Effect of Starting Materials on the Characteristics of $(La_{1-x}Sr_x)\ Mn_{1+y}O_{3-\delta}$ Powder Synthesized by GNP

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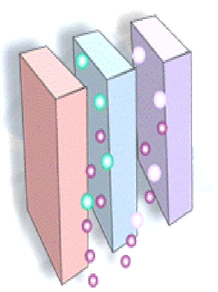
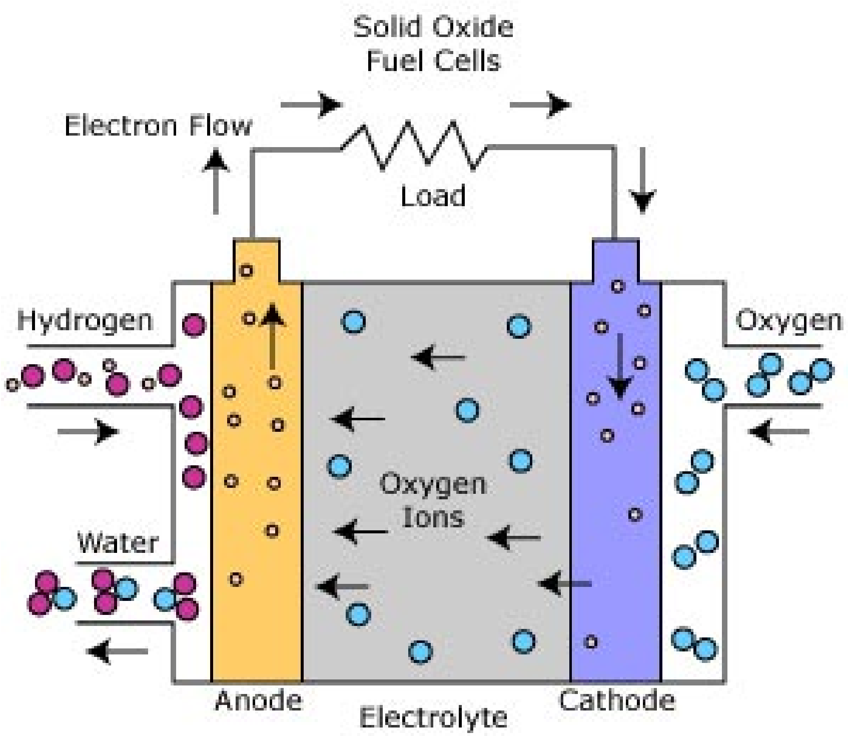


Fuel cells are making headlines across the globe in almost every area of power production including buildings, cars and portable electronics.

MI-Jai Lee

Principle

What is SOFC ?



Anode : $H_2 + O^{-2} = H_2O + 2e^-$

Cathode : $1/2O_2 + 2e^- = O^{-2}$

Total : $H_2 + 1/2O_2 = H_2O$

Solid oxide fuel cell is energy conversion device that produces electricity by electrochemical. It operate at high temperature over 600℃ with pollution-free technology.

Principle

Advantage & Disadvantage

Advantage

- Highest energy conversion efficiency
- No need to use noble metal catalyst (600~1000℃ operation)
- LNG, coal gas can be used
- No problems of electrolyte loss
- High quality byproduct heat
- Modular construction
- Potential for cogeneration
- Much lower production of pollutants.

Disadvantage

- Not reliable to thermal cycle
- Low physiochemical stability

Principle

Key Research Material Areas ?

