Synthesis and Atomic Spacing of $La_{.5}(Ca_{.5-x}Sr_x)MnO_3$ for x=.3 and .4

Jermain Franklin

[1]Will Raziano

[2]Dr. Larry Henry (Mentor)

LA-SiGMA
Louisiana Alliance for Simulation-Guided Materials Applications

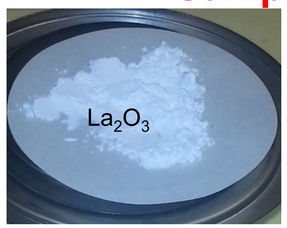
Abstract

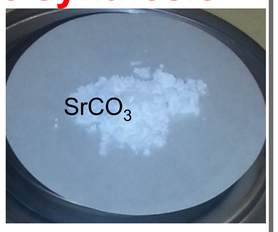
In a previous study, the structural data of $La_{.5}(Ca_{.5-x}Sr_x)MnO_3$ was examined at x=0, .1, .2, .3, and .5. When x=0 to .2 the atomic spacing increased linearly (38.2, 38.3, 38.4 nm). When x=.3, the atomic spacing was 40.1 nm. At x=.5 the atomic spacing is 38.5 nm. To verify x=.3 another sample was fabricated. Also, an x=.4 sample was fabricated (both using solid state reaction techniques). The atomic spacing and effects of UV radiation were examined. The atomic spacing for x=.3 and x=.4 was 33.0 nm and 38.5 nm, respectively. The UV radiation had no effect on either material.

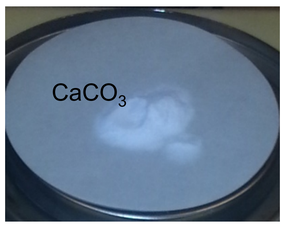
Background

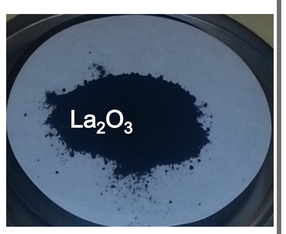
$La_{.5}(Ca_{.5-x}Sr_x)MnO_3$ is a perovskite material (ABO_3) capable of transitioning from insulating to metallic and it exhibits colossal magnetoresistance. It also has the ability to conduct electric current. This opens the possibilities of being used as solar cells, electrical outputs, and energy storage devices.

Sample synthesis

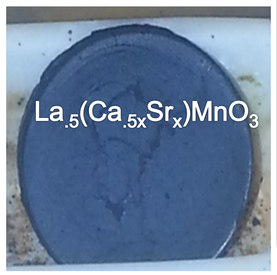








Synthesis Process:
Mix constituent high purity powders, grind, press into pellet sinter in air at 1500° C (2 cycles).
Results : 4 pellets (2 x = 0.3 and 2 x = 0.4)



Formulas

Balanced Equations for synthesizing 4 grams of desired compound

X=0.3: $10La_2O_3+12SrCO_3+8CaCO_3+40MnO_2 \rightarrow 40[La_{.5}(Ca_{.2}Sr_{.3})]MnO_3+20CO_2+5O_2$

X=0.4: $10La_2O_3+16SrCO_3+4CaCO_3+40MnO_2 \rightarrow 40[La_{.5}(Ca_{.1}Sr_{.4})]MnO_3+20CO_2+5O_2$

Scherer's equation (atomic spacing

$$S=k\lambda/\beta\cos\theta$$

- K – constant value (~1)
- λ –wavelength of the x-ray
- β-width of x-ray intensity peaks
- Θ-angle of the diffraction peak

Gaussian Equation (Curve fit)

$$Y = m_1+m_2*\exp(-(m_0-m_3)*(m_0-m_3)/(m_4*m_4)$$

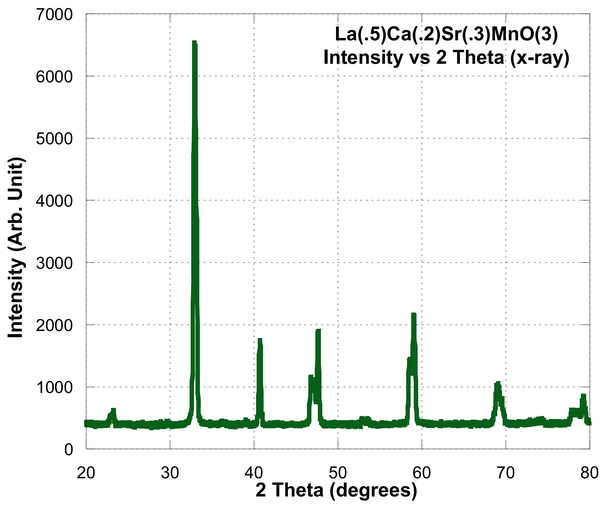
Electrical Resistivity

$$\rho=RA/l$$

- R- Resistance (Ω)
- A- Area (m^2)
- l-length (m)
- ρ-resistivity(Ω*m)

