Developing sustainable synthetic routes to lithium-ion battery electrodes

Allyson Ee
Chemical Engineering ‘22
Howie Nguyen
Clément Group
Materials Department

Final Presentation
August 12, 2019
Batteries meet the demand for energy storage

**Applications**

**Benefits**
- Reduce effects of global warming
- Portable energy
- High charge efficiency (~99%)
- Long service life

**Problem**
Battery system *energy cost must be reduced from $400-600 to $125 per kW/h* to support electric vehicle commercialization.
How are battery materials synthesized?

**Optimization of Material**

1. **Weigh & Grind Reagents**
   - Prepare reagents based on computed ratios and grind to ensure homogeneity

2. **Pellet Press**
   - Compresses reagents into a pellet to support crystallization

3. **Tube Furnace**
   - Heats material to 1000 °C for 20-30 hours to form crystalized material

4. **X-Ray Diffraction (XRD)**
   - Gives information on the 3D structure and composition of the material
How can battery cost be reduced?

Conventional
- Surface-to-core heating
- 20-30 hours
- 6-8 kW/h

Microwave
- Homogeneous heating
- 10-15 mins
- 0.25-0.5 kW/h
How is microwave synthesis determined complete?

X-Ray Diffraction (XRD)
Gives information on the 3D structure and composition of the material

Atomic Emission Spectroscopy (AEP)
Quantifies material composition more precisely

Nuclear Magnetic Resonance (NMR)
Shows accurate material structure

Battery Cycler
Determines electrochemical properties of material
Microwave synthesis of a battery material shows issues with phase purity.

Peaks show structure of material, combination of peaks estimate composition of material.
Microwave synthesis is a promising method to reduce battery costs

Through microwave synthesis...
- Nearing phase purity
- Reduce energy consumption significantly
- 120x faster creation of battery materials

In the future...
- Further characterization using AEP and NMR
- Battery performance testing and comparison
- Tesla for everyone!