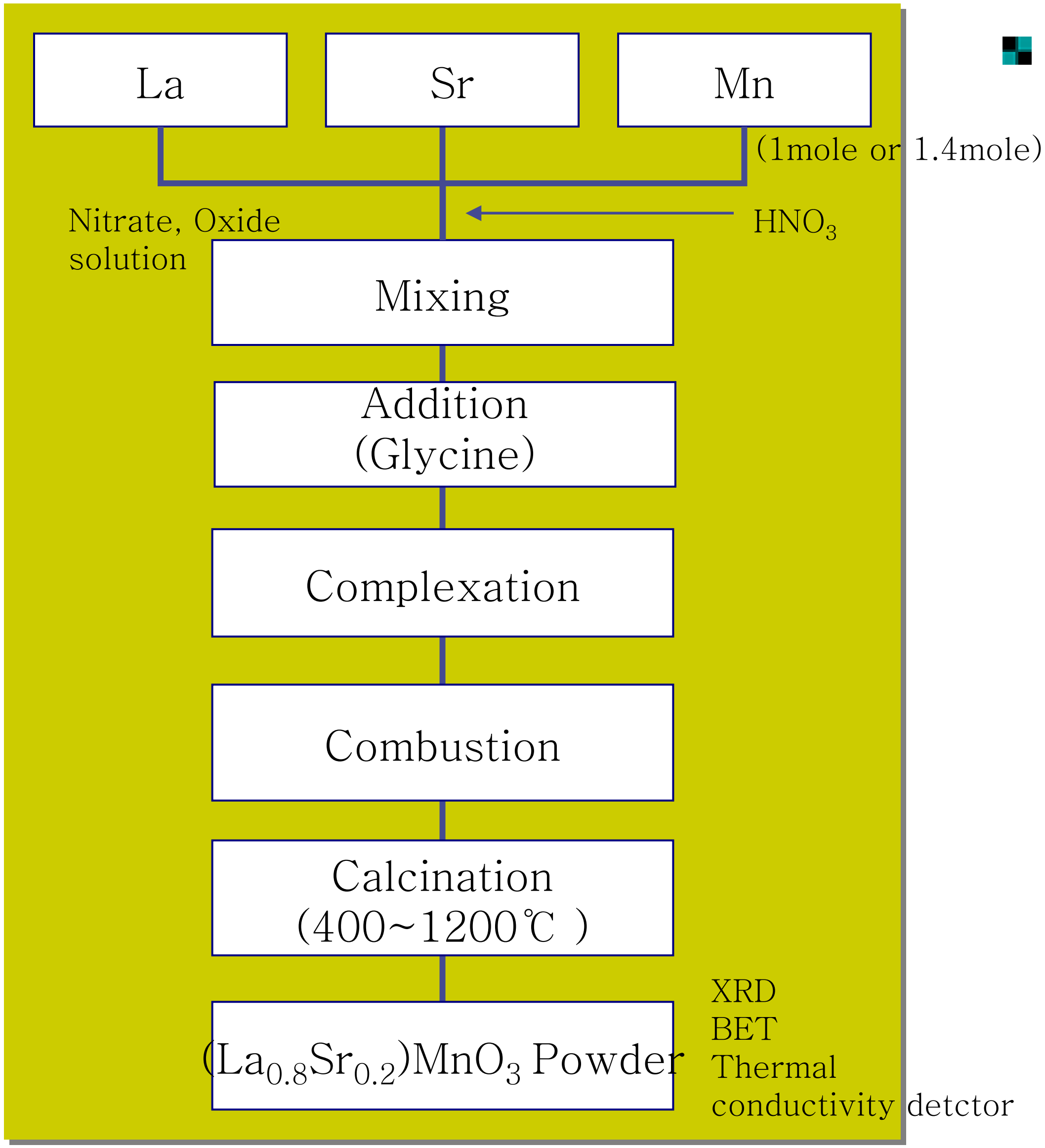
General Materials

- **Nano-scale materials, and synthesis**
  - Nano-powders
  - Composites
- **New cathode materials**
  - Higher conductivity
  - Lower polarization
- **Fuel flexible anode materials**
  - Sulfur tolerance
  - Various fuels