Results and Discussions

Table 1: Intensity of material (x=.3) at angle 2Θ



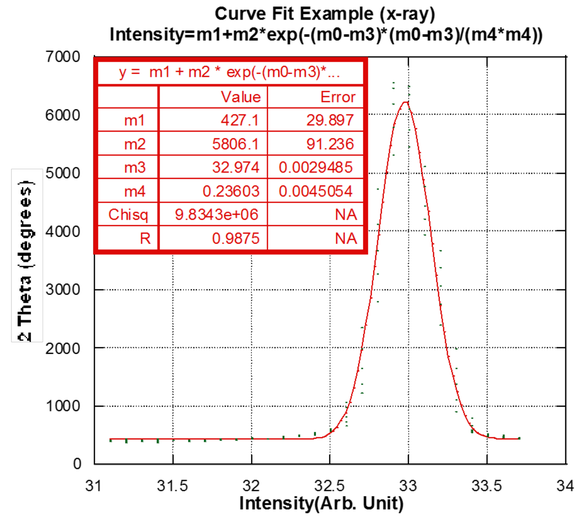
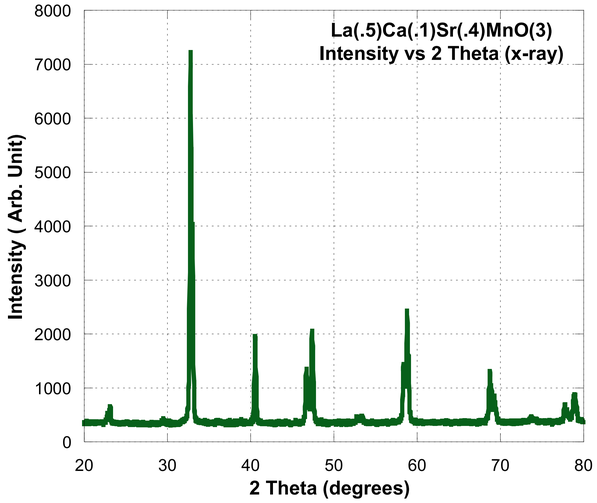


Table 2: Intensity of material (x=.4) at angle 2Θ



Physical Properties

Sample Identity →	Properties Found →	h (height)	w (width)	l (length)	R (electrical resistance)	ρ (electrical resistivity)
270614A (x=.3)		2.11 mm	3.34 mm	4.425m m	5.6375×10^{-2} Ω	8.978×10^{-2} Ωm
010714A (x=.4)		1.788 mm	3.86 mm	4.89 mm	7.8675×10^{-3} Ω	1.1101×10^{-3} Ωm

Atomic Spacing

- 33.0 nm x=.3
- 38.5 nm x=.4

Conclusion

The results suggests there is an internal process occurring at x=.3 that doesn't occur in the other variables. The trend for the atomic spacing at x=.4 exhibits similar traits to the other values (excluding x=.3). Also, the exposure to UV radiation had no effect on the material.

Acknowledgements

"This material is based upon work supported by the National Science Foundation under the NSF EPSCoR Cooperative Agreement No. EPS-1003897 with additional support from the Louisiana Board of Regents."

References:

1. Heat Capacity investigation of the Insulator-Metallic transition in the $La_{0.5}(Ca_{0.5-x}Sr_x)MnO_3$ system
   L.L. Henry, G.L. Zhao, A. Harvey, Jr. and J. J. Jackson. PACS numbers: 65.40.Ba, 75.40.Cx, 78.40.Kc
2. Begley, Anthony M. "Heat capacity investigation of the insulator-metallic transition in the $La_{0.5}$ $(Ca_{5-x}Sr_x)MnO_3$ system by L.L. Henry,
3. Pyle et al. "Toward the Development of a Proposal to Study the Effects of UV Radiation on some La(Sr/Ca)MnO Compounds".
   Proceedings of Louisiana EPSCoR RII LA-SiGMA 2013 Symposium. 2013.
4. Ebbing, Darrell D., and Mark S. Wrighton. *General chemistry*. Boston: Houghton Mifflin Co., 1984. Print.
5. Lindberg, Blue M., Furnace and Process Controller (High temperature furnace). April 1996