

Solid Electrolytes: Use

Li⁺, Na⁺

- All-solid-state rechargeable batteries
- Stabilized Li⁰ or Na⁰ anode
- Separator for dual liquid electrolyte
- Separator of liquid or gaseous electrodes

O²⁻

- SOFC
- SOFC in rechargeable-battery mode
- MIEC catalytic cathodes

H⁺

- Replace PEM of PEMFC
- H₂ from steam
- FC with 100°C < T_{op} < 500°C

Oxide Solid Electrolyte: Structures

Li⁺: Layered (2D), Garnets (3D), Spinel (3D)
Li-substituted Perovskites ($\text{Li}_{0.3}\text{La}_{0.53}\text{TiO}_3$)
Frameworks (LISICON)

Na⁺: Layered [$\beta, \beta'' \text{Na} \cdot 11\text{Al}_2\text{O}_3$]
Frameworks (NASICON)

O²⁻: Fluorites (YSZ)
Perovskites (LSGM)
 $\text{R}_2\text{MO}_{4+\delta}$ (?) [$\text{La}_2\text{NiO}_{4+\delta}$]

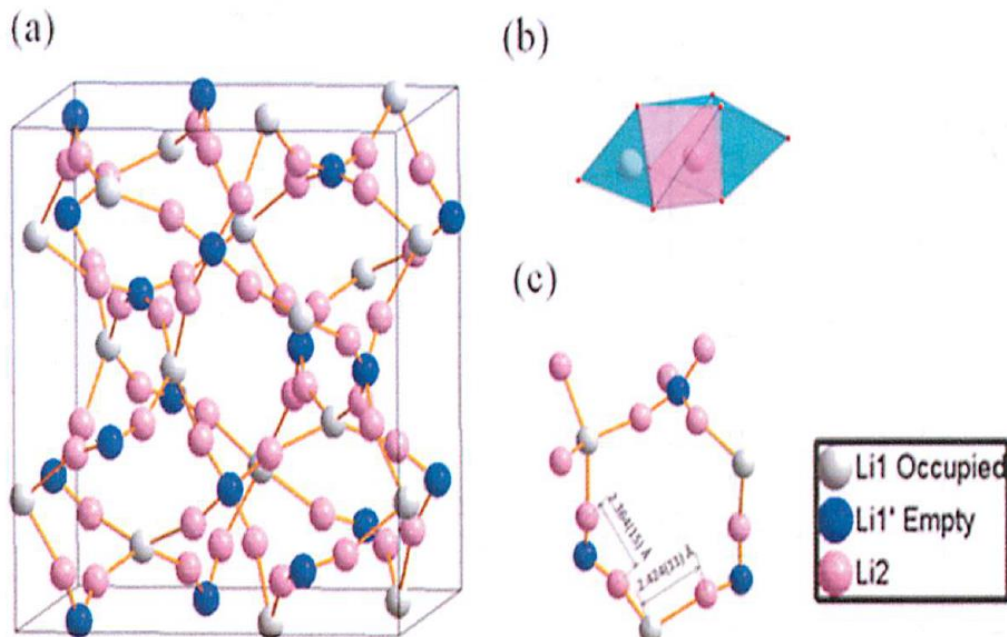
H⁺: Polyanion Acids (KH_2PO_4)

Other Solid Electrolytes

- Glass (Rigid)
- Polymers
- Polymer/liquid composites
- Polymer/solid-electrolyte composites

