A Novel Li Conducting Solid State Electrolyte by Sol Gel Technique

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Objective

Develop novel inorganic solid state lithium ion conductor:

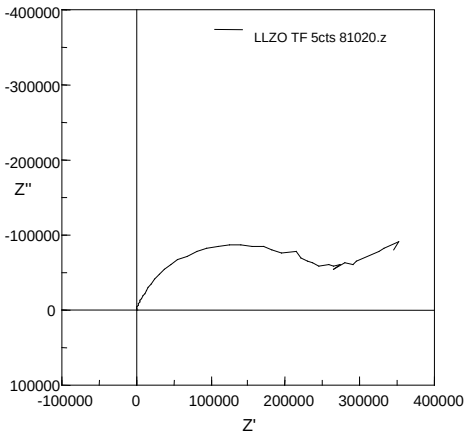
a) high Li ion conductivity
b) transport number of ~1
c) stable with Li metal
d) thermally stable
e) adequate electrochemical window of stability

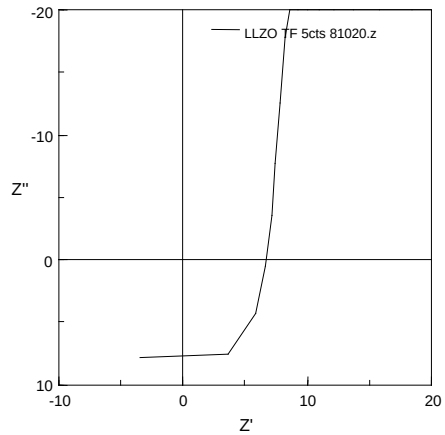
Construct and test a battery that contains the novel electrolyte

Novel sol gel solid electrolyte (NSGSE)

In contact with Li metal:
Organic electrolytes (liquid/polymer) get reduced: HAZARDS
Most oxide solid electrolytes become mixed conductor: SHORTS