Materials Processing

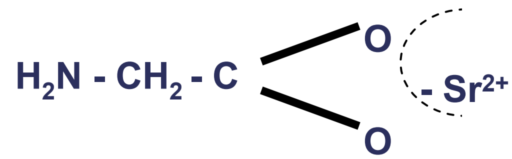
- Thin films
  - lower temperatures
  - new processes
- Chemical synthesis routes for development of mixed conductors
- Investigation of complex perovskite-type oxides
- MEA fabrication and characterization (solid acids, proton conducting oxides)

Experimental Procedure

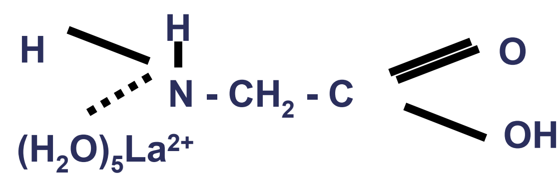


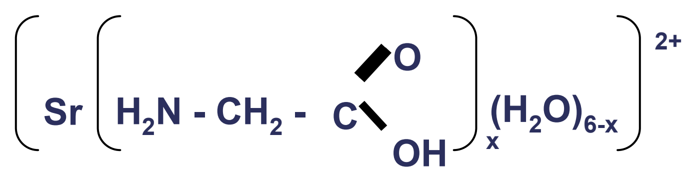
Chemical Reaction of Glycine-Nitrate Process

