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Dielelctric constant, dielectric loss & structural studies of $SbFeO_3$ ferroelectrics: temperature dependences

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ABSTRACT

In this paper, we have study the synthesis of $SbFeO_3$ ceramics by solid state reaction method. The x-ray method depicts the $SbFeO_3$ have rhombohedral pervoskite structure. The ferroelectric measurement shows the exhibits ferroelectric nature with saturation. The dielectric constant and loss a function of temperature 25 -325^{0}C. The dielectric shows that the dielectric constant and loss increases with increasing temperature. The room temperature dielectric measurement with frequency reveals the dielectric constant and loss with increasing frequency.

Keywords: dielectric loss, dielectric tangent, ferroelectric and $SbFeO_3$ ceramics.

INTRODUCTION

Mutiferoic materials posses' simulatenous existence of electric and magnetic nature together in a single phase. Sb based multiferroics have potential applications information storage, microelectronics, memories, spintronics magneto electric sensor devices, multi state memory devices and magneto electronics [1-7]. In this novel class of materials there exists a strong coupling between magnetic and electric order parameters which results into the existence of ferromagnetism. These materials have potential application for many devices from the technological point of view. [8-13].Recently, Biao et al. studied the structural, electronic, magnetic and ferroelectric properties of $SbFeO_3$ are predicted by DFT [14].

The main aim of this work to determine the ferroelectric and dielectric properties of $SbFeO_3$ ceramics synthesised by a simple solid state reaction.

MATERIALS AND METHODS

Materials & synthesis of $SbFeO_3$

The sample $SbFeO_3$ was prepared by a standard solid state using Fluka Switzerland chemical India, Sb2O3 as a starting materials, firstly the Sb_2O_3 and Fe_3O_3 in stiochemertic ratios were thoroughly mixed in a stiochiometric ratios and ball milled for 24 hrs. The mixered were calcined and sintered at 600^0 C for 1 hour. Finally these pellets were carried out for further characterization and measurements.

Characterizations

The sintered pellets were characterized by X-ray diffraction using CuK radiation for phase identification in the 2 range 20-60^0.The surface morphological studies were addressed by using SEM. Dielectric measurement was performed on Zenith capacitor measurement unit M-92A in the frequency range of 10 KHz to 1 MHz with variable temperature range from30-400C and the dielectric constant as a function of frequency. All measurements were carried on a sintered pellets polished with athin layer of silver paste fired at 350c for 30 minute. the silver layer act as an electrode. A LCR-Q meter (model-928, Systronic, India) was used to measure the capacitance(C) and quality factor (Q) of the sample at different temperatures and at a frequency of 1kHz. The dielectric constant (ε') and dielectric loss (ε'') of the sample was calculated by using the following relations.

$\varepsilon' = Cd/\varepsilon_0 A$

$\varepsilon'' = \varepsilon'/Q$

where C = the capacitance of the capacitor in Farad, d= thickness, A= face area of the pellet, ε_0 = the permittivity of free space and Q= quality factor respectively.

RESULTS AND DISCUSSION

X-Ray diffraction studies

Fig.1 shows the XRD pattern of at room temperature. The XRD results showed that have rombhederal pervoskite structure with space group R3c. typical results show good agreement with the reported data with an additional secondary phase corresponding to have been appearing around 30 in 2 range marked by starts. The average crystallite size was found to about 60 nm.