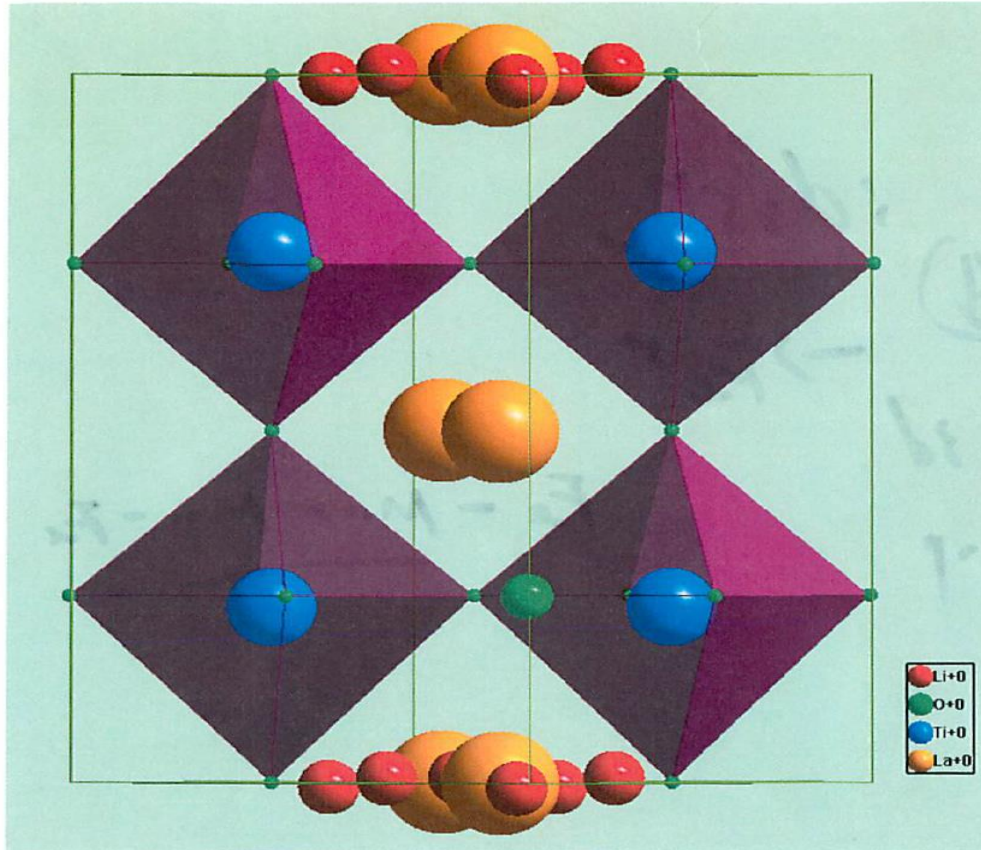
$A_3B_3C_2O_{12}$

- Garnet framework: $B_3C_2O_{12}$
 - Interstitial A sites bridged by face-sharing octahedral sites
- Lithium Garnets:
 - $Li^+ - Li^+$ coulomb interactions prevent introducing 9 Li^+ /formula unit



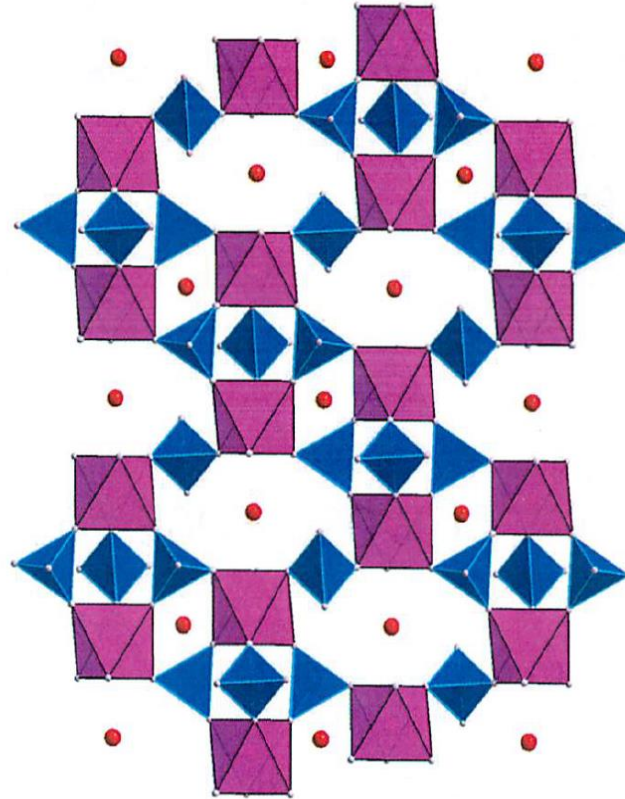
Ideal order of
vacancies with
7.5 Li^+ /formula

Adventitious Al^{3+} enter oct. sites with neighboring A sites vacant.
Nominal $Li_{6.5}La_3Zr_{1.5}Ta_{0.5}O_{12}$ has $\sigma_{Li} \approx 10^{-3} S cm^{-1}$

