High Surface Area, Mesoporous (La, Sr)MnO_3 for Solid Oxide Fuel Cells

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Project Goal

The goal of this project is to improve the solid oxide fuel cell (SOFC) cathode performance by preparing high-specific-surface-area catalysts for cathode infiltration.

1. ***Synthesis of high-surface-area (La, Sr)MnO_3***
2. ***Develop mesoporous (La, Sr)MnO_3 particles***

Project Motivation

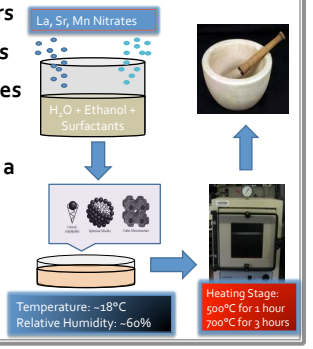
- SOFCs are energy conversion devices with high efficiencies and reduced CO_2 emissions
- The efficiency of SOFCs is limited by cathode performance
- Incorporation of catalysts by infiltration has been reported to improve cathode performance by reducing electrode polarizations
- Infiltration with higher specific surface area catalysts can further enhance SOFC performance

Challenges / Needs

- Must develop a synthesis method that generates high surface area catalysts (LSM) as compared to conventionally synthesized (4 ~ 20 m^2/g) cathodes
- Must determine if mesoporous catalysts are improved over solid particles
- Must demonstrate thermal stability to high surface area catalysts in SOFC conditions
- Must transfer the method for SOFC infiltration

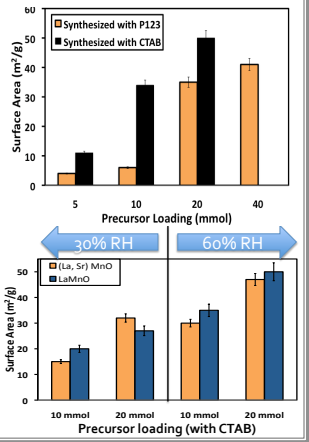
Evaporation-induced Self-assembly (EISA)

- Developed by Mobil researchers
- Simple, low cost, wet synthesis
- Can form mesoporous structures
- Has produced oxide particles
- Surfactants self-assemble into a template by gradual increase of concentrations
- Must control: surfactant, concentrations, evaporation (relative humidity)



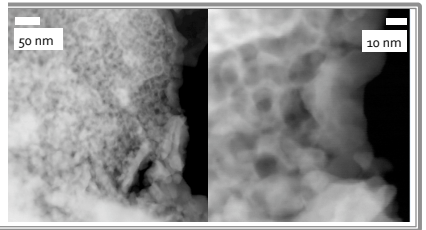
Surface Area and Process Parameters

- High surface area cathode materials were synthesized:
  - 50 m^2/g for $LaMnO_3$ and
  - 40 m^2/g for (La, Sr)MnO_3
- CTAB produced LSM with higher surface areas than P123
- Increased precursor loading lead to increased surface area
- High relative humidity favored high-surface-areas



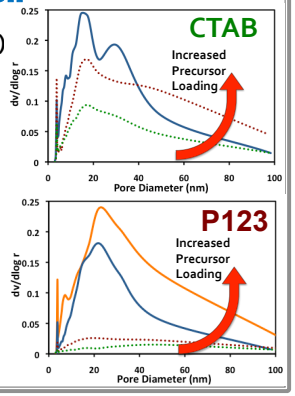
Mesoporosity

- Particles are mesoporous
- Pore diameters are 10-30 nm
- High pore volumes



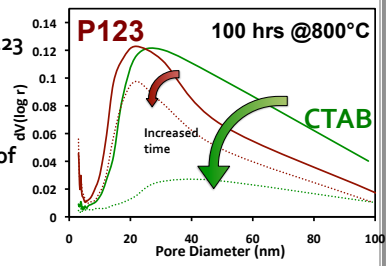
Pore Size Distribution

- 10-50 nm pores (mesopores)
- High surface areas are associated with the higher number of mesopores
- With CTAB, the number of larger pores decreases at highest precursor loading



Thermal Stability

- Mesopores synthesized with P123 are stable at high temperatures
- Thermal stability of the mesopores is depended on templating agents



Conclusions

- High-surface-area (La, Sr)MnO_3 were produced by EISA
- The particles synthesized are mesoporous
- Mesopores formed with P123 are thermally stable at operating temperatures

Future Work

- Incorporate method to cathode infiltration to introduce high-surface-area catalysts in SOFCs
- Cell testing for the cathodes infiltrated via EISA