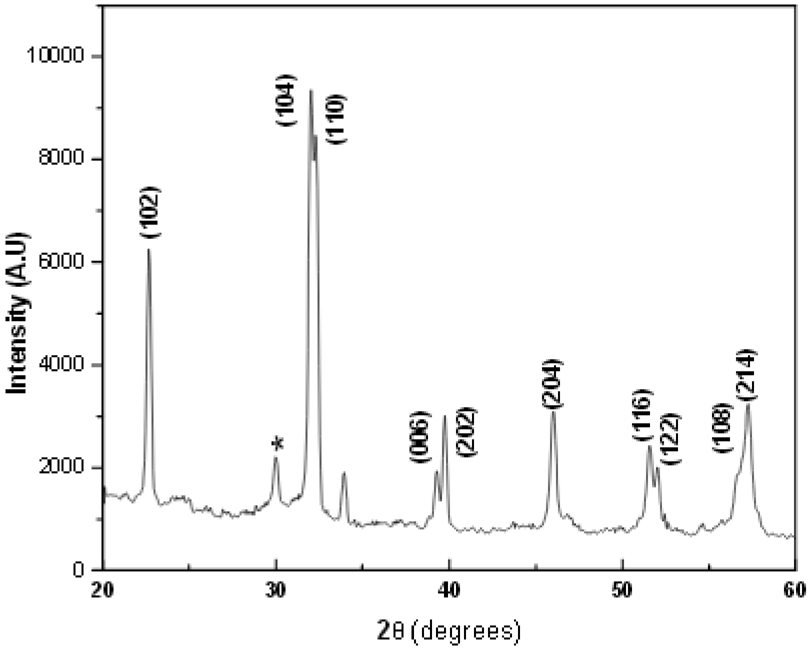

Fig.1 XRD spectra of $SbFeO_3$

Dielectric constant temperature measurement

In fig.2 shows a dielectric constant versus temperature measurement for $SbFeO_3$ sample in the temperature range 30-350^{0}C with the frequency range 10 KHz-1 MHz. The dielectric constant shows a continuous increase with increasing temperature. The measured values of permittivity were ε~ 2549, T=325^{0}C and ε~ 156 at room temperature for 10 KHz in $SbFeO_3$ ceramics.

