



Advanced Membranes for Flow Batteries

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Membrane Commercialization:

Nearly 2 years trying to get a materials start-up running (Energy Enablers).

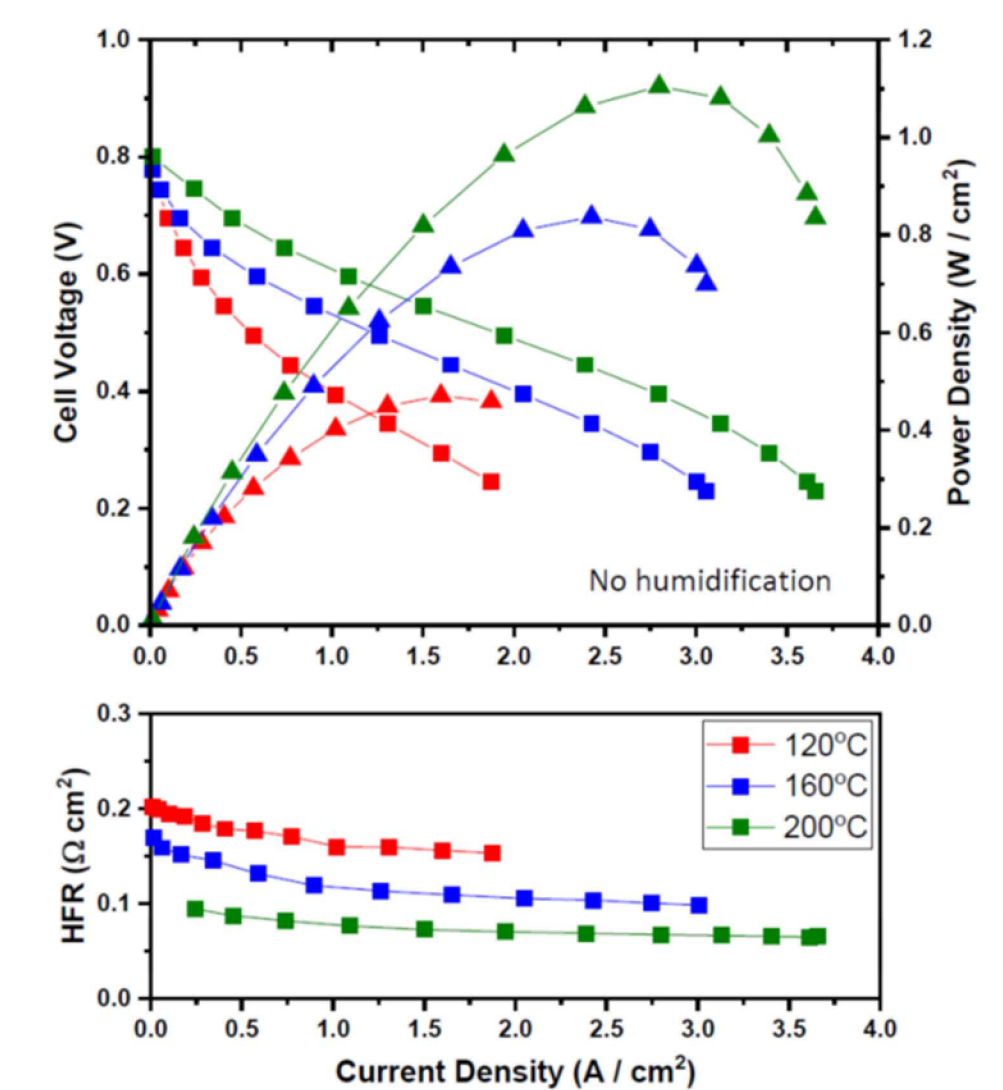
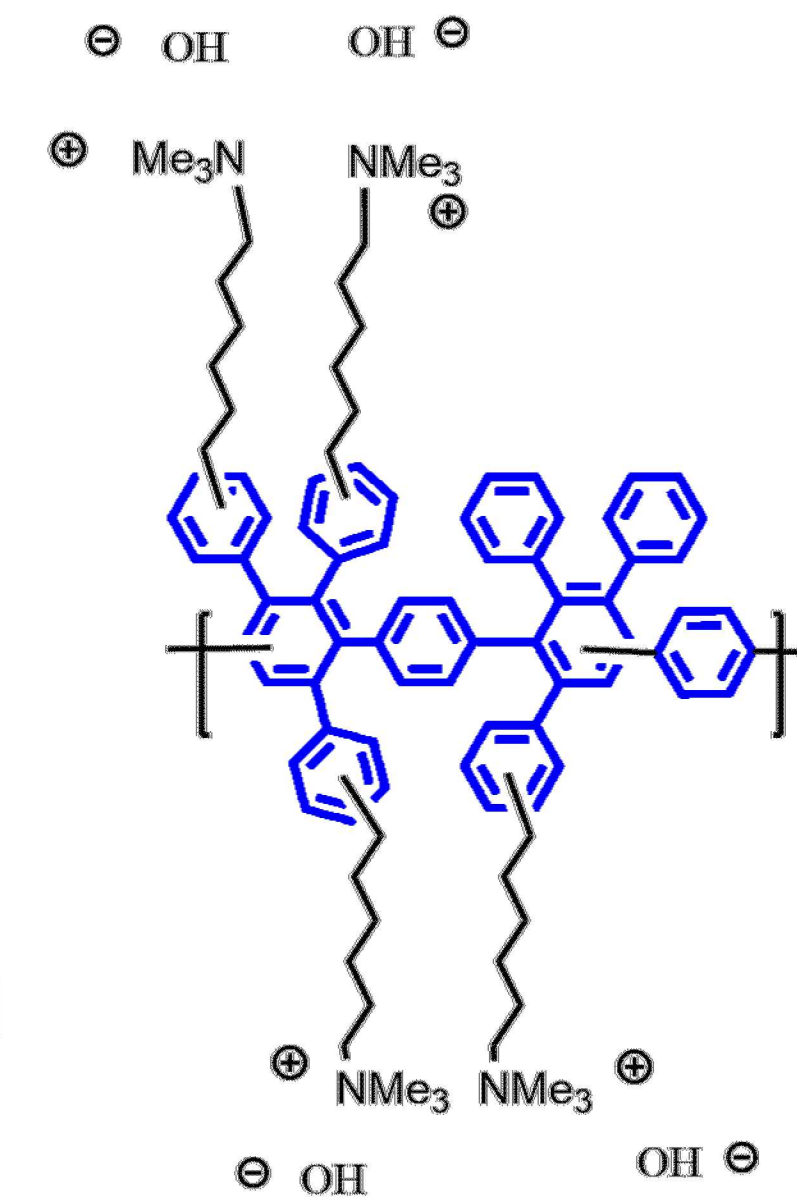
VC concerns are:

1. Materials company profit margins typically small.
2. Difficult to compete with large industry.
3. Small changes in demand of product could have dramatic consequences.

Next Steps

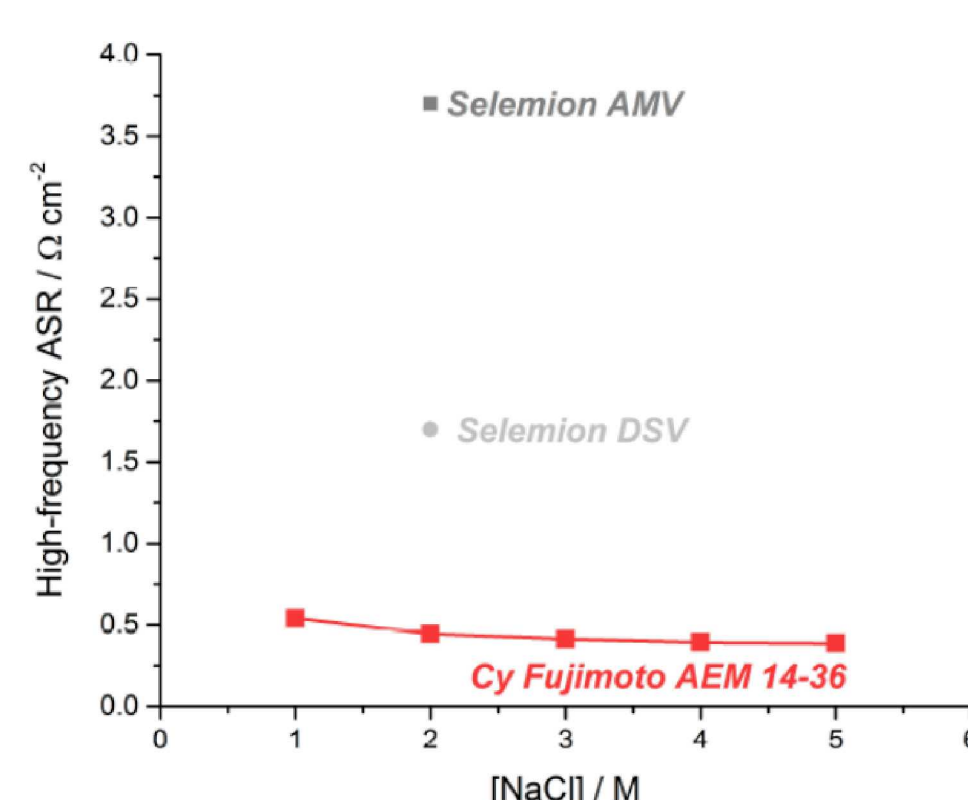
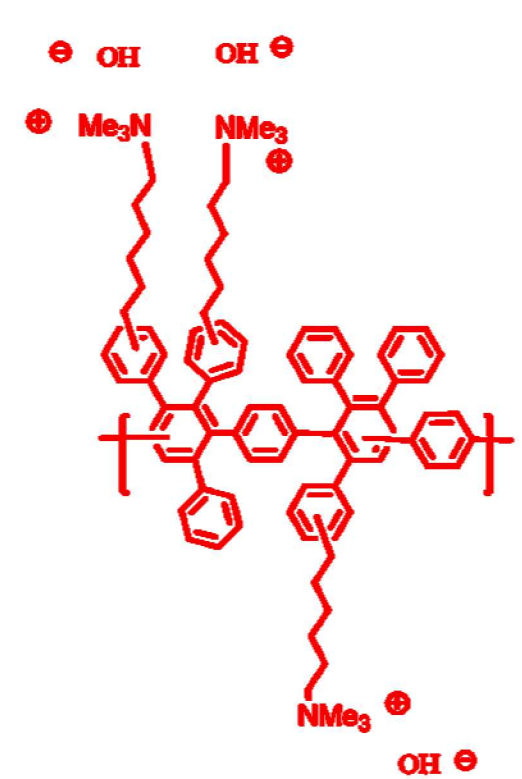
Material + Integrated System = Promising start up?

SNL has game changing material: alkaline stable, anion exchange membrane. LANL may have game changing application employing SNL membrane.

[illegible]

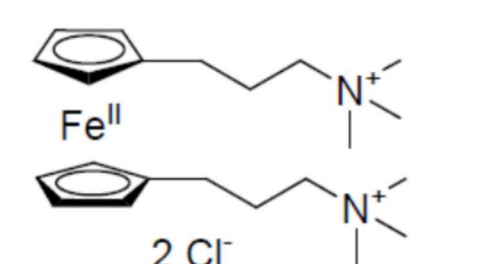
Aqueous Soluble Organic FB:

ASOFB to become commercially viable there is a need for new materials (electrolyte, membrane, electrochemical species, etc.).
Current anion exchange membrane not optimized yet for ASOFB.



