Reduced Dimensionality Effects in Ferromagnetic Behavior in $La_{1-x}Sr_xMnO_3$

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Abstract

We study the magnetic properties of $La_{1-x}Sr_xMnO_3$ samples for concentrations x, $0 \leq x \leq 0.5$. An analysis is done to accurately determine the transition temperature or critical temperature. Magnetic phase diagrams showing the various concentrations at different temperatures will be determined for our thin films. Using the phase diagrams for both bulk and thin film materials can show how reducing the dimensionality from the third dimension to approaching the second-dimension affects the phase diagram.

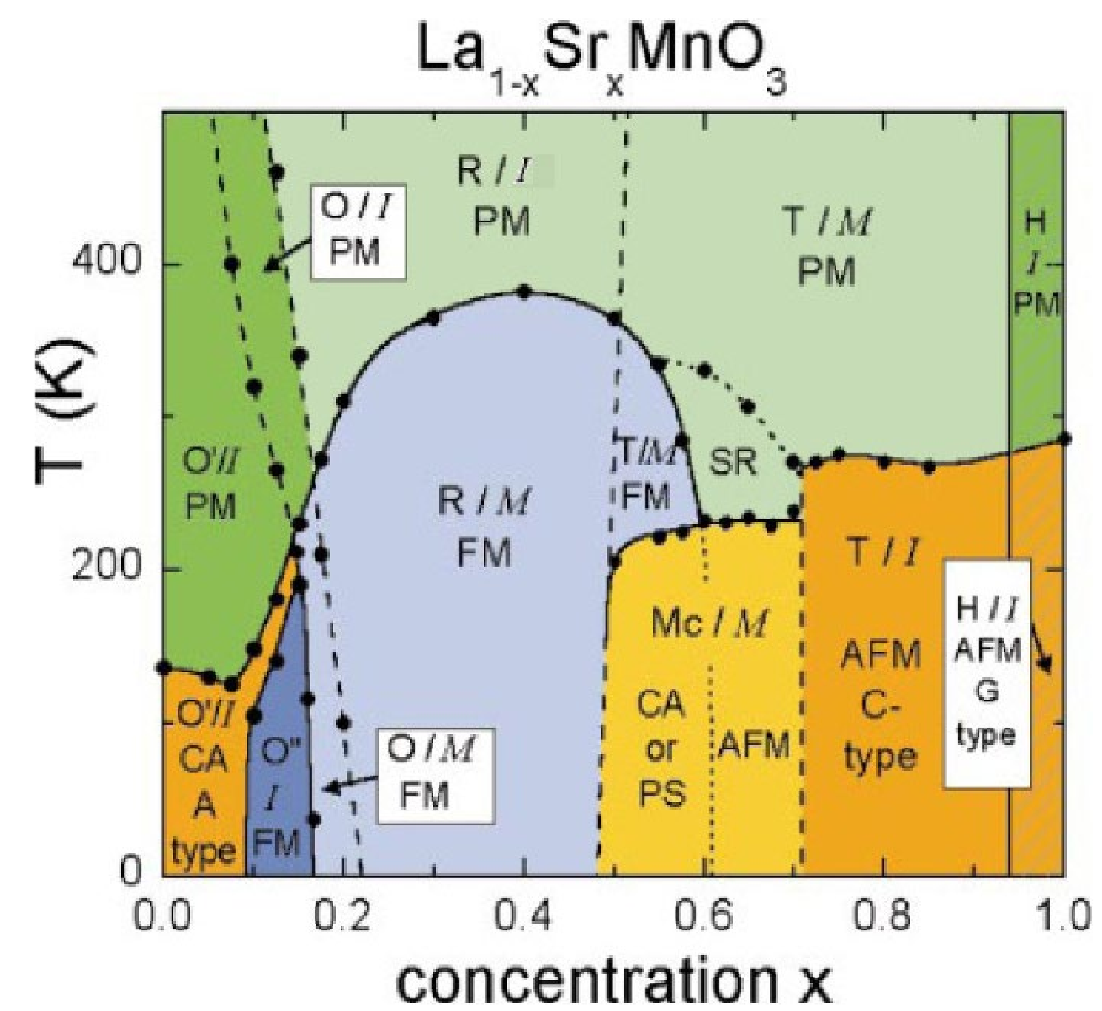

FIG. 1 Shown above is a phase diagram of the temperature versus the concentration of x for bulk. [1]Hemberger *et al*, PRB 66, 094410 (2002).

Bulk Phase of $La_{1-x}Sr_xMnO_3$

- Figure 1 shows the concentration of x ranging from 0.0 to 1.0, however, for thin film we only are focusing on concentration ranging from 0.0 to 0.5.
- As the concentration of x increases the amount of strontium increases but the amount of lanthanum decreases.