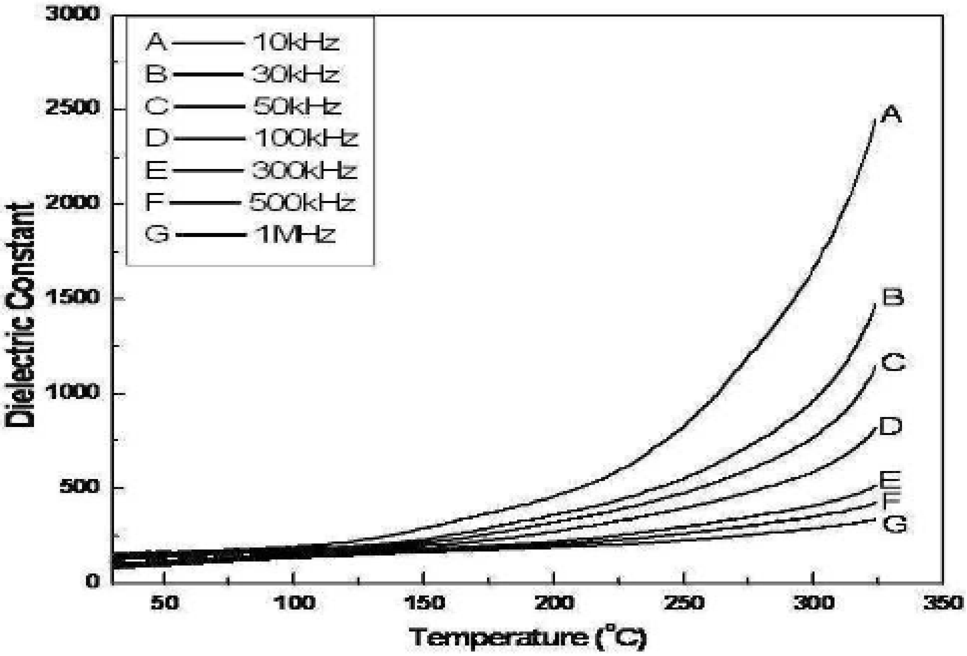

Fig.3 dielectric constant vs temperature

Dielectric loss temperature measurement

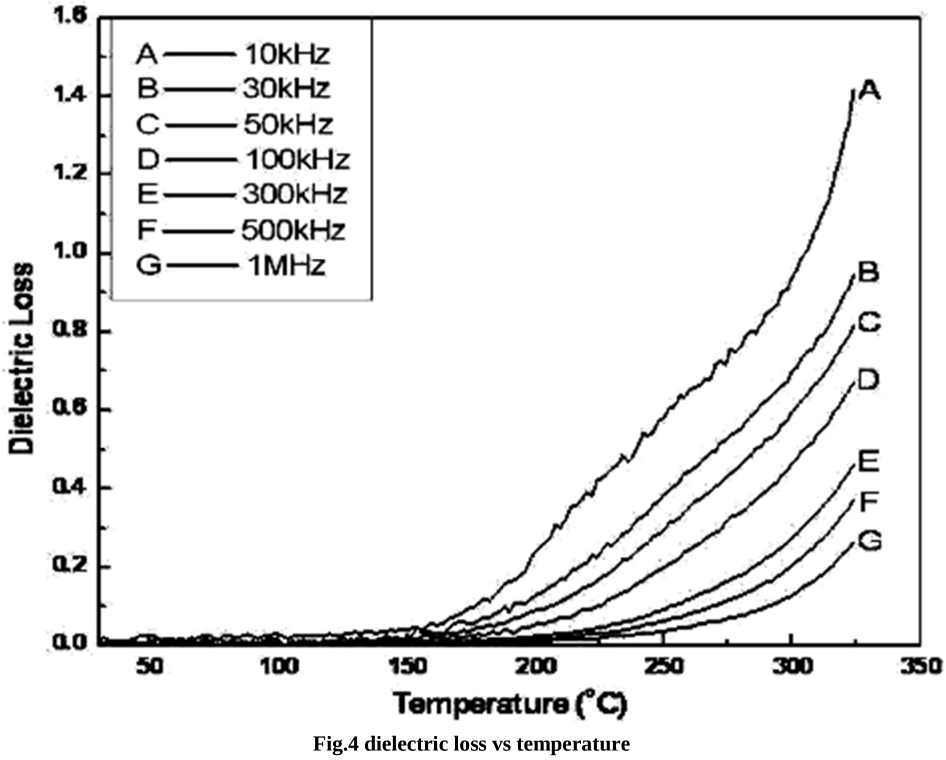

Fig.4 dielectric loss vs temperature

Fig. 4 shows a dielectric loss versus temperature plot of $SbFeO_3$ samples in the temperature range 30-350 ^{0}C at frequency range 10 KHz -1MHz. the dielectric loss exhibits a continuous increase with increasing temperature. The small values of dielectric loss was tan δ-0.29, f= 10 KHz at room temperature and tan δ=0.001, f=1MHz at temperature T=400^0 C for $SbFeO_3$

Dielectric constant frequency measurement

Fig.5 (a) shows variation dielectric constant versus frequency obtained $SbFeO_3$ sample at room temperature in the frequency range 10KHz-1MHz shows the dielectric constant decreases with increasing frequency.

Fig.5 (b) shows variation of dielectric loss versus frequency obtained for $SbFeO_3$ sample at room temperature in the frequency range 10KHz-1MHz show the dielectric loss decreases with increasing frequency.

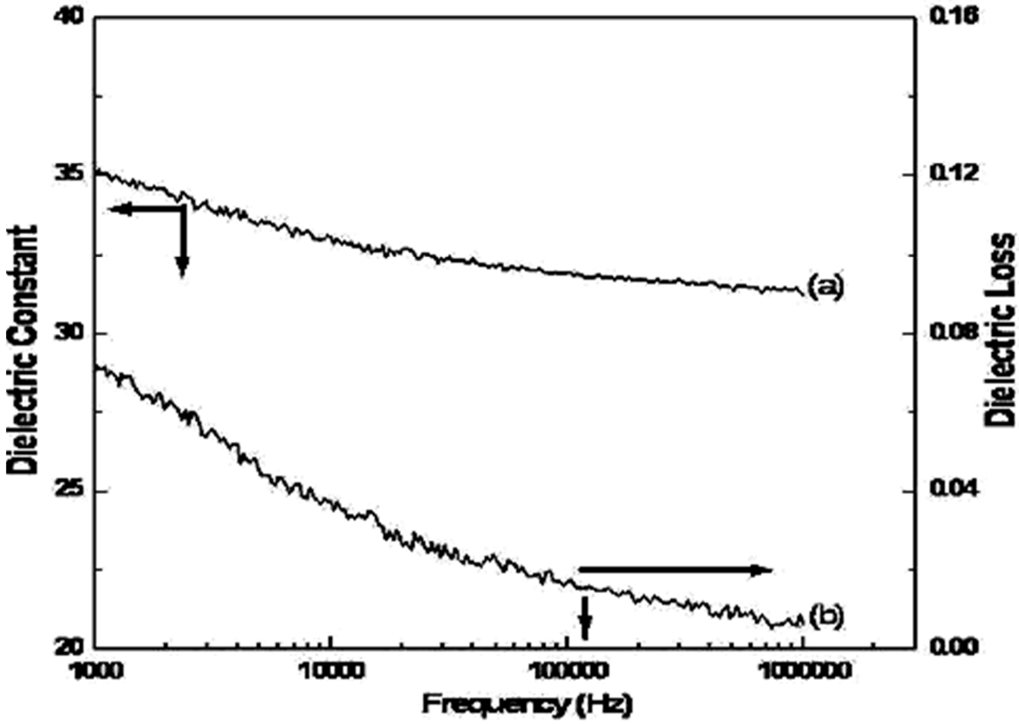

Fig.5 (a)dielectric constant vs frequency (b) dielectric loss vs frequency

CONCLUSION

The solid states synthesized $SbFeO_3$ ceramics shows the rhombhohedral pervoskite structure. The ferroelectric measurement reveals the ferroelectric nature of $SbFeO_3$ with saturation. The dielectric constant and loss as a function of temperature shows the dielectric constant and loss increases with increasing temperature. The room temperature dielectric measurement with frequency reveals the dielectric constant and loss decreases with increasing frequency.

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