Spiro-ammonium imide salts as electrolytes for lithium batteries

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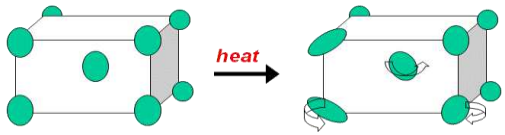
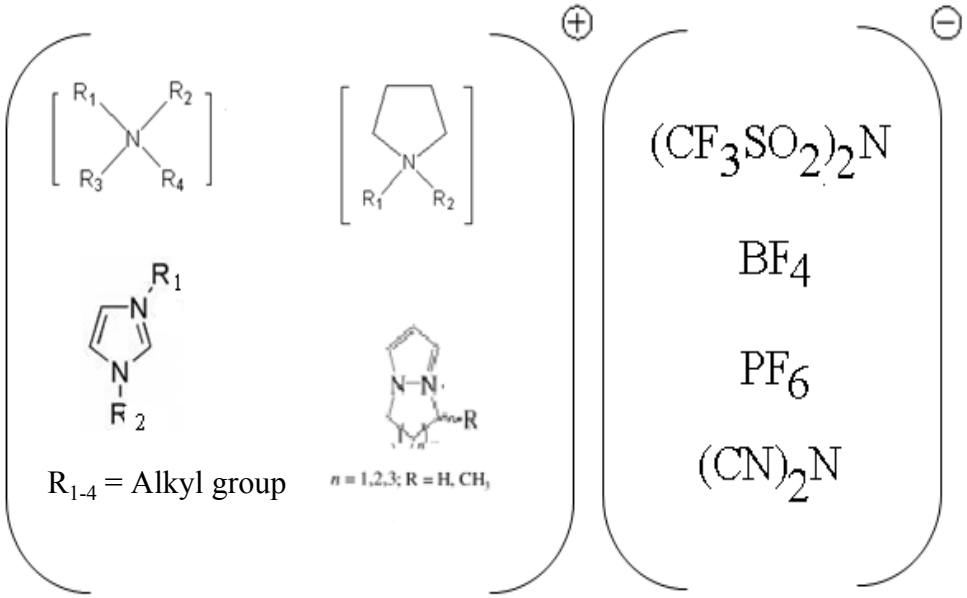
Organic salts: Ionic liquids and Plastic crystals

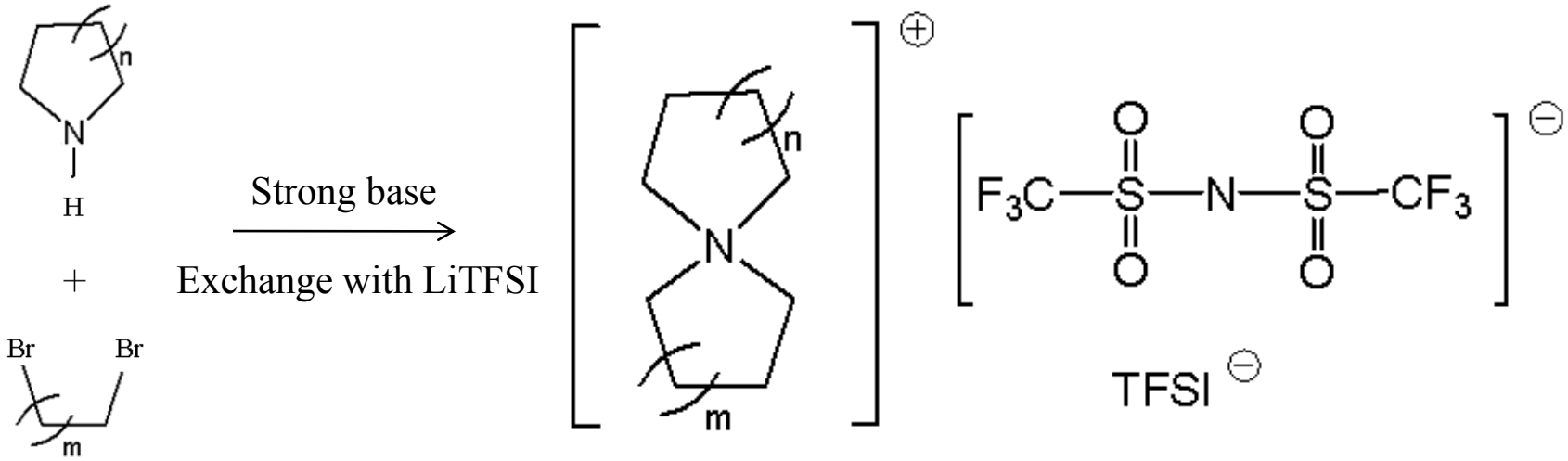
- **Ionic liquids**
  - *Good thermal (Non-volatile, Non-flammable) properties.*
  - *chemical and electrochemical properties.*
- **Plastic crystalline phases**