Acknowledgements

- This research was supported by UNF's Office of Undergraduate Research grant.

References

[1]Hemberger *et al*, PRB 66, 094410 (2002).

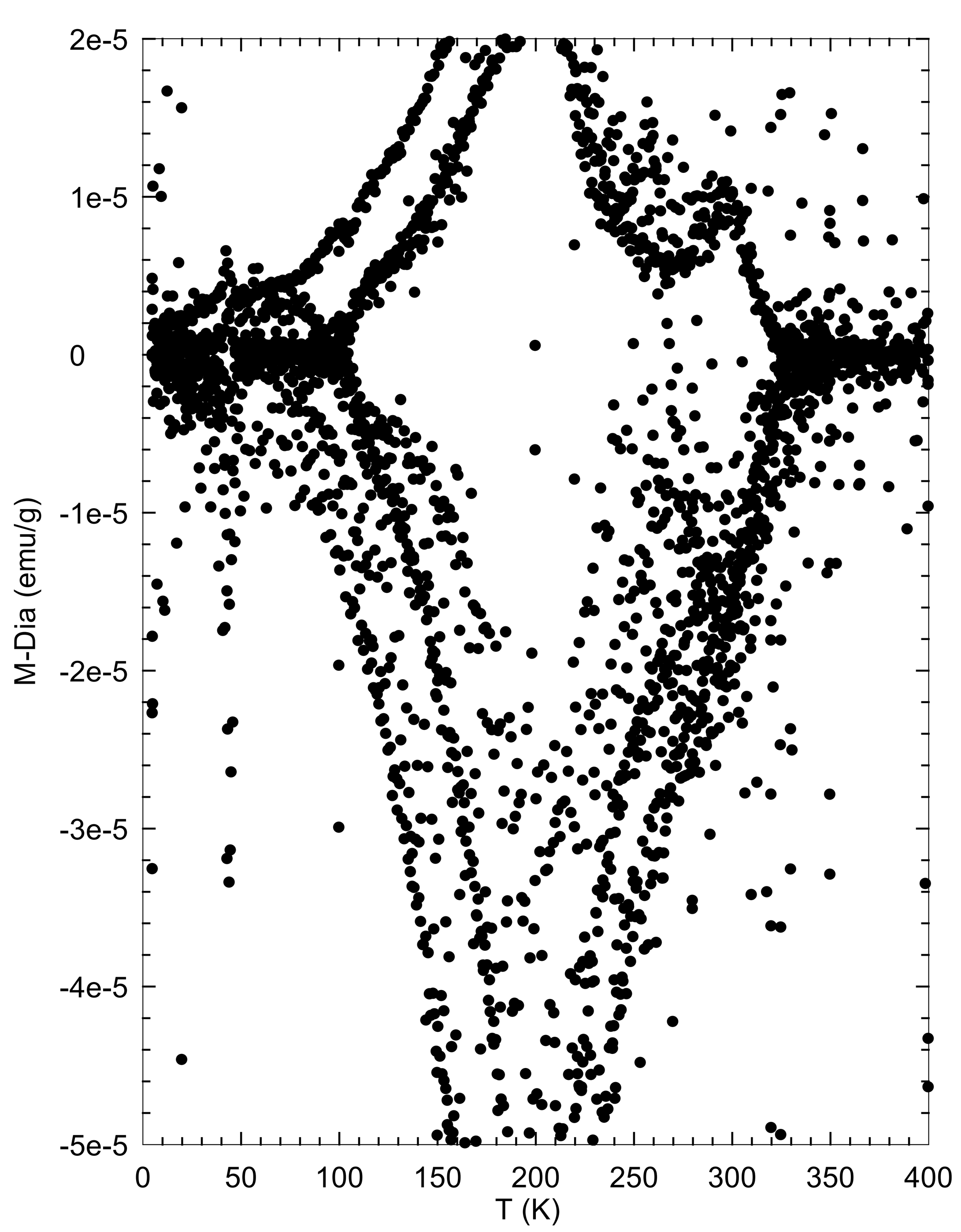

FIG 2. Displayed is the derivative taken of magnetization with respect to temperature for concentration x = 0.200.