(a) Carboxylic Acid Group



(b) Amine Group

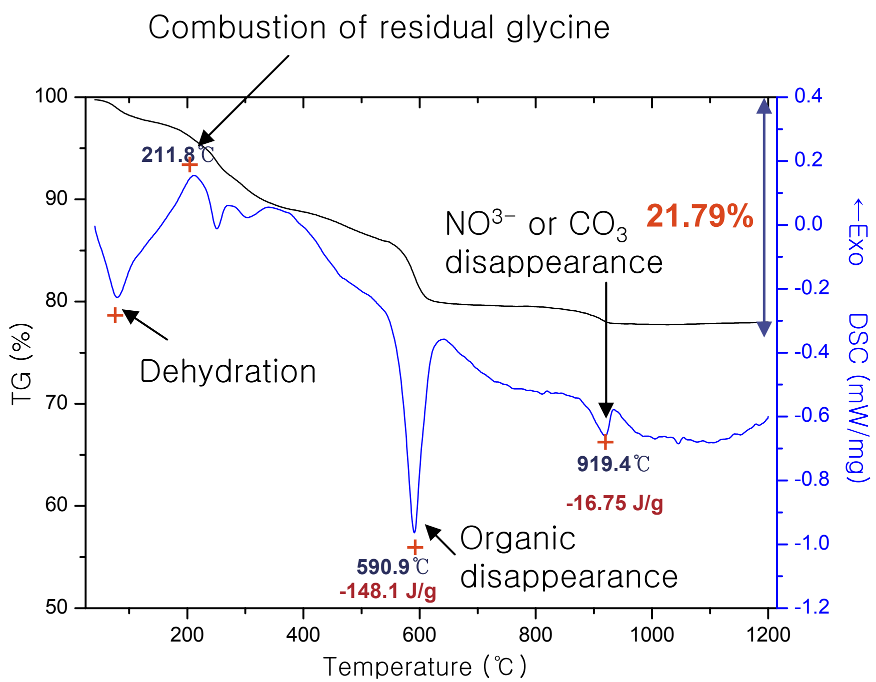




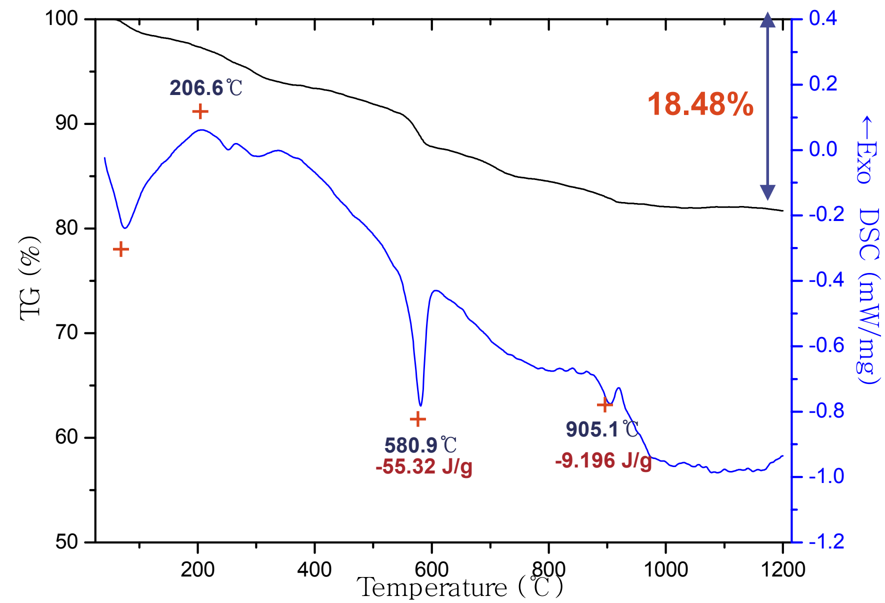
Initial stage of glycine-metal complexation in an queous solution.

Result

DT-DSC curve of synthesized $La_{0.8}Sr_{0.2}MnO_3$ powder (Stoichiometric)