  - *Below melting: sustain high ionic conductivity,*
  - *plastic solid material*
- **Lithium batteries**

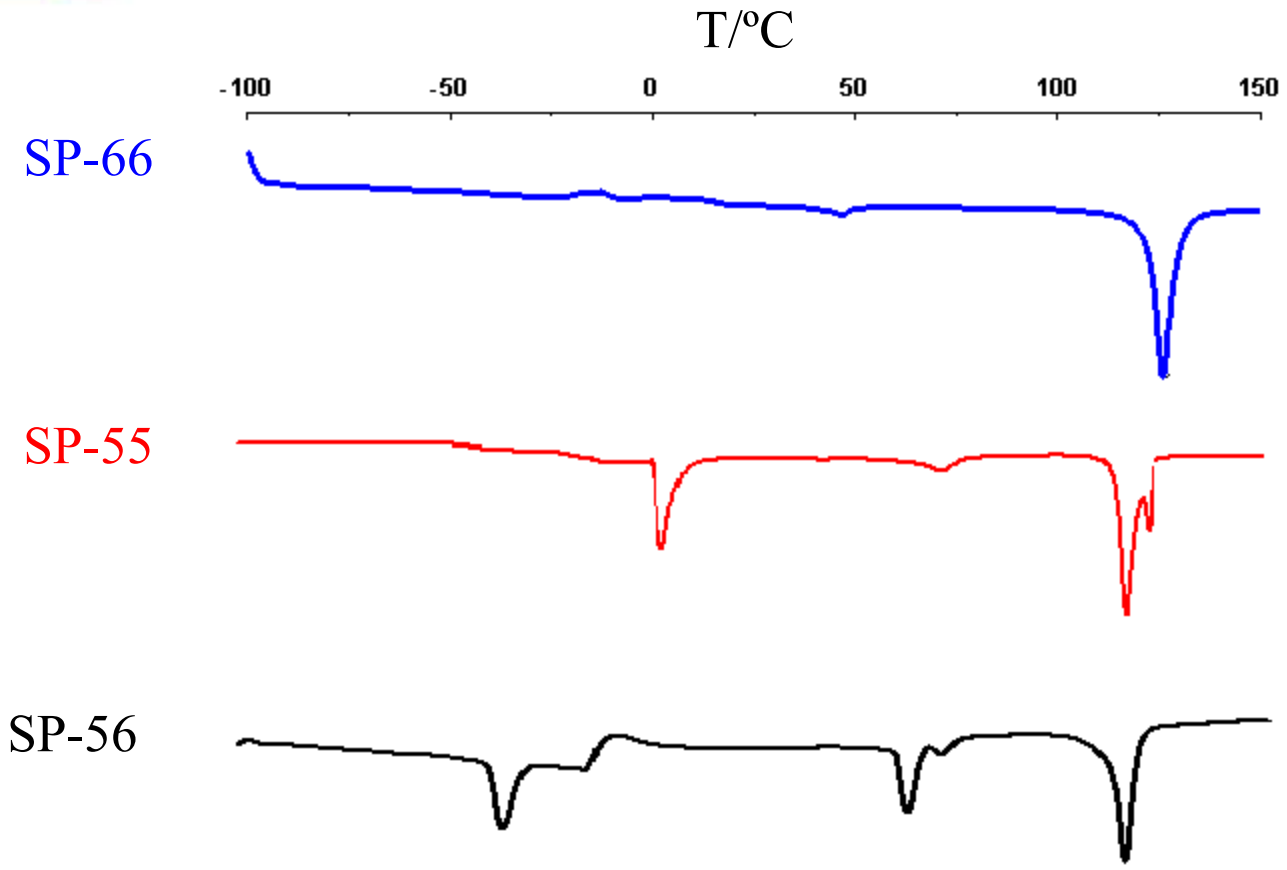


Spiro-ammonium imide salts

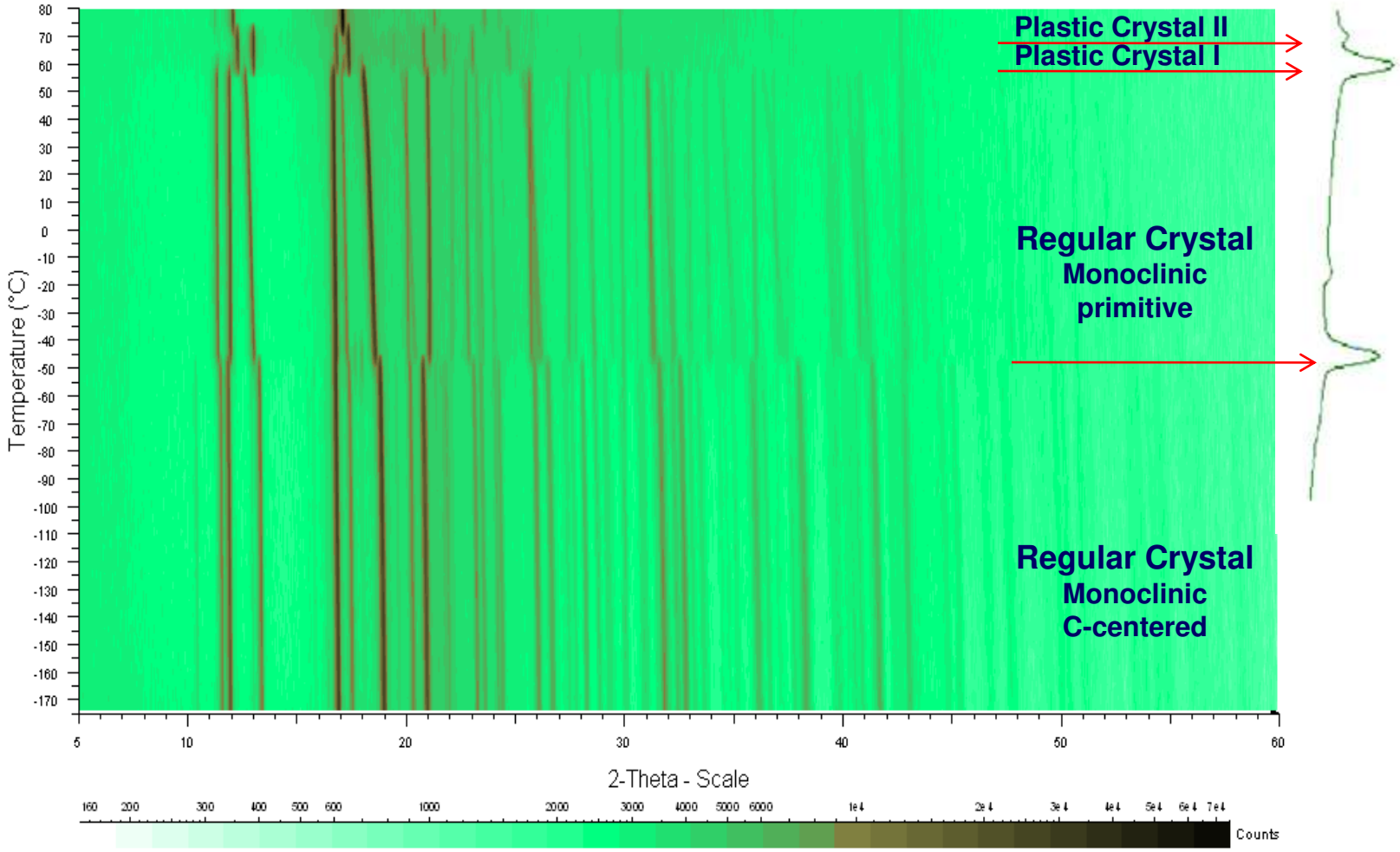


Spiro-ammonium imide Salt	n	m
SP-55	1	1
SP-56	1	2
SP-57	1	3
SP-66	2	2
SP-67	2	3

DSC of neat salts



XRD as a function of T



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Effect of anion type on SP-56

