International Journal for Innovative Engineering and Management Research

A Peer Revieved Open Access International Journal

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IJIEMR Transactions, online available on 5th Jul 2021. Link :http://www.ijiemr.org/downloads.php?vol=Volume-10&issue=ISSUE-07

DOI: 10.48047/IJIEMR/V10/I07/17

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Volume 10, Issue 07, Pages: 97-100

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A Peer Revieved Open Access International Journal
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Investigation of cobalt doped manganese perovskitefor microwave applications

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Abstract:
manganese perovskite ceramics have ilmenite structure which has very good applications in resonators and microwave applications. These **manganese perovskite** ceramic materials have good dielectric properties which are very much needed to the microwave applications. In the present work, the Cobalt doped **manganese perovskite** were synthesized by solid state reaction route with 1:1 stoichiometric ratio. We were studied the enhancement of dielectric properties of Manganese Titanate ceramics with the addition of Cobalt composition. The prepared samples were calcined for 21h at 930^{O}C and sintered at 1050^{O}C for 3h. The characterizations of the samples were performed with XRD, SEM and Hitester for dielectric measurements and we found the enhancement of the dielectric characteristics which are very much required for the microwave applications. The avg. grain size goes to be increased from 21.5-35.7μm as composition of cobalt increased. The dielectric constant is also increased with temperature and decreased with frequency.

Introduction:

anganese is a chemical element with the symbol **Mn** and atomic number 25. It is a hard, brittle, silvery metal, often found in minerals in combination with iron. Manganese is a transition metal with a multifaceted array of industrial alloy uses, particularly in stainless steels. It improves strength, workability, and resistance to wear. Manganese oxide is used as an oxidising agent; as a rubber additive; and in glass making, fertilisers, and ceramics. Manganese sulfate can be used as a fungicide.The microwave communication, data processing, a series of microwave devices, such as tunable microwave phase shifters, filters and resonators, are widely used in defense [1]. The manganese ions are undoubtedly has a special place, owing to its various oxidation states that allow Mn to occupy both A and B site of ST perovskite lattice without any charge compensation.Mn^{4+} may enter ST lattice at octahedral coordinated Ti sites, whereas Mn^{2+} should occupy dodecahedrally coordinated Sr sites, which is also supported by ionic size consideration. The temperature position and diffuseness of the peak was found to be controlled by the Mn content [2]. Strontium manganese titanate compound is unique material revealing antiferrodistortive elastic property, polar dielectric and spin glass magnetic behavior simultaneously. $Co_xMn_{1-x}TiO_3$ (x= 0, 0.3, 0.6, and 0.9) is an attractive material for applications in microwave dielectrics, catalysts and phosphors. So far there is no through studies on the synthesis of $Co_xMn_{1-x}TiO_3$ (x= 0, 0.3, 0.6, and 0.9by solid state diffusion method and characterization by structural, dielectric, electrical and thermal

Manganese is also an essential human dietary element, important in macronutrient metabolism, bone formation, and free radical defense systems. It is a critical component in dozens of proteins and enzymes.[3] It is found mostly in the bones, but also the liver, kidneys, and brain.[4] In the human brain, the manganese is bound to manganese metalloproteins, most notably glutamine synthetase in astrocytes.

Experimental Details:

$Co_xMn_{1-x}TiO_3$ (x= 0, 0.3, 0.6, and 0.9)ceramic samples were prepared byconventional solid state reaction technique.High Purity chemicals of $MnCO_3$, ZnO, andTiO_2, (all from Aldrichof 99.9%) were usedas the raw materials. Materials, first dried toeliminate any moisture present, were thenweighed as per the stoichiometric. Thesepowders were mixed thoroughly and groundto obtain fine powders .The powders wereuniaxially pressed initially into a cylindricaldisc of 1.2cm in diameter and about 2mm ofthickness. This mixed powder was calcinedin the temperature range of 1050-1150^{o}C for10 hours. The powders were uniaxially

pressed initially into a cylindrical disc of

3. Results and Discussions:

The X-ray diffraction studies of $Co_xMn_{1-x}TiO_3$ (x= 0, 0.3, 0.6, and 0.9)were reported and determined the crystal structures and unit cell volumes and compared the results of the above

properties. Strontium titanate-based ceramics were widely used to fabricate some electronic components, such as grain boundary layer capacitors (GBLC) was fabricated [4], it has been shown to have a great many merits, such as high-capacitance, low dielectric loss, and small size for low-voltage circuitry [5–9].