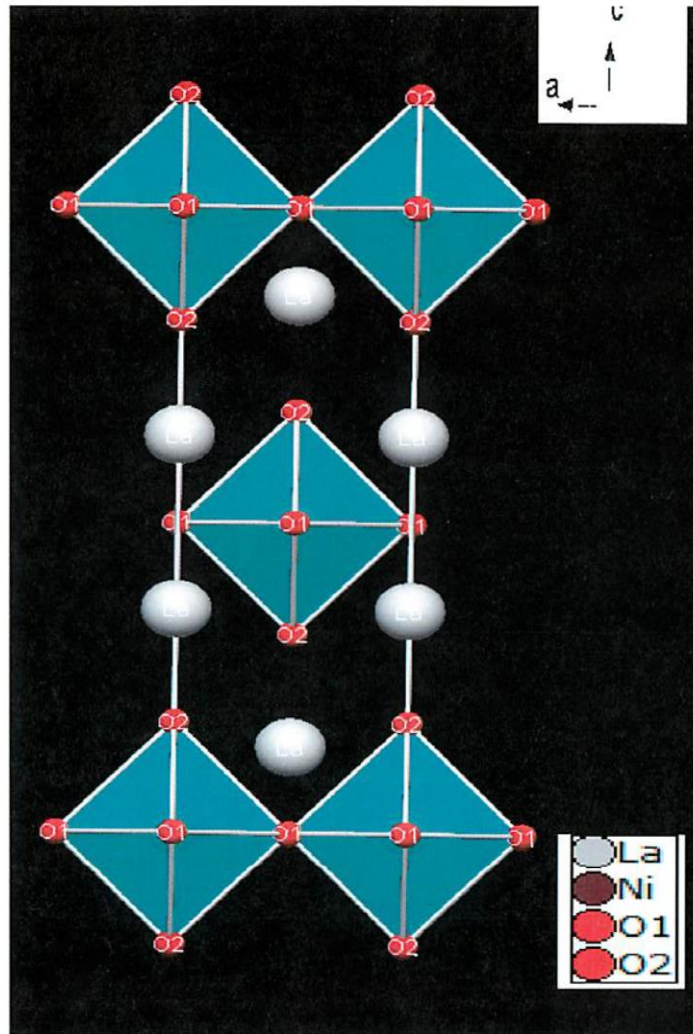


Crystal Structure of $\text{Li}_{0.3}\text{La}_{0.57}\text{TiO}_3$

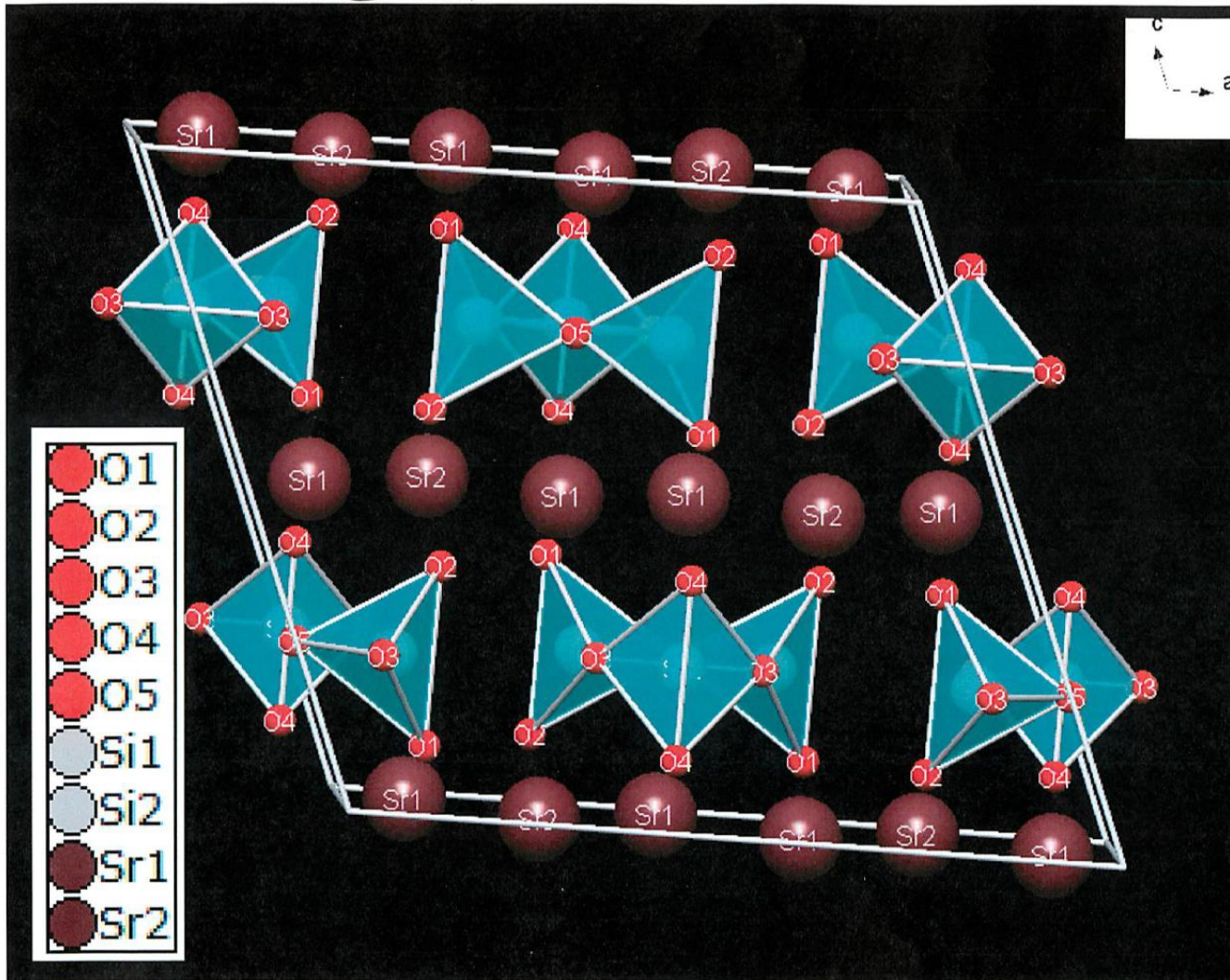
Framework Structures



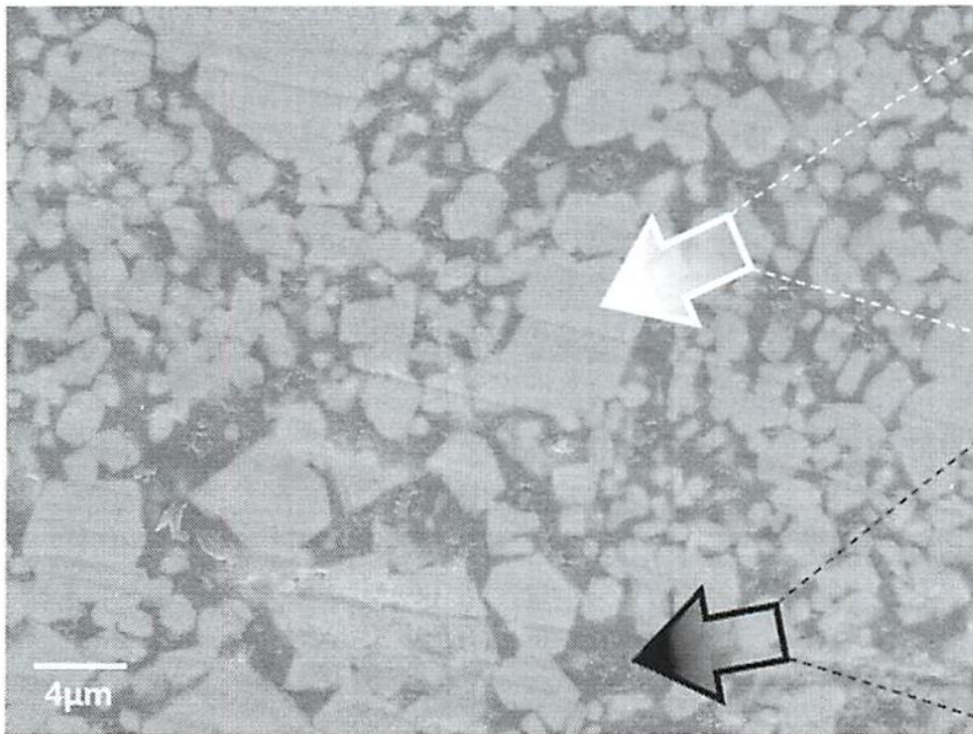
NASICON



La_2NiO_4 Structure



Kevn Huang's Slide



Bright	at%	ratio	
O K	59.14	-	-
Na K	1.18	6.8	42.3
Sr L	16.1	93.2	
Si K	23.58	-	57.7

Dark	at%	ratio	
O K	60.79	-	-
Na K	18.73	99.8	47.8
Sr L	0.03	0.2	
Si K	20.45	-	52.2