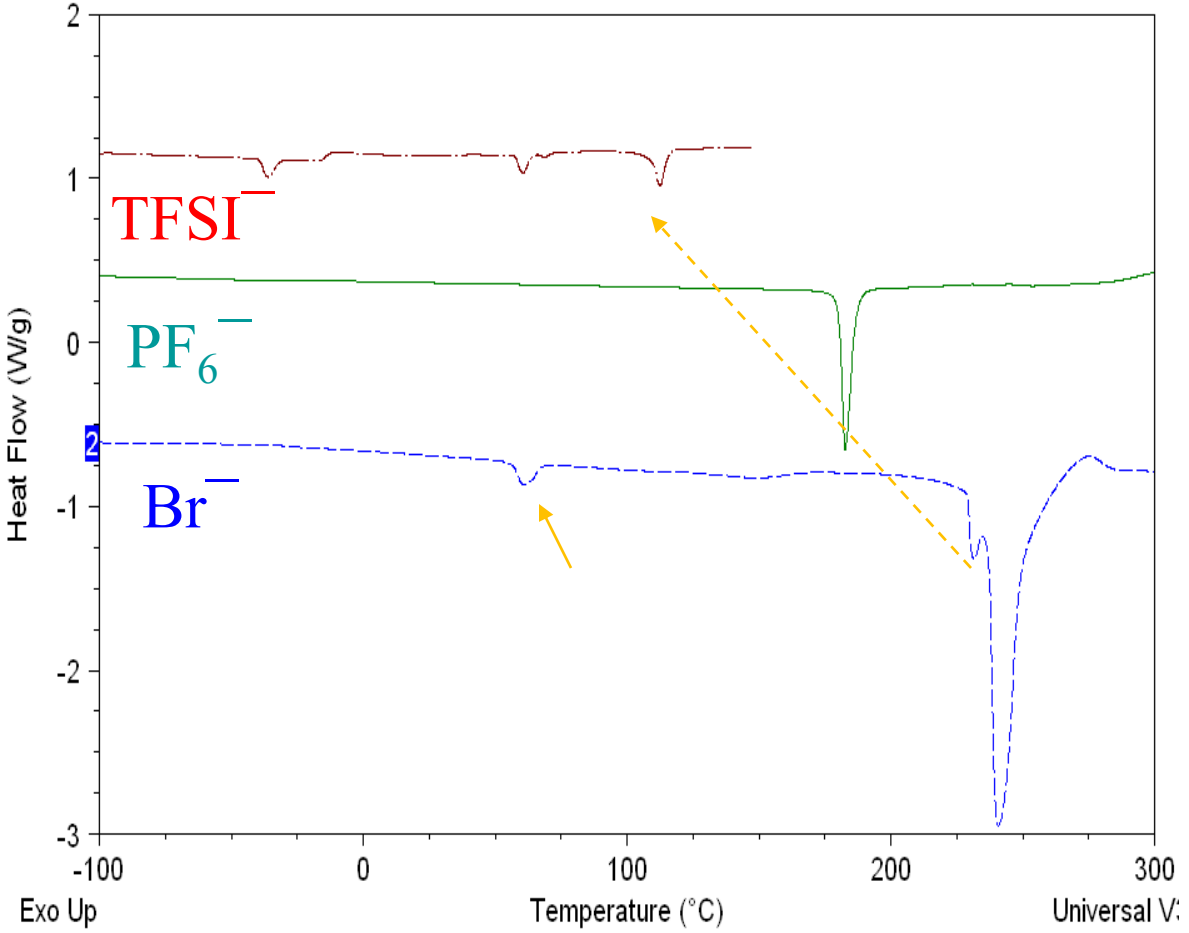
- Salts synthesized as Br^-
- Exchanged for $TFSI^-$ and PF_6^-
- Melting Point:

$TFSI^-$ < PF_6^- < Br^-

- PC phases:

Br^- : One transition at 50 °C

PF_6^- : No transitions



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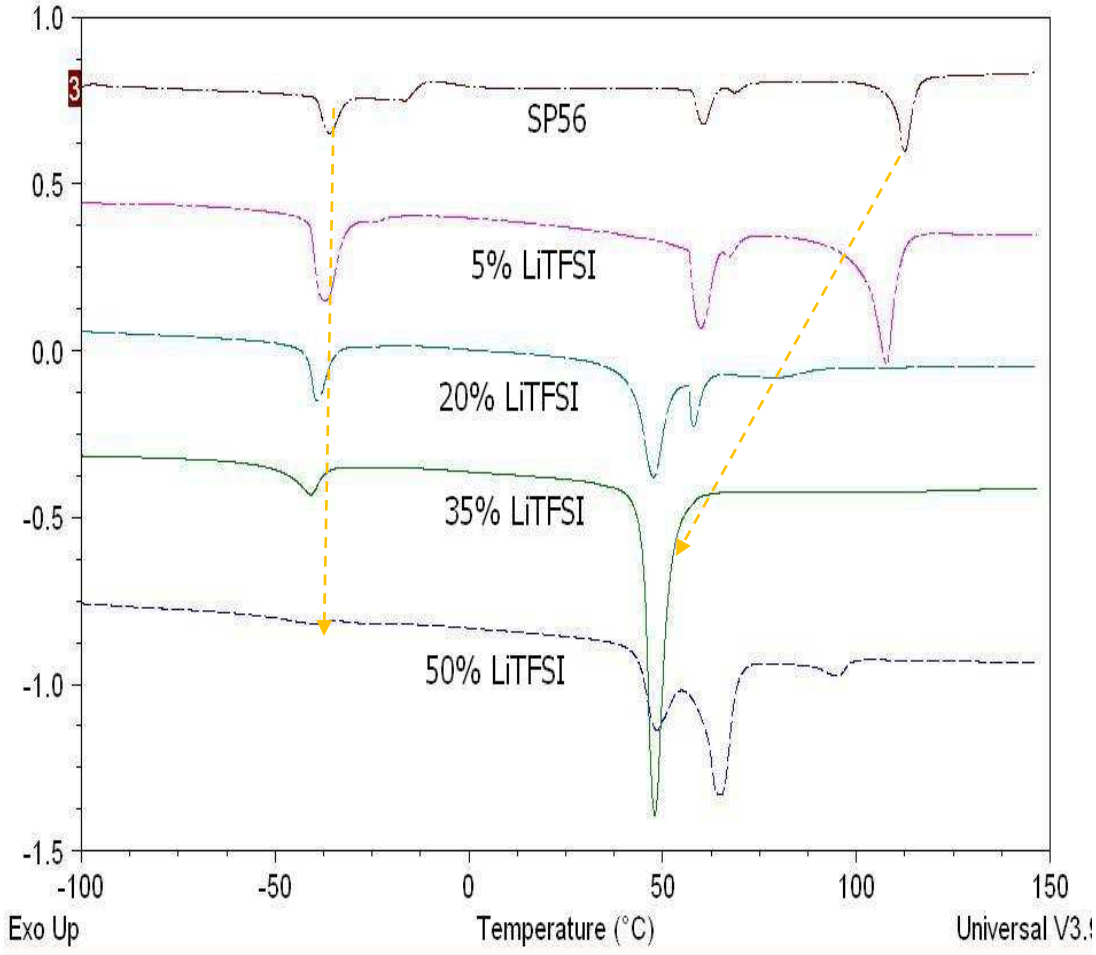
Effect of salt content on SP-56