1.2cm in diameter and about 2mm of thickness at a pressure of 10 Tons (shown in figure 2.15). These discs were sintered finally in the temperature range 1150-1250^{o}C for 2 hours in a crucible. The purpose of the sintering is to increase the mechanical strength of the pellet. These pellets were then annealed at ~300°C for about 2 hours under vacuum (10^{-2} torr) to remove the strain introduced due to mechanical stress. X-ray diffraction profile was recorded at room temperature with Seifert X-ray diffractometer using Ni-filtered Cu-Kαradiation (λ = 1.54056Å) at a rate of 2°/min. in the range of 10°-90° for the confirmation of the sample

compounds and interpreted according to the literature [10–15]. Figure 1 depicts the XRD plots of $Co_xMn_{1-x}TiO_3$ (x= 0, 0.3, 0.6, and 0.9)ceramics. $Co_xMn_{1-x}TiO_3$ (x= 0, 0.3, 0.6, and 0.9)compositions of $Co_xMn_{1-x}TiO_3$ (x= 0, 0.3, 0.6, and 0.9)

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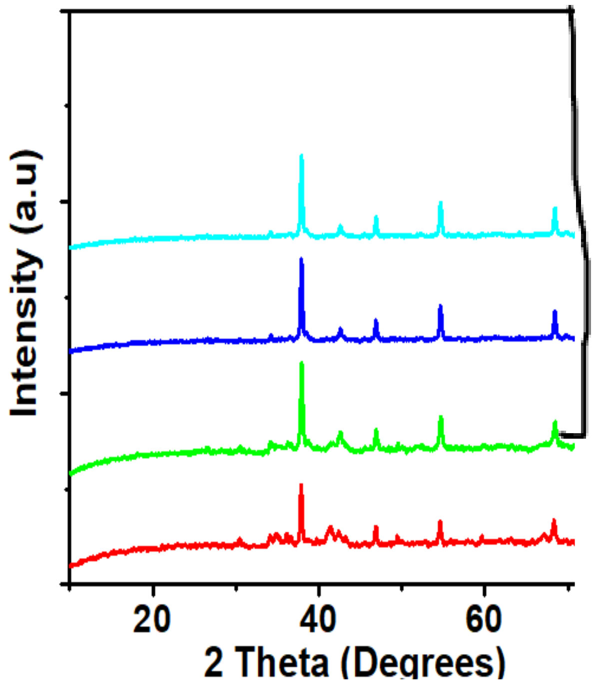

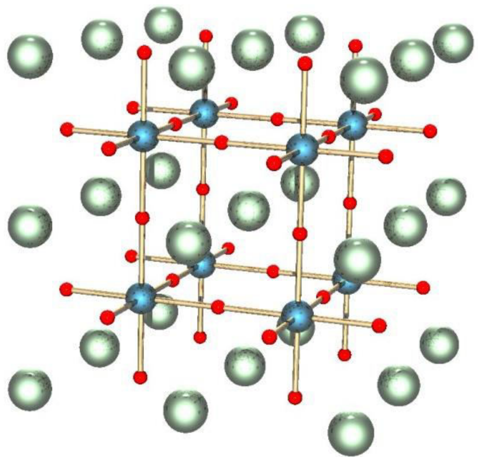

Conclusions:

Structural characteristics were found that in the $Co_xMn_{1-x}TiO_3$ (x= 0, 0.3, 0.6, and 0.9)ceramic materials, the structure of the material was found to be ilmenite hexagonal with the help of XRD characterization studies of the sample. The lattice parameters

5.0538A^{O} c= 14.1860 to 14.0165A^{O} , volume is in the order of 462.23 cm^{3}, the particle size were found to be 2-6 A^{O} and density of the sample is in the order of 6-8 gm/cc which are very much closer to the literature.

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