Study of Phase Stability and Negative Permittivity Behaviour of Undoped and Doped Sr_2MnO_4

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DOCTOR OF PHILOSOPHY

by

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Chapter 7

Conclusions and Future Scope

7.1 Summary and Conclusions

The thesis work mainly deals with the investigation of phase stability of undoped and doped Sr2MnO4 and their permittivity behaviour in radio frequency region. For the present study, all samples were prepared in single phase by solid state ceramic route. Different experiments were carried out and results were carefully analysed to monitor the phase stability and permittivity behaviour of undoped and doped Sr_2MnO_4. This chapter presents a concise summary based on the results of the previous chapters and the discussions.

1. Pure phase Sr_2MnO_4 can be synthesized by quenching in ambient atmosphere from 1500 ^oC.

2. Rietveld refinement of XRD data has confirmed that all the samples synthesized in this work have tetragonal crystal and space group ($I4/mmm$).

3. A perfect match of the XRD patterns of fresh and six-month-old powders was found, confirmed the long-term stability of the Sr_2MnO_4 phase.

4. The band-gap of 1.15eV confirmed its semiconductor nature and suitable for solar cell application.

5. Studies of Electrical conductivity in pure Sr_2MnO_4, confirmed the conduction in the sample through polaron tunnelling.

6. The single phase doped Sr_2MnO_4 can be synthesized without quenching process via La doping at Sr site or Sn/Nb doping at Mn site.

7. XPS analysis has confirmed the presence of Mn in mixed-valence states Mn^{3+}- Mn^{4+} and, its concentration can be altered by doping at Sr and Mn site.

8. The observed negative permittivity behaviour is attributed to plasmonic oscillations of free carriers, generated by the thermal excitation process and from dopant.

9. The negative permittivity behavior of bulk ceramic highlights inductive nature of it, shows strong potential towards the development of coil-less inductor.

10. The desired temperature at which (and above) negative permittivity appears can be tailored by choosing an optimum dopant and its concentration, makes Sr_2MnO_4 promising candidates for switching devices.

7.2 Future Scope

The experimental results reported in this thesis are preliminary results. There are no reports available in the literature on these samples for the comparison therefore, further systematic and more detail studies are required. Due to time bounded in Ph.D. program, these studies which could not be possible but require to support above mentioned results and conclusions are listed;

1. A more detailed studies on the phase stability with different dopants with various processing parameters is required.
2. A more detail exercise on the optimization of processing parameters for synthesized compositions is required to get best results of the samples.
3. Measurement of Seebeck and Hall coefficients of the samples to understand electrical properties of the samples in depth.
4. The study of effect of dopant in altering absolute negative dielectric values is needed to optimize desired negative permittivity.
5. Application oriented measurements to explore possibility of use of these synthesized compositions as shielding material for stealth technology and towards the development as switching material & coil-less inductor.

6. The Sr_2MnO_4 is an antiferromagnetic material, therefore the prospect of observing negative permeability (-μ) in it needed to studied.