Cross-over issues

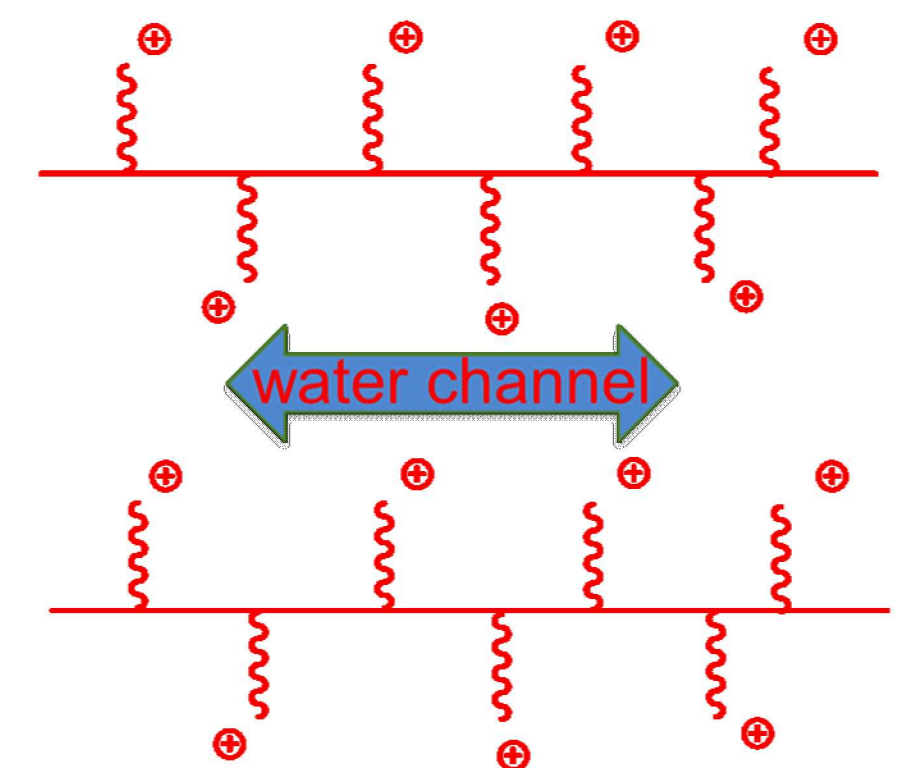
But...



