# Investigation of Structural, Electron Transport, and Microwave Absorption Properties of $La_{0.4}(Sr_{0.4}/Ca_{0.2})MnO_3$


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NSF

## Abstract

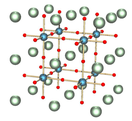

The purpose of our research was to examine the effects of magnetic fields and ultraviolet radiation (UVR) on the electron transport properties of $La_{0.4}(Sr_{0.4},Ca_{0.2})MnO_3$. Bulk and "thick" powder film samples were synthesized to determine if particulate (powder) samples would yield different results from the bulk. X-Ray Diffraction was used to determine the structure of the material. Microwave absorption measurements were also performed to collect data on the material's absorption ratio, reflection and transmission properties.

We hypothesize that in the presence of a magnetic field the resistance of the bulk and thick film samples will decrease. We also hypothesize that upon exposure to UVR, the thick film samples will show greater changes in electron transport properties compared to the bulk samples.


## Introduction

LaMnO:[1]

- A ceramic material that contains a perovskite crystal structure.
- Certain compositions of LaMnO exhibit Colossal Magneto Resistance.
- The material is able to exhibit insulating and metallic properties in the presence of various dopants.
- Exhibits paramagnetic, ferromagnetic and antiferromagnetic transitions at various temperatures.



Sintering:[2]

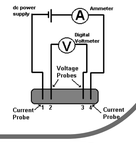
- Process utilized in forming ceramic materials through pressure and heat.
- Temperature must be high enough to allow an acceptable rate of diffusion to occur.
- Upon completion diffusion allows the individual powder particles to intermix with others forming one atom.

Particles before sintering

Particles after sintering

Four probe method:[3]

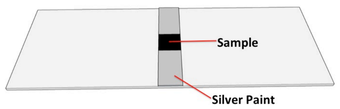
- Used to determine resistivity of a sample material
- Four leads are attached to a sample connected to a multimeter that supplies a current to the sample while measuring resistance.

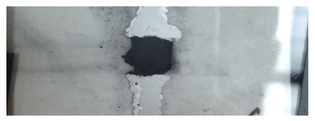



## Thick Film Development

**Development Process:**

- Ground sintered pellet to form powder.
- Used clear nail polish as a binding agent.
- Coated nail polish with powder
- Conductive silver paint applied to measure resistance

| Dimension | Value |
|---|---|
| Length | 3.18 mm |
| Width | 6.35 mm |
| Thickness | .237 mm |

## Solid-State Synthesis (Bulk)

**Equation For Synthesizing Compound:**

$$2La_2O_3 + 10MnO_2 + 4SrCO_3 + 2CaCO_3 \rightarrow 10La_{0.4}(Sr_{0.4}Ca_{0.2})MnO_3 + 6CO_2 + O_2$$

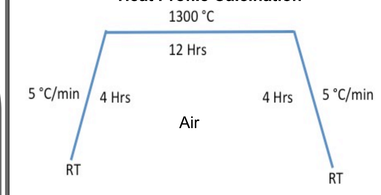
**Synthesis Process[1]:**

- Mixed 99.999% High Purity Powder
- Calcined sample to remove $CO_2$ and $O_2$.
- Grinded sample into a powder.
- Sintered sample by pressing into pellet and heating.

| Reactant | Mass Required |
|---|---|
| $La_2O_3$ | 1.939g |
| $MnO_2$ | 2.587g |
| $SrCO_3$ | 1.757g |
| $CaCO_3$ | 0.596g |

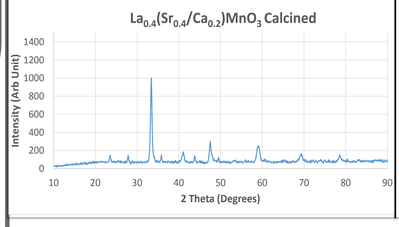
### Calcination

**Heat Profile Calcination**



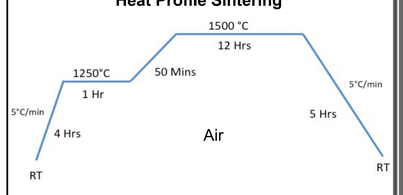

**Sample Post Calcination**

**X-Ray Diffraction Post Calcination**



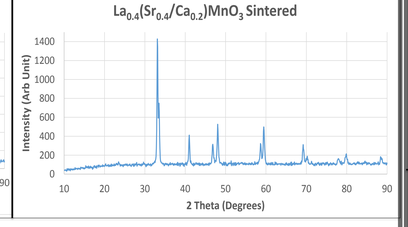

### Sintering

**Heat Profile Sintering**




**Sample Post Sintering**

**X-Ray Diffraction Post Sintering**




| Dimension | S1 | S2 |
|---|---|---|
| Diameter | 12.28mm | 12.95mm |
| Thickness | 1.041mm | 1.029mm |
| Mass | .59g | .60g |

**Physical Properties (Pellet):**

- Material had a black color.
- Material appeared glossy.
- Material was **very** hard.
- Material was attracted to a magnet.