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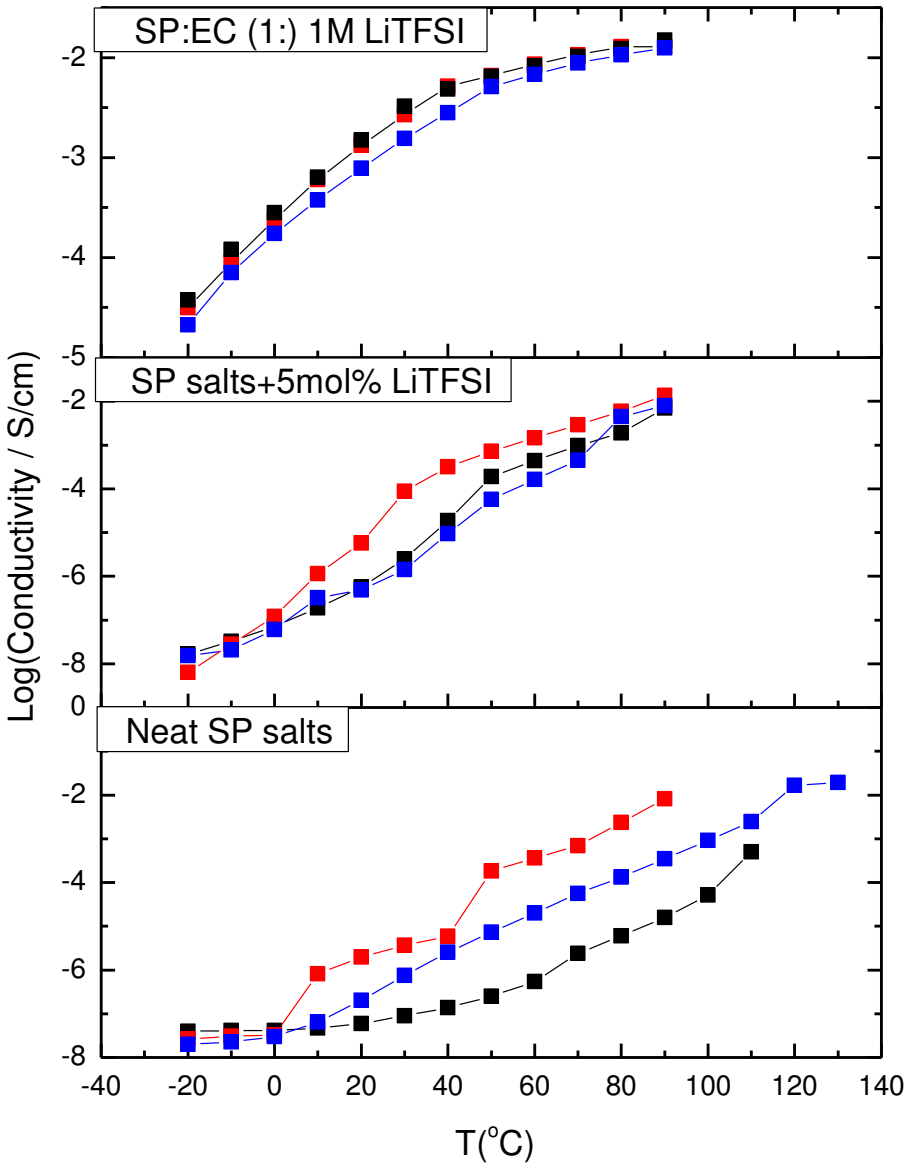
Conductivity of the salts

- **SP-56 showed the highest conductivities**



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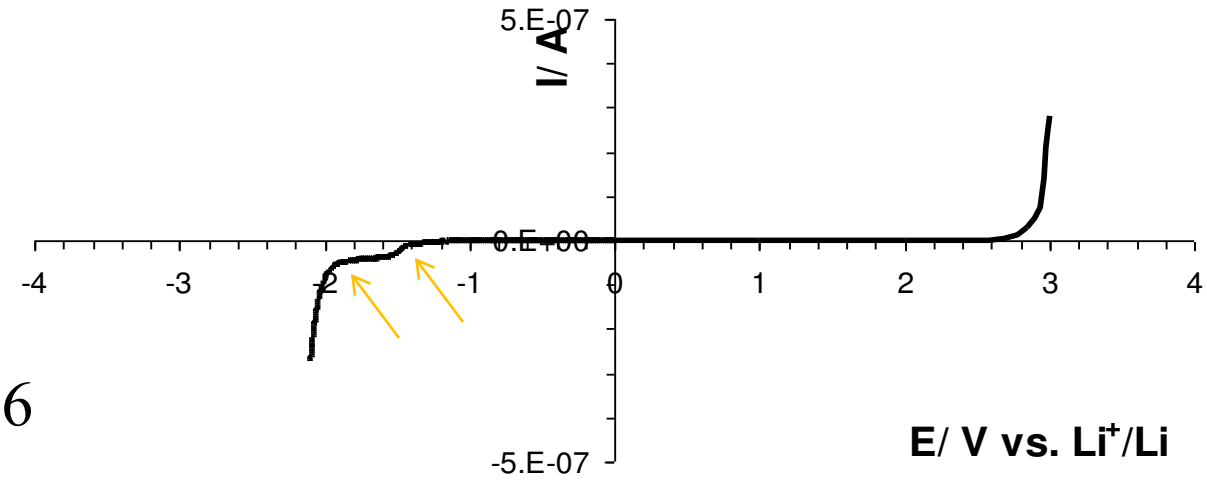
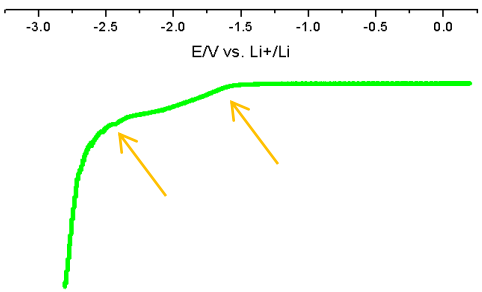
Electrochemical stability of SP-56



