

# 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  $\sim 1$
- c) stable with Li metal
- d) thermally stable
- e) adequate electrochemical window of stability

Construct and test a battery that contains the novel electrolyte

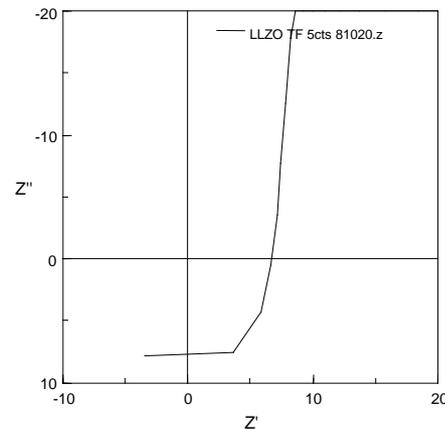
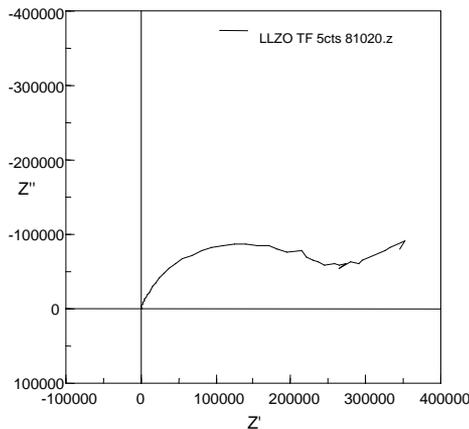
# Novel sol gel solid electrolyte (NSGSE)