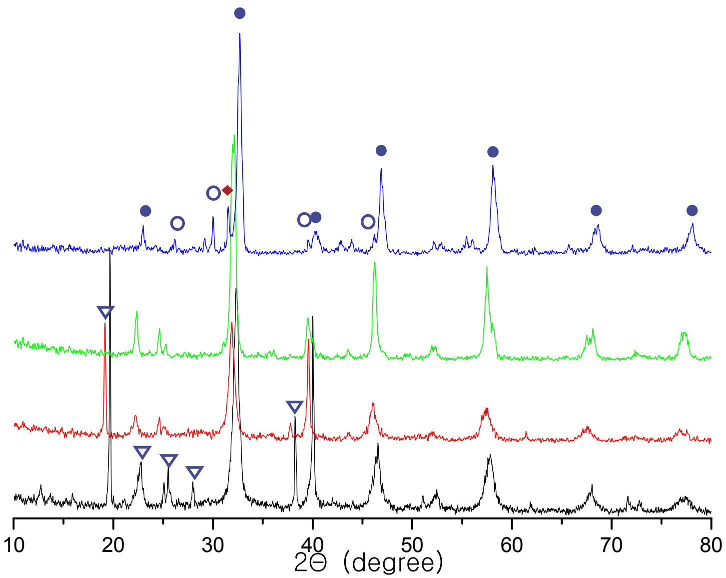
(a) Nitrate solution



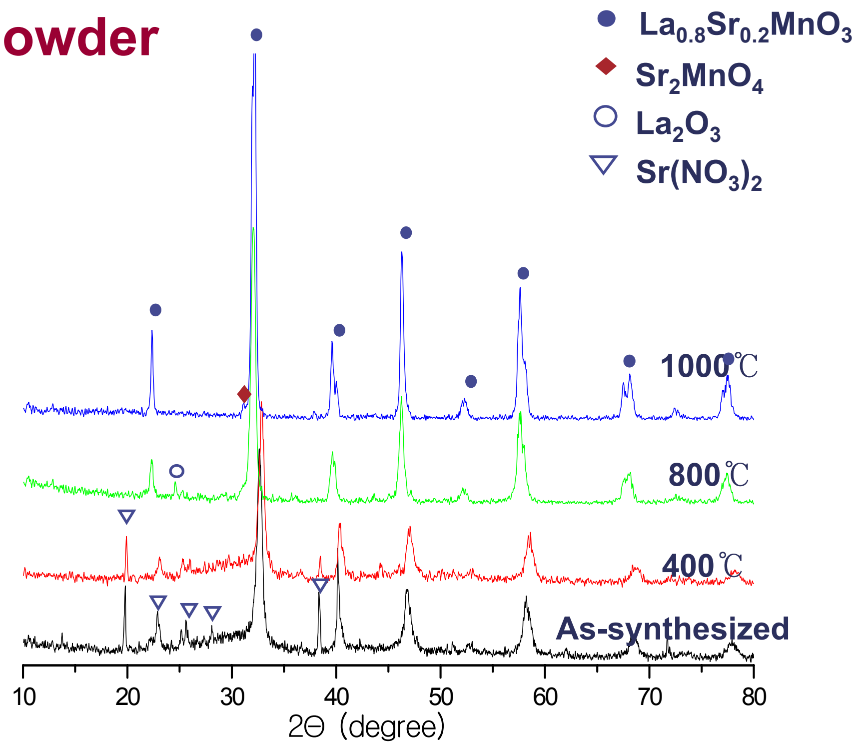
(b) Oxide solution

Result

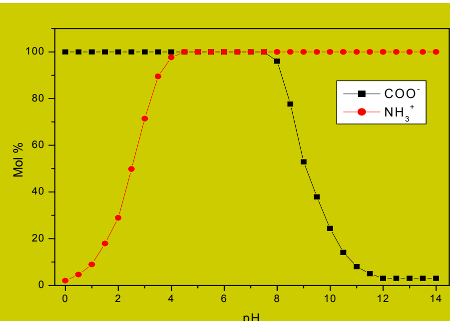
XRD patterns of $(La_{0.8}Sr_{0.2})MnO_3$ powder (Stoichiometric)



(a) Nitrate solution



(b) Oxide solution



Under pH < 1, Amine group are only existing.

Result

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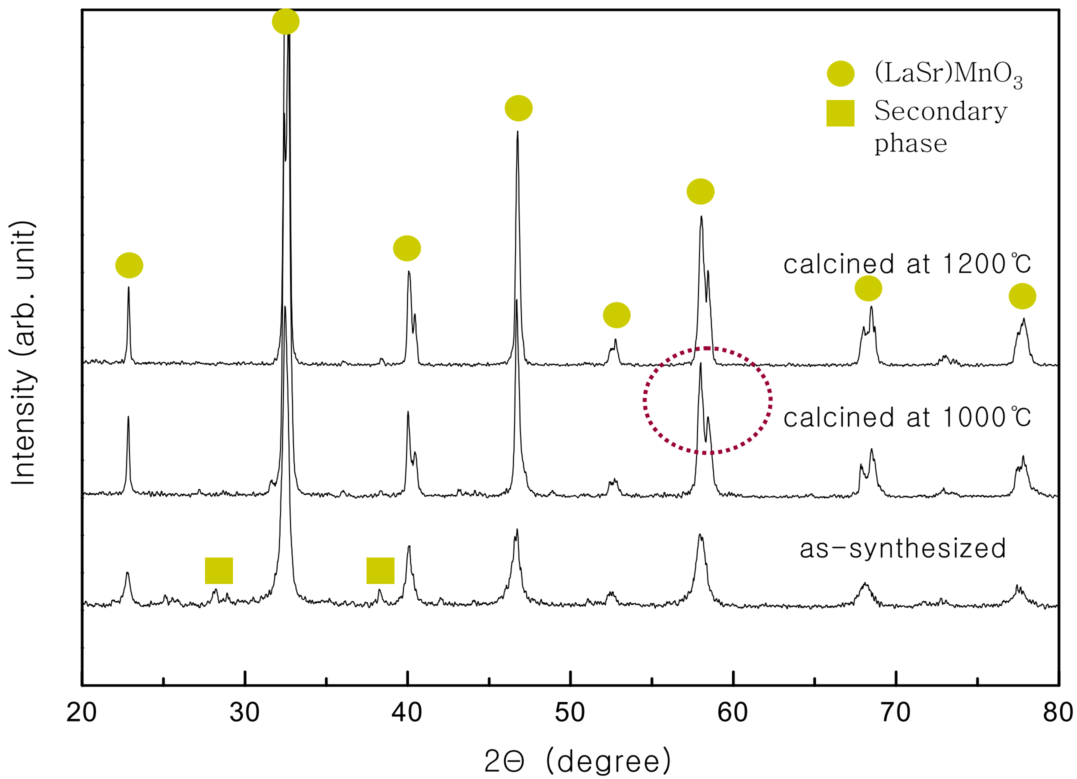
■ **XRD patterns of $(La_{1-x}Sr_x)Mn_{1.40}O_3$ powders (Non-Stoichiometric, Nitrate Solution)**

