Breakout #1: Looking forward

- What would a material or approach need to look like to help us reach the goal of getting a solid ion conductor into large deployment?
  - Do we know the ideal structure of a solid ion conductor, ignoring constraints?
  - How should we think about the limits of what can be achieved by solid ion conductors?
  - What are creative material end points?
  - What is an ideal way to make and integrate a solid ion conductor in a device?

Breakout #1 participant input

- Electric vehicles with batteries
  - Incumbent is lithium ion
  - Move to metal anode assuming electrolyte weight/volume is similar
  - Eliminate electrolyte/metal sei
- Conductivity is enough; interface and all the other stability issues and manufacturability are the problem
  - Eg. Surface stability of the garnets and others vs H2O, CO2
- Thin and mechanically robust
  - YSZ is made at 20 micron thick at large scale. And flexible
- Polymer/ceramic composite
  - May introduce issues related to dendrite suppression
  - Need high loading of ceramics

Breakout #1 participant input

- Solid/solid interface issues
  - 3D composite cathode
  - Is all solid state system a worthwhile goal? Yes
- Less-liquid batteries…
- New opportunities in mixed conductor
- Self forming electrolyte
  - Electrode becomes electrolyte
  - Electrolyte becomes active
- Look for new compositions of ion conductors; the current materials set is small
- How to define metrics for your own
  - Has to have conductivity and stability
  - Processability
  - Q efficiency to give 10k cycles

Breakout #1 participant input

- No ideal structure
  - Need to be tuned to application
  - Cannot look at ideal conductor – need a team that connects electrochemist to device maker to guide metrics (multi-disciplinary approach)
- Limited by oxygen reduction via electrode
  - Can't look only at oxygen transport, need to look at cation transport too due to particle coarsening
- Manufacturing
  - Provide composite materials, self-healing, pin hole free
  - 3D printing could be an enabling technology

Breakout #1 participant input

- Work is not funded via long term sources
  - Not done at NSF
- Grain boundaries may be good or bad
  - Conductance via the bulk or grain boundaries
- Dendrite formation mechanism is not well understood
  - Need more understanding to determine what membrane is need
  - Mechanical aspect and chemical aspect to dendrite suppression
- Stress/strain
  - Can added stress change the conductivity properties of material?

Breakout #1 participant input

- High throughput
  - Need a better interaction with computational and experimental high throughput to guide each other
  - Currently, findings occur randomly
- Perhaps we should specify the electrode chemistry and then guide the ionic conductivity
  - How does the layer interface with the electrodes? Need to look at whole system
- Need to specify the application first
  - Then set the targets and architecture
- Do you really need a system with peak efficiency? Or better with longer life?