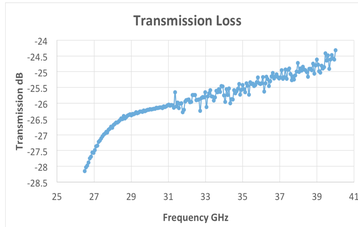
## Conclusion

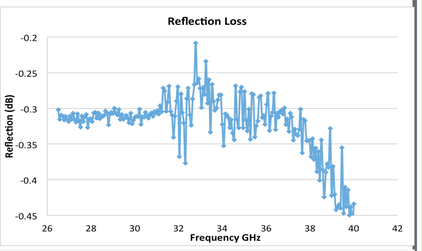
1. Bulk sample did not exhibit a change in resistance in presence of magnetic field.
2. Sample exhibited ferromagnetic properties upon sintering.
3. Illumination of the "thick" powder film by an incadencense 60w light source resulted in an unexpected increase in resistance that persisted after an extended period of time (greater than 12 hours) after removal of the light source.
4. Although UV exposure has not been conducted, we anticipate doing that within the next week.

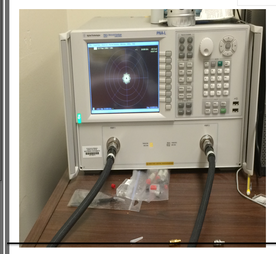
## Experimental Setup/Data

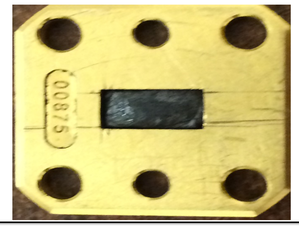
### Microwave Absorption

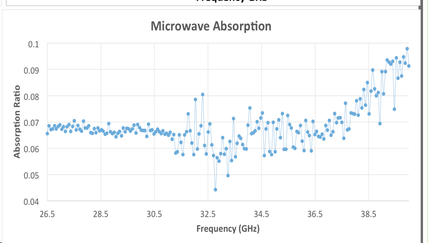
| Dimension | Value |
|---|---|
| Length | 7.09mm |
| Width | 3.46mm |
| Thickness | 2.79mm |



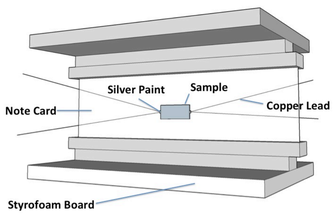



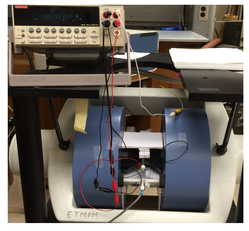



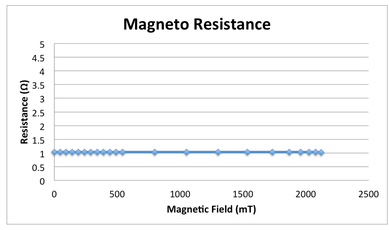




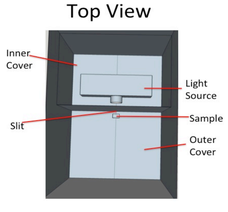

### Magneto Resistance

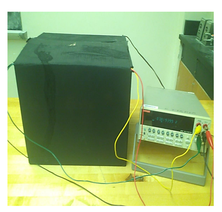


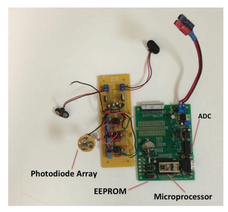






### Ultraviolet Radiation






## Future Research

- Examination of "thick" powder film produced from previous research samples may yield new results.
- Development of a four probe method able to interface with our BalloonSat Board will allow for conducting trials that span several hours.
- Utilizing liquid nitrogen, and a heating plate, trials at various temperatures will be able to be conducted.
- Developing a method for producing 'thin' film samples will provide further comparison towards bulk and "thick" powder film samples.

## References


- [1]Kornfield, M.C.; Wicker, S.; Henry, L.L. "Synthesis and structural characterization of $La_{.5}Ca_{.25}Sr_{.25}MnO_3$
- [2]"Sintering of a Powder Compact." *Sintering.* N.p., n.d, Web. 15 July 2015.
- [3]Raziano, William; Franklin, Jermain; Henry, Larry. "Ultraviolet Radiation effects on the electrical resistivity of some La(Ca/Sr)MnO materials." Proceedings of Louisiana EPSCoR RII La-SiGMA 2014 Symposium.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## Acknowledgements


This work was funded by the Louisiana Board of Regents, through LASIGMA [Award Nos. EPS-1003897, NSF (2010-15)-RII-SUBR, and HRD-1002541].