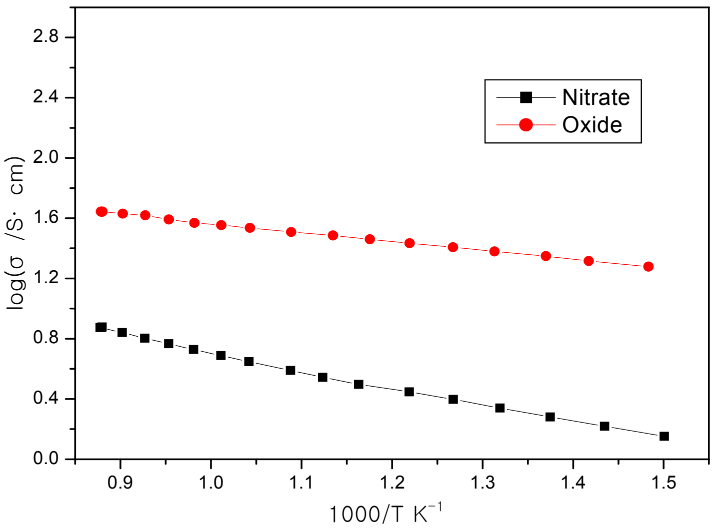


It has single phase after calcination at 1200℃ for 4hrs.

$(La_{0.8}Sr_{0.2})Mn_{1.4}O_3$

Result

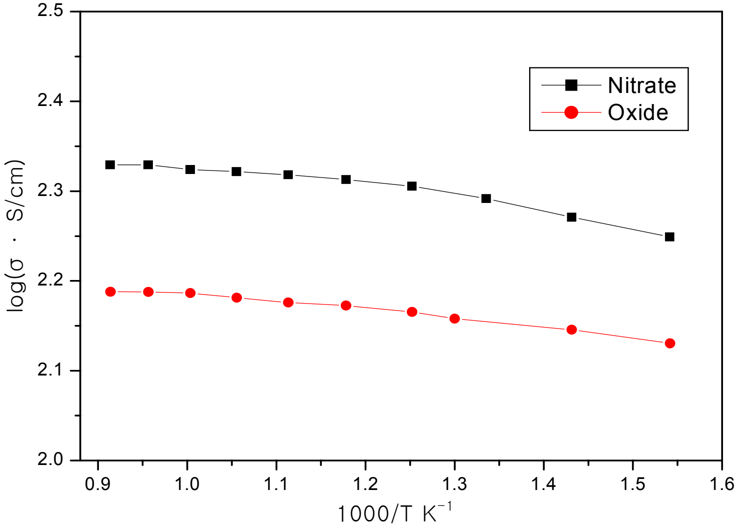
Electrical conductivity of $(La_{0.8}Sr_{0.2})Mn_{1-x}O_3$ powders



(a) Stoichiometric (Mn = 1mole)

Nitrate solution : 4.87 S/cm at 700℃

Oxide solution : 35.7 S/cm at 700℃



(b) Non-Stoichiometric (Mn = 1.4mole)