NSGSE by sol gel process, spin coated: *an oxide & stable with Li !!*



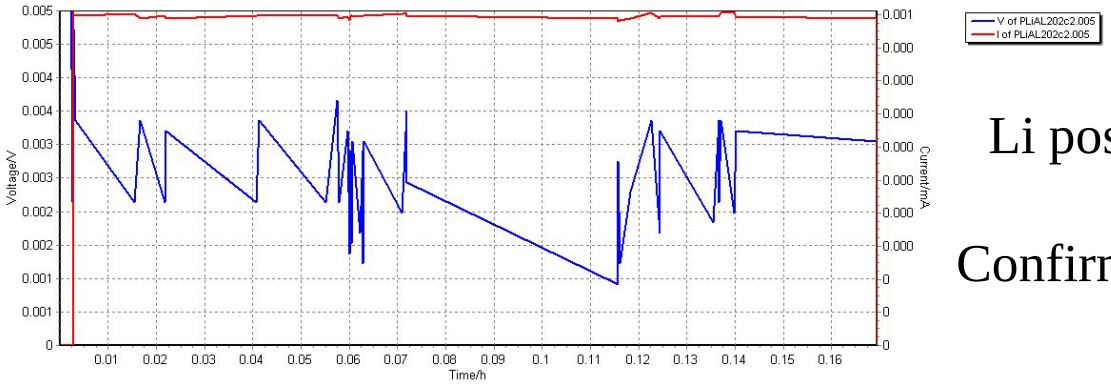


Li ion conductivity > 1E-3 S/cm

from high frequency intercept

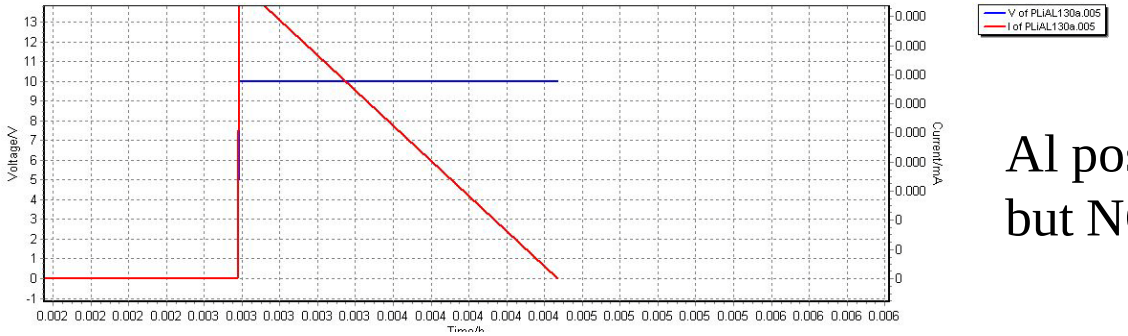
Novel sol gel solid electrolyte

Li plating in Li/NSGSE/Al cell test, same NSGSE TF thickness & area



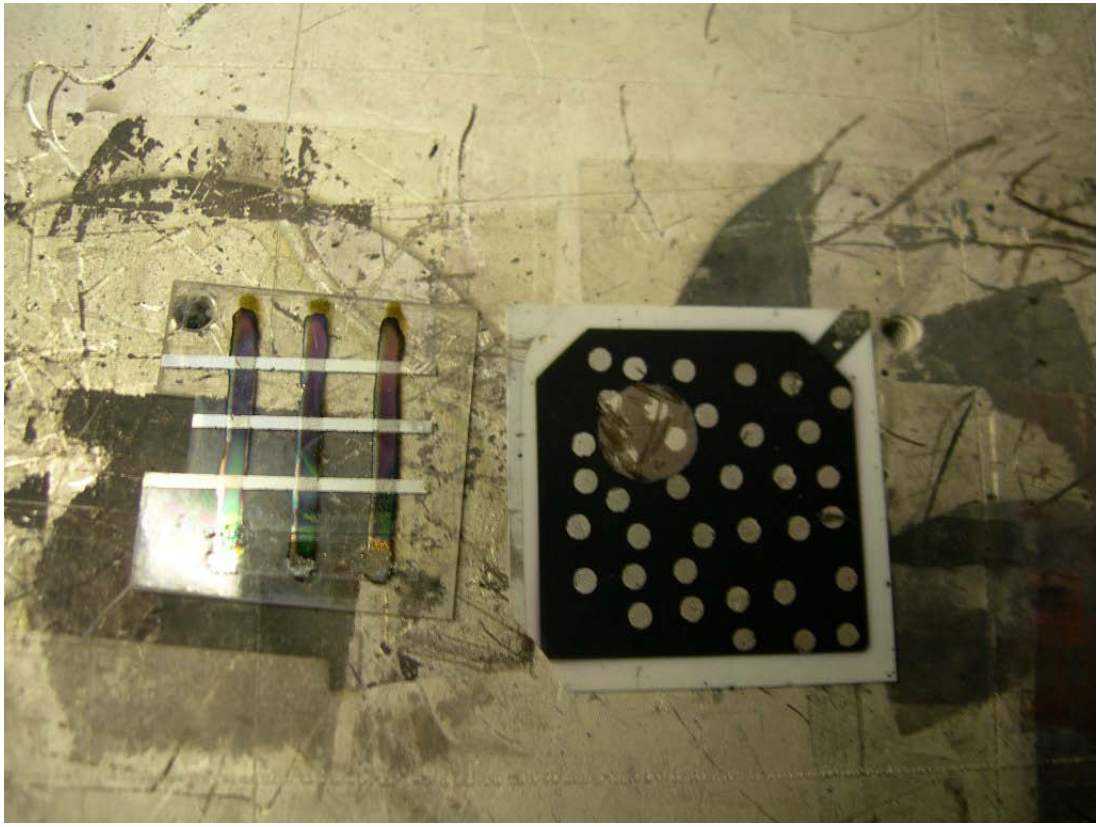
Li positive, R ~ 3 kOhm

Confirms > 1E-3 S/cm conductivity



Al positive, V=10V,
but NO breakdown of NSGSE

Novel sol gel solid electrolyte



Li on NSGSE
stable after 2 weeks
in glove box

NSGSE appears stable
in organic liquid
electrolytes and water

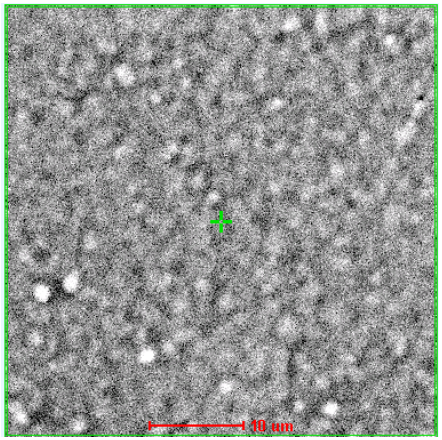
Novel sol gel solid electrolyte

Li/NSGSE/LiMnOx cell:

OCV in 1.5 to 2.5 V range

OCV values kept for a few weeks

Cell cycling is problem

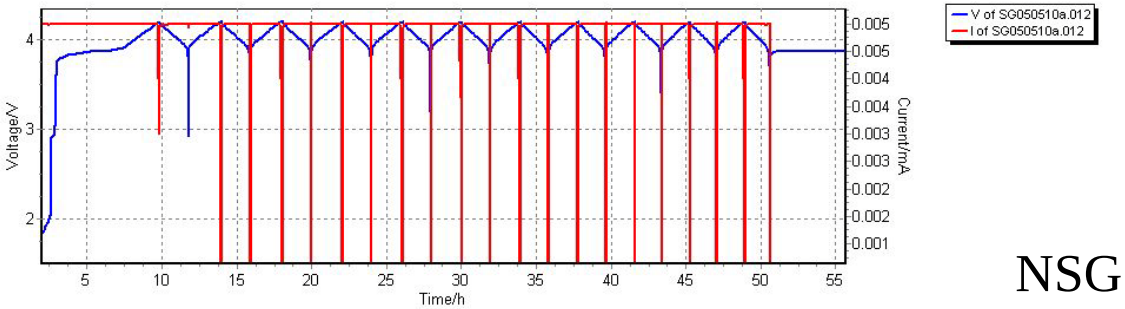


NSGSE film

LiPON on top of NSGSE to enable cycling and developing low resistance cathode interface

Novel sol gel solid electrolyte

Li/LiPON/NSGSE/LiMnOx (LMO) cells cycled



Sample Cell	ASR (Ohm-cm^2)
Li/LiPON/NSGSE/LMO (1 hour LiPON)	840
Li/LiPON/NSGSE/LMO (6 hour LiPON)	1500
Li/LiPON/LMO (no NSGSE, 6 hour LiPON)	1860

NSGSE has better interface with LMO than LiPON:

much lower ASR (!!)

In another project shown that NSGSE can operate stably in a battery at 150 C

Novel sol gel solid electrolyte

Progress so far:

- outstanding properties of NSGSE as Li ion conductor demonstrated
- low NSGSE/cathode interface impedance achieved

Future plans:

construct solid state battery with NSGSE

Challenges: debris over large area
NSGSE/Li interface impedance