-A1169 (2015). doi: 10.1149/2.0171507jes
2. R. Amin and Y.-M. Chiang, *J. Electrochem. Soc.*, 163(8) A1512-A1517 (2016). DOI: 10.1149/2.0131608jes

Work performed at MIT

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