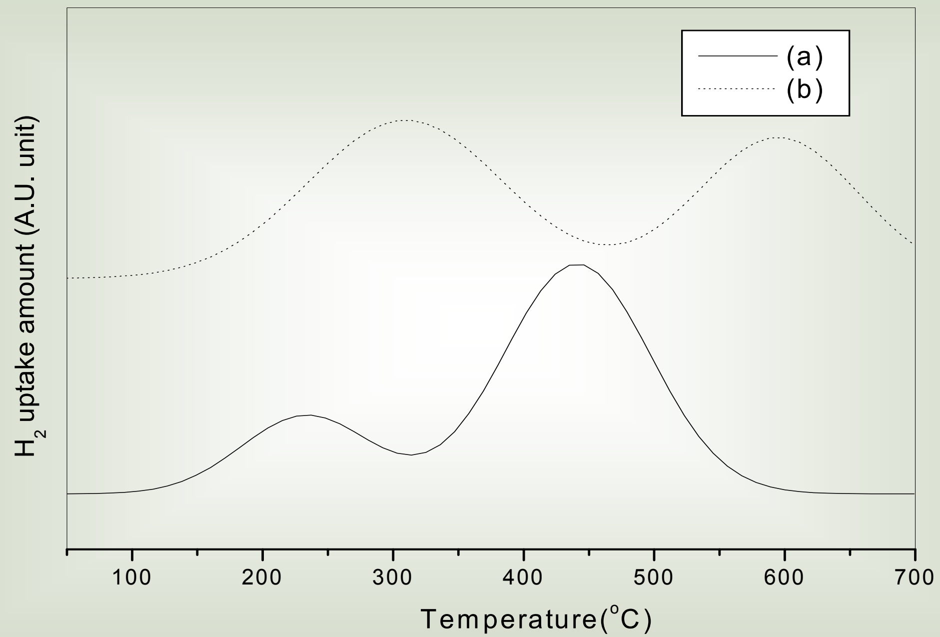
Nitrate solution : 210.3 S/cm at 700℃

Oxide solution : 152.7 S/cm at 700℃

Temp.(℃)	σ (S/cm)	Refs.
800	180	Solid State Ionics 110(1998)61
900	155	J. Mater. Chem. 1997, 7(13)

Result

Temperature programmed reduction (Non-Stoichiometric)



Temperature programmed reduction of $La_{0.8}Sr_{0.2}Mn_{1-x}O_3$ powder after calcination 1000℃ for 4hrs with different starting Materials. (a) nitrate and (b) Oxide

Conclusion

Effect of Starting Materials on the Characteristics of $(La_{1-x}Sr_x)Mn_{1+y}O_{3-\delta}$ Powder Synthesized by GNP

- Case1 : Nitrate solution (La:Mn=1:1)
  - LSM powders show secondary phases after calcination at 1000℃ (La_2O_3, Sr_2MnO_4)
  - Average particle size is 0.90 ㎛ and BET is 26.5 m^2/g
  - The particles show porous structure
  - Electrical conductivity shows 4.87 S/cm at 700℃ after sintered at 1200℃

- Case2 : Oxide solution (La:Mn=1:1)
  - Average particle size is 9.04㎛ and BET is 16.8 m^2/g
  - LSM powders show a secondary phase Sr_2MnO_4 after calcination 1000℃ for 4hrs.
  - Electrical conductivity shows 35.7 S/cm at 700℃ after sintered at 1200℃ for 4hrs.

- Case3 : Mn excess (La:Mn=1:1.4, nitrate solution)
  - Average particle size is 2.46 ㎛
  - The powders have good sinterability
  - Deoxidization peak of the synthesized $(La,Sr)MnO_{3+\delta}$ powders using nitrate solution appeared at lower temperature than the synthesis powders using oxide solution, at 450℃(β-peak)
  - Electrical conductivity shows 210.3 S/cm at 700℃ after sintered at 1200℃ for 4hrs.