Molten neat SP-56

T = 125 °C



1mM SP-56 solution in Propylene carbonate

T = 25 °C

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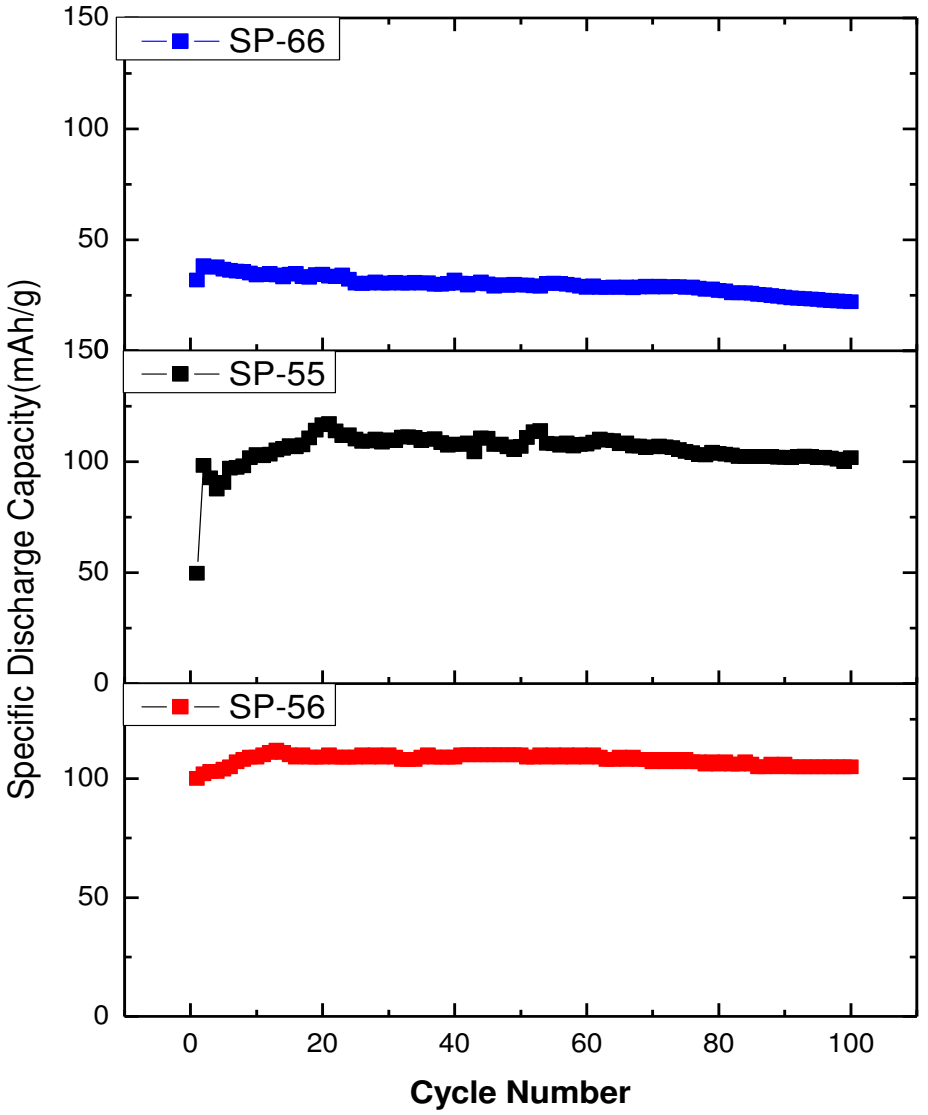
Lithium battery performance

- SP-56 and SP-55 mixtures with EC (1:1) showed high capacities with good retention.
- SP-66 showed the lowest capacity



Summary

- *Spiro-ammonium imide salts exhibit:*
  - *high melting points (>100 °C)*
  - *Plastic crystalline phases*
  - *More than one regular and one plastic crystalline phases*
  - *low cathodic stability*

- *Mixing the salts with conventional solvents (1:1 w.t.) gave good lithium battery cycling results.*

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Canada

Appendix