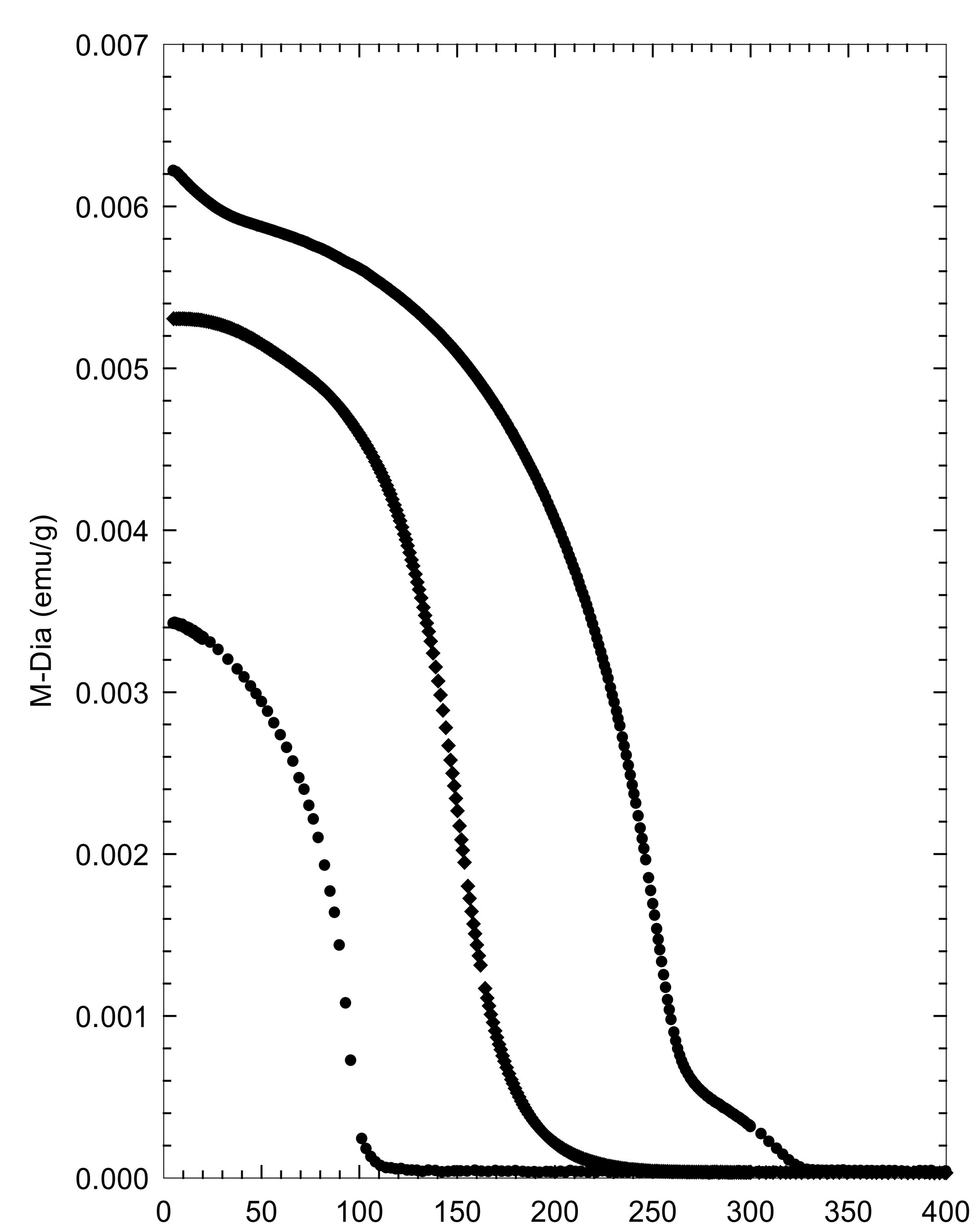

FIG 3. The traces for concentration of x being 0.000, 0.167, and 0.400, left to right.

Thin Film Critical Temperature, T_c

- We have used samples with concentrations of x equaling 0.000, 0.040, 0.167, 0.200, 0.330, 0.400, and 0.500. We are looking at the interplay where lanthanum and strontium in different stochiometric ratio from the concentration of lanthanum being one and the concentration of strontium being 0 to 50% and 50%, respectively.
- The method to find the critical temperature was to take the derivative of the magnetization, $\frac{dM}{dT}$. When taking the derivative, we are able to find the critical temperature, T_c. As figure 2 demonstrates, there is a distinct point at which the data approaches from both the left and the right, where the concavity changes. This gives an accurate value at where the critical temperature is located.
- It is noted that an increase in the value of x results in the increase of a higher critical temperature. The higher the critical temperature, the more thermal energy that is required to break ferromagnetic moments apart. Therefore, as we increase x, we see that there is a stronger magnetic interaction occurring. Figure 3 displays concentration x = 0.000, 0.167, and 0.400, moving left to right.