

Breakout #2: What we can draw on

- ▶ What tools and examples are available to us now that weren't available 5 years ago?
 - Examples: synthetic techniques, computations, characterization.
 - What can we learn from materials or fabrication processes with features we care about in unrelated areas?
 - What other communities of researchers or inventors should be engaged for our problem statement?

Breakout #2 participant input

- ▶ How we are going to look for new materials?
 - Computational power: dft advancements; new MD; need to focus on searching for new structure
 - In-situ characterization to follow transport mechanisms (e.g. new user facilities and NMR), including interface and surface; this is challenging for computation
 - Inspiration from LIPON
 - Bulk combinatorial
 - Advancement in solid state chemistry? Maybe use model thin film system? Including Epi growth?

Breakout #2 participant input

- ▶ Materials and device engineering
 - Surface modification, eg. ALD
 - Solid/solid interface using a soft buffer
 - Additive manufacturing
 - Nano-ionics: having space charge layer overlap; strain effect; fundamentals not well understood
 - Polymer electrolyte/single ion conductor
 - Mixed oxygen ion conductors for oxygen separation, anything new?
 - Hybrid organic/inorganic materials just like perovskites? MOF?
 - Room temperature proton conductor? Graphene oxide? 2D materials?

Breakout #2 participant input

▶ Expertises

- Solid chemists: sintering, low temperature synthesis (solution based to meta stable systems), sol-gel? High rate CVD? Hydrothermal? Ultrasonic spray?
- Learning from Na double beta

▶ Measurement tools

- Stability protocols
- Conductivity measurement on thin film
- In-situ techniques to probe interfaces

Breakout #2 participant input

- ▶ Define the big win for a program in this area:
 - Generate excitement just with the ARPA-E brand, maybe someone else will pick it up.
 - Demo a device to show what performance is possible.
 - Demo a conductor with “promising” properties with new composition/structure, similar to what Kanno did.

Breakout #2 participant input

- ▶ In situ electro polymerization to reduce the pin hole defects.
Can you do this with solid electrolytes?
- ▶ Things that improved in 5 years
 - Cost of technology
 - SIMS better resolution
 - Atomic switching based on ion movement
 - Xray tomography
 - In situ TEM
 - High throughput computation
 - High throughput solid state material synthesis

Breakout #2 participant input

- ▶ New communities
 - Semiconductor industry (new solid state ionics community come from there)
 - Glass manufacturing (high temperature ceramics)
 - Crystal growth (interface knowledge; know how to grow films and crystalline material)
 - 3D printing
- ▶ What do you want to see in the next 5 years
 - Tools available to measure potential across barrier interfaces
 - Measure very low levels of voltage/impurities
 - Subsurface measurements for structural measurement
 - Reference electrode/probe species
 - Need better probes/tools and better interpretation of data

Breakout #2 participant input

- ▶ Need to build a solid ionic community
 - Expertise separated into sections: batteries, fuel cells, membranes