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Studies spectroscopy impedance of the Y-type Hexagonal Ferrite [$Ba_2Co_2Fe_{12}O_{22}$ (Co_2Y)] Doped with PbO

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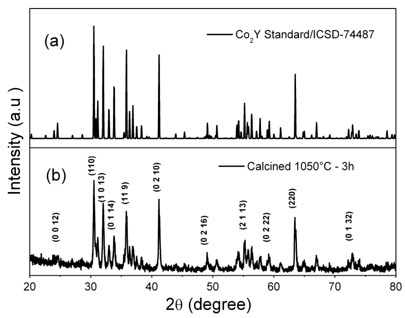
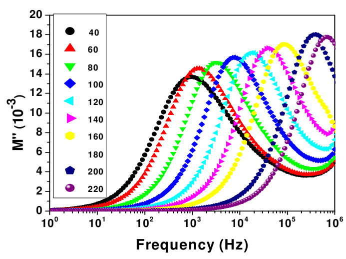
Abstract –The physical properties of ferrites are controlled by the preparation conditions, chemical composition, sintering temperature and time, type and amount of substitutions, were studied over a range of frequency (1Hz to 1MHz) and temperature (30-220^{o}C) using the complex impedance spectroscopy (CIS) technique. Electrical transport process parameters (such as carrier/ion hopping rate; conductivity relaxation time, etc) in the material can be analyzed via complex electric modulus formalism. This presents an alternative approach based on polarization analysis. Complex electric modulus plots give more importance to elements with the smallest capacitance occurring in the dielectric system.

The physical properties of ferrites are controlled by the preparation conditions, chemical composition, sintering temperature and time, type and amount of substitutions. The classical ceramics method for preparing $Ba_2Co_2Fe_{12}O_{22}$ ferrite requires a high calcining temperature, which induces aggregation of the particles. Many physical properties of polycrystalline ferrites are very sensitive to the microstructure. The bulk (grain) and grain boundary are the two main components that determine the microstructure. In the work, the structural and dielectric properties of the $Ba_2Co_2Fe_{12}O_{22}$ (Co2Y) doped with PbO (0,3,5 and 10 wt.%), was prepared by the solid state reaction method. The starting materials with analytical reagent grade, such as $BaCO_3$, Co_2O_3, and Fe_2O_3, were mixed together according to their molecular weight ratios and were milled for 1 h on a Fritsch Pulverisette 5 planetary mill. The mixed powders were calcined at 1050°C in the atmosphere for 3 h and slowly cooled at a rate of 5°/min to room temperature, were studied over a range of frequency (1Hz to 1MHz) and temperature (30-220oC) using the complex impedance spectroscopy (CIS) technique. The X-ray diffraction analysis together with the MEV of the samples will also be presented and discussed.

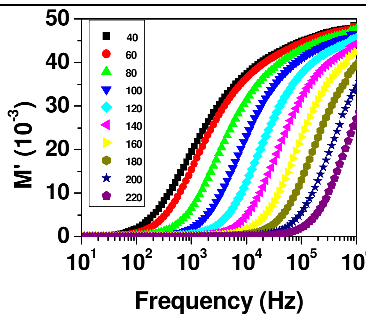
Electrical transport process parameters (such as carrier/ion hopping rate; conductivity relaxation time, etc) in the material can be analyzed via complex electric modulus formalism. This presents an alternative approach based on polarization analysis. Complex electric modulus plots give more importance to elements with the smallest capacitance occurring in the dielectric system. The variation of imaginary part of electric modulus as a function of frequency at different temperature and concentrations PbO, shows in dispersion region of M'. It is characterized by: a) presence of modulus peaks in the pattern, b) significant asymmetry in the peak with their positions lying in the dispersion region of M' versus frequency pattern and c) the modulus peak position shift towards higher frequency side with increasing temperature. Appearance of peak in the pattern indicates the presence of conductivity relaxation in the material. The activation energy calculated from conductivity shown the same value indicates that the relaxation and conductivity process may be attributed to the same type of charge carriers. Further, the appearance of peak in the modulus spectrum provides a clear indication of the conductivity relaxation.



XRD standard (ICSD/74487) of Co2Y powders and (b) processes (1050°C for 3 h) (CuKα, λ=1.5405 Å)



M" vs frequency in different temperature, for sample with 3% PbO.



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References - Ram, M and Chakrabarti, S. Journal of alloy and compounds 462 (2008) 214-219.