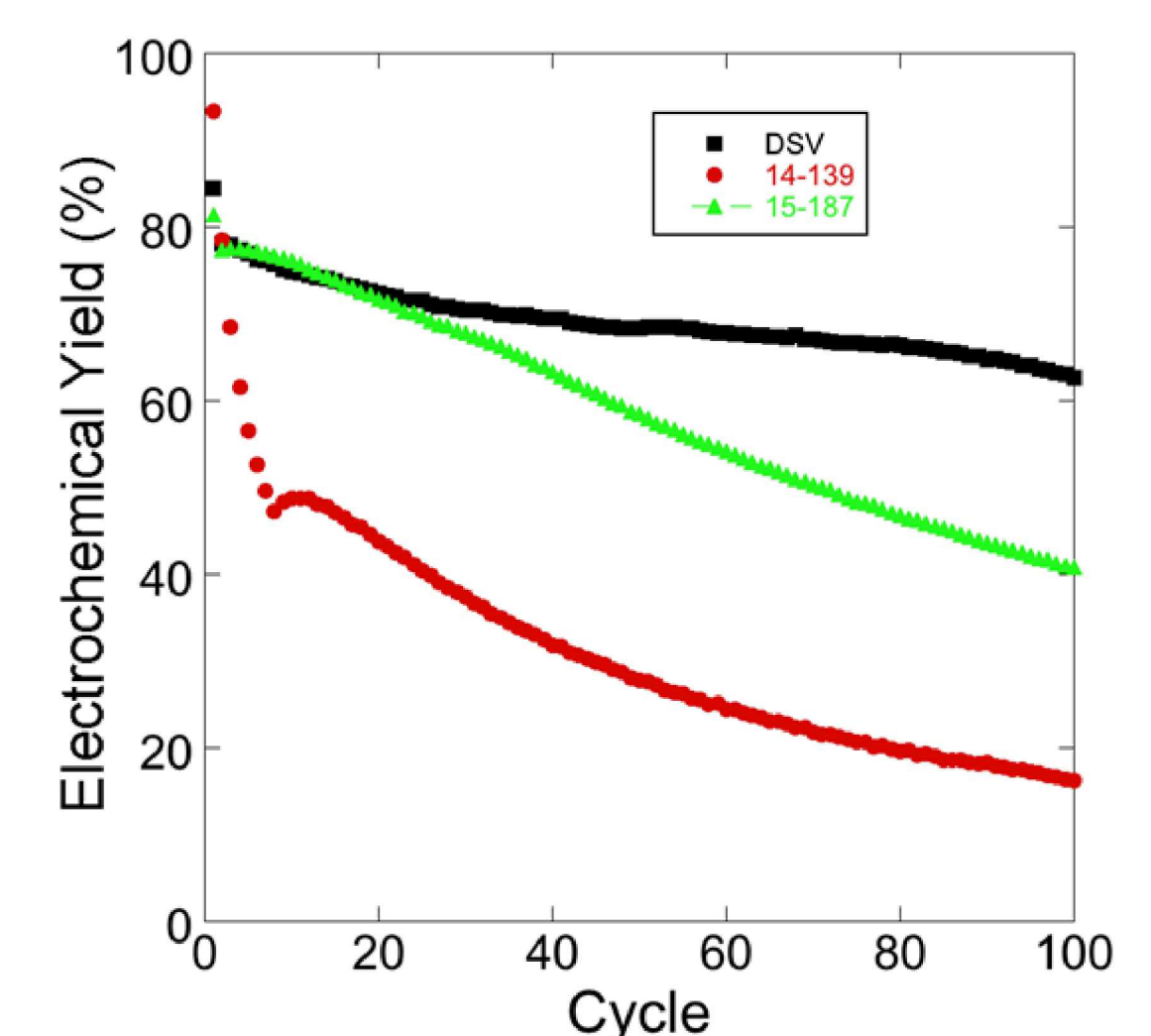
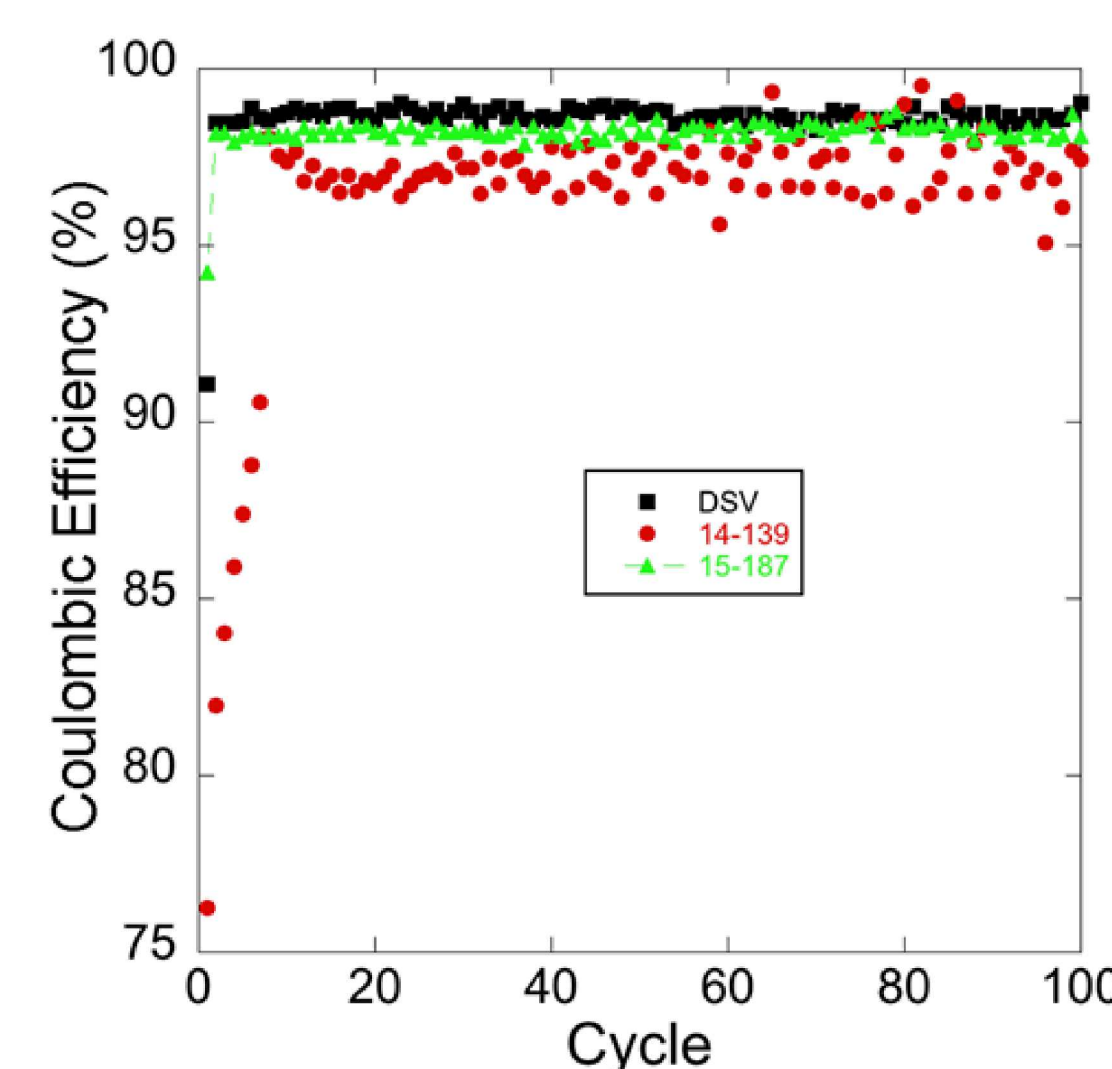
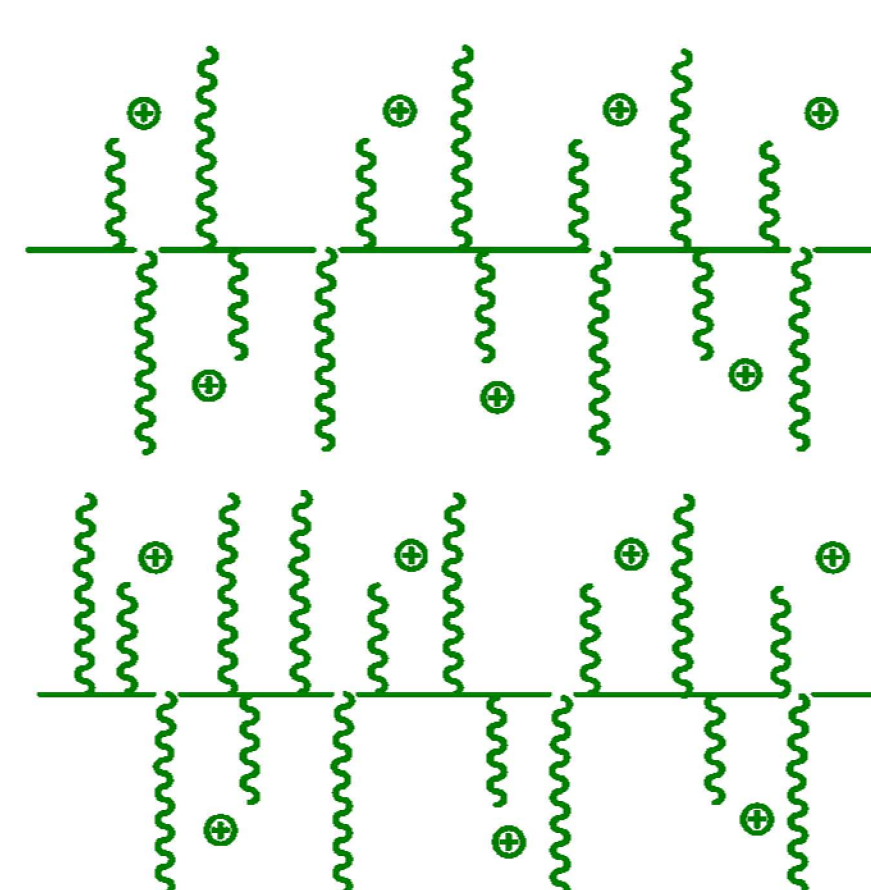
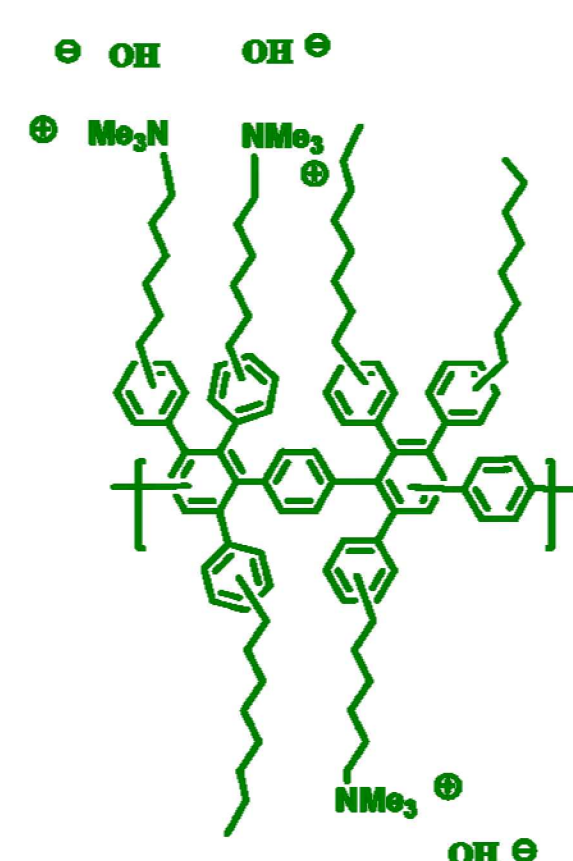
Why....

Target $1 \times 10^{-10} \text{ cm}^2/\text{s}$
SNL $6 \times 10^{-9} \text{ cm}^2/\text{s}$
Selemon DVS $1 \times 10^{-12} \text{ cm}^2/\text{s}$

Due to bulky backbone/substituents, large chain to chain distance = larger hydrophilic domain high ion cross over.



To improve membrane selectivity
goal: Crowd the ionic units with
non conducting groups that will
sterically block transport of larger
ions.



Crowd the ionic units with non conducting groups that will sterically block transport of larger ions. Further optimize by shorting ion tether and lengthen non ionic tether.

Conclusions/Future:

- 1..Anion exchange membranes have been getting attention due to good performance and durability.
2. Anion exchange membranes need to be modified for improved flow battery performance – have concept show promise.
3. Developing fluorinated poly(phenylene)s for VRFB.
4. Membrane commercialization
5. Battery testing of new polymer architectures (Travis/Harry), send to collaborators.

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