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 !!*

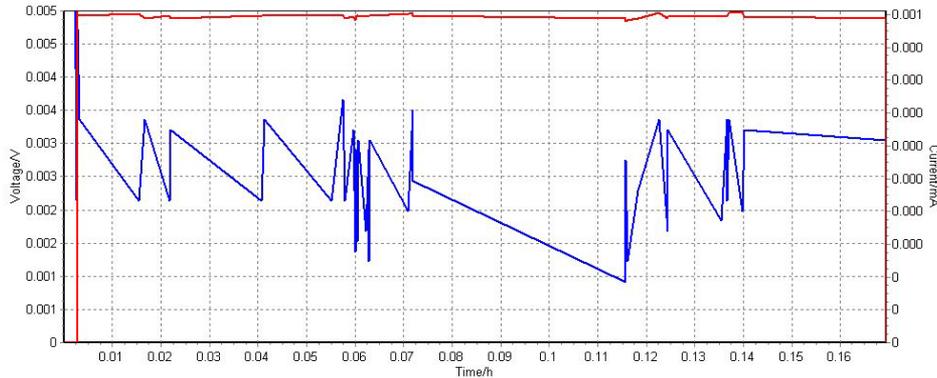


Li ion conductivity  $> 1\text{E-}3$  S/cm

from high frequency intercept

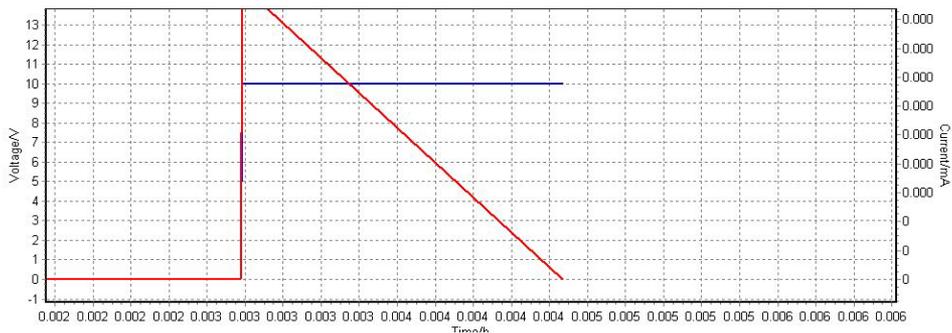
# Novel sol gel solid electrolyte

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



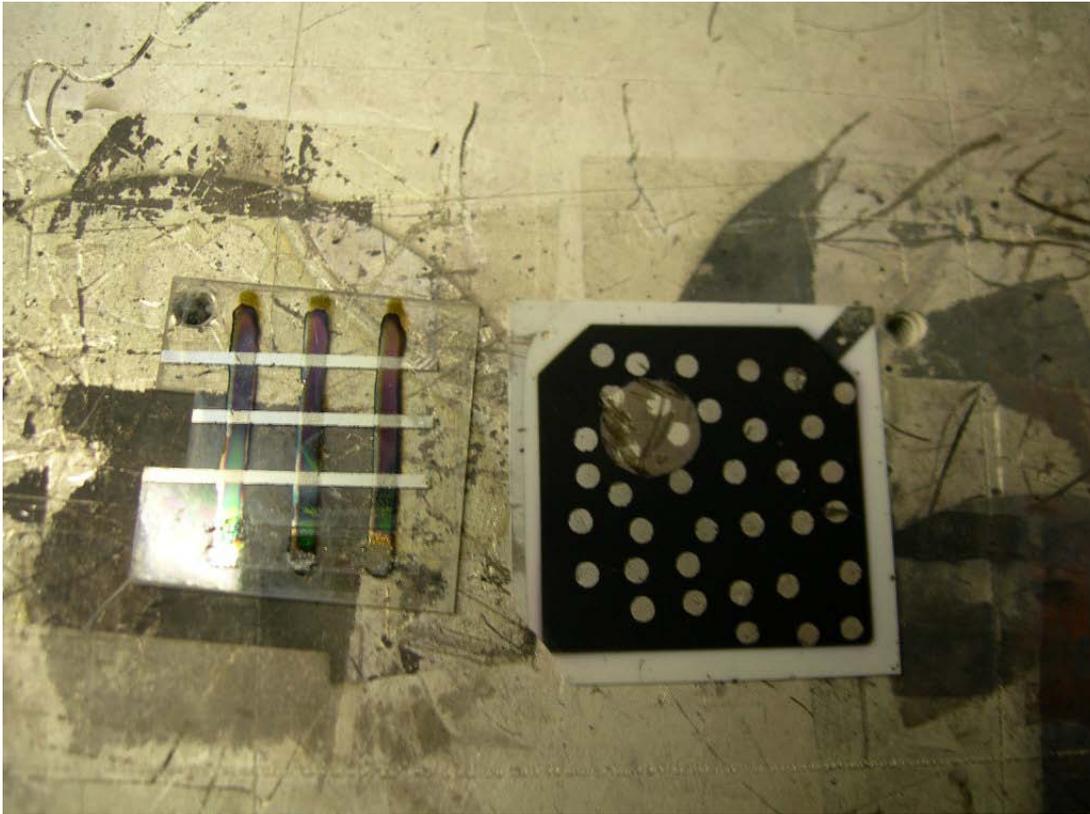
Li positive,  $R \sim 3 \text{ k}\Omega$

Confirms  $> 1\text{E-}3 \text{ S/cm}$  conductivity



Al positive,  $V=10\text{V}$ ,  
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

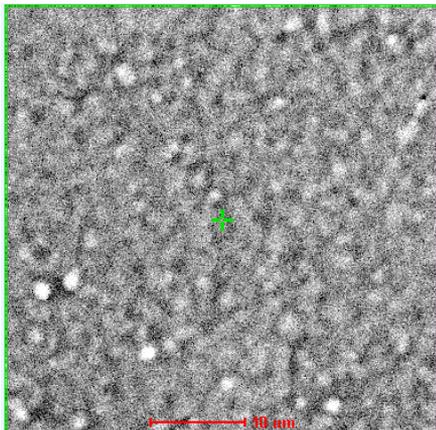


Li/NSGSE/LiMnO<sub>x</sub> cell:

OCV in 1.5 to 2.5 V range

OCV values kept for a few weeks

Cell cycling is problem

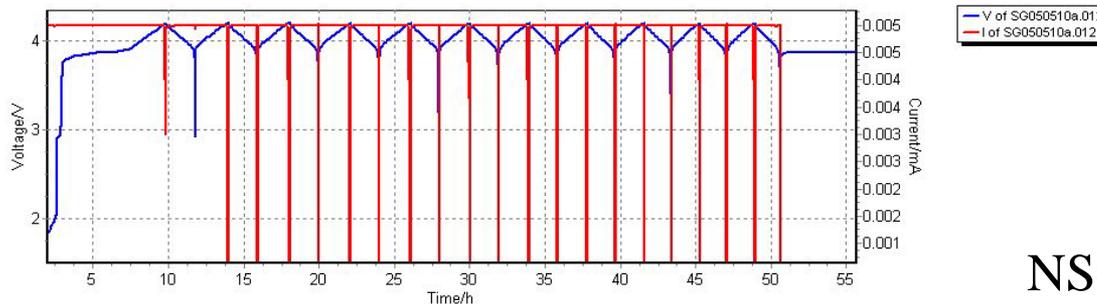


← NSGSE  
film

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

# Novel sol gel solid electrolyte

Li/LiPON/NSGSE/LiMnO<sub>x</sub> (LMO) cells cycled



NSGSE has better interface with  
LMO than LiPON:  
much lower ASR (!!)

Sample Cell	ASR (Ohm-cm <sup>2</sup> )
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

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

