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Preparation and Synthesis of Columbite MNb_2O_6 Ceramics by Chemical Reaction (Where M = Zn, Ni, Co)

Praveen Kumar* Bharat Mishra* Mukul Pastor**
*Department of Physical Science, MGCGV, Chitrakoot, Satna (M.P.)
**Innovation centre, Bundelkhand University, Jhansi(U.P.)

ABSTRACT

Columbite MNb_2O_6 (M = Zn, Ni, Co) ceramics produce by the chemical reaction process (sol gel) were investigated. Ethylene glycol was used to precipitate M (Zn, Ni, Co) and Nb^{+5} cation as hydro were also prepared by the traditional solid state method. The phase evaluation were studied by the powder X-ray diffraction (XRD).

Keywords : - Ceramics, Materials, Sol-gel, XRD.

1. INTRODUCTION

Columbite material have been widely investigated for the use of resonators and filters in the satellite and mobile communication system. [1, 2] The binary niobate ceramic, with a general formula MNb_2O_6 where M is a divalent alkalineearth or transition metal cation with ionic-radius less than $1A^0$, usually crystallize in the columbite structure. Raw material Ta_2O_5 is expansive as compared with Nb_2O_5, MNb_2O_6 (where M = Mg, Zn, Ni, Ca, Cu, Mn and Co) columbite niobate compound of low sintering temperature and low cost have received much attention [3-6]. Zn Nb_2O_6 (ZN) ceramics were reported to exhibit excellent dielectric properties. Columbite niobate compounds are investigated for the application in electromagnetic properties.

The powder of reactants are homogenized and activated in high energy vibromill in this mechanical technique. The sol gel process is a wet chemical method used for the fabrication of both glassy and ceramic materials. In this process the sol (solution) envolves gradually towards the formation of a gel like network containing both a liquid phase and a solid phase.

2. EXPERIMENTAL PROCEDURE :

All samples in this study were prepared from sol-gel method. Appropriate amounts of raw material for stoichiometric MNb_2O_6 were weighted milled in acetone with zirconia balls for 12 h.

2.1. Prepare the $ZnNb_2O_6$ by Sol-gel method :

The pure and dopped ZnO nanoparticles were synthesized in sol-gel methods, with the help of precursor solution of ethylene glycol and zinc acetate with in 1 : 1 ratio a precursor solution was prepared in deionized water.

We prepare the columbite material ($ZnNb_2O_6$) by solid state reaction. The solid state reaction rout is the most widely used method for the preparation of polycrystalline solids from a mixture of solid starting materials. We take the raw material ZnO and Nb_2O_5 same ratio 2:2 . We grinded the both material in pestle. Then finally a powder was calcined at 1000^0C for 4 hours.

2.2. Prepare $NiNb_2O_6$ by sol-gel method

The pure and doped NiO nanoparticles were synthesized in sol-gel method, with help of precursor solution of ethylene glycol and Nickel nirate [$Ni(NO_3)_2$] with in 1:1 ratio a precursor solution was prepared in a deionized (DI) water. Formerly Nickel nitrate hexahydrate [$Ni(NO_3)_2$ $6H_2O$). A continuous string solution with 3-4 hours at 50^0C, a green solution was acquired. The homogeneous mixture was maintained under reflux at 130-150^0C for 8 hours. A wet gel was attined after the evaporation of excess solvents. Then finally a powder was calcined at 800^0C for 4 hours and then grinded.

Prepared the columbite material ($NiNb_2O_6$) by solid state reaction. The traditional solid state reaction rout for the synthesis of meltiferroic consist of mixing by milling the appropriate metal oxides or carbonates and then calcinating at high temperature to allow interdiffusion of the eation the chemical reaction occurs by solid state diffusion of the ions, which is characterized by a slow binetic rate.

We collect the raw material NiO and Nb_2O_5 same ratio 2 : 2. We grinded the both material in pestle. Finally a powder was calcined at 1000^0C for 4 hours.

2.3. Prepare the $CoNb_2O_6$ by sol-gel method

The pure and dopped CoO nanoparticles were synthesized in sol-gel methods, with help of precursor solution of ethylene glycol and citric acid [$C_6H_8O_7$] with in 1:1 ratio a precursor solution was prepared in a deionized (DI) water. Formerly copper nitrate trihydrate [$Co(NO_3)_2$ $3H_2O$]. A continuous strring of solution with 3-4 hours at 50^0C, a green solution was acquired. The homogeneous mixture was maintained under reflux at 130-150^0C for 8 hours. A wet gel was attined after the evaporation of excess solvents. Then finally a powder was calcined at 800^0C for 4 hours and then grinded.

We prepare the columbine material ($CoNb_2O_6$) by solid state reaction. Solid state reaction are performed in the absence of solvents by either grinding or melting the starting materials together or simply applying heat to a mixture of starting materials.

We take raw material CoO and Nb_2O_5 same ratio 2 : 2. We grinded the both material in pestle. Then finaly a powder was calcined at 1000^0C for 4 hours.

3. RESULT AND DISCUSSION :

3.1. $ZnNb_2O_6$

Final calcinations powder X-ray diffraction was conducted on a Phillips analytical XPERT diffractometer using a Cu Kα radiation (λ=1.54056 A^0) in range 2θ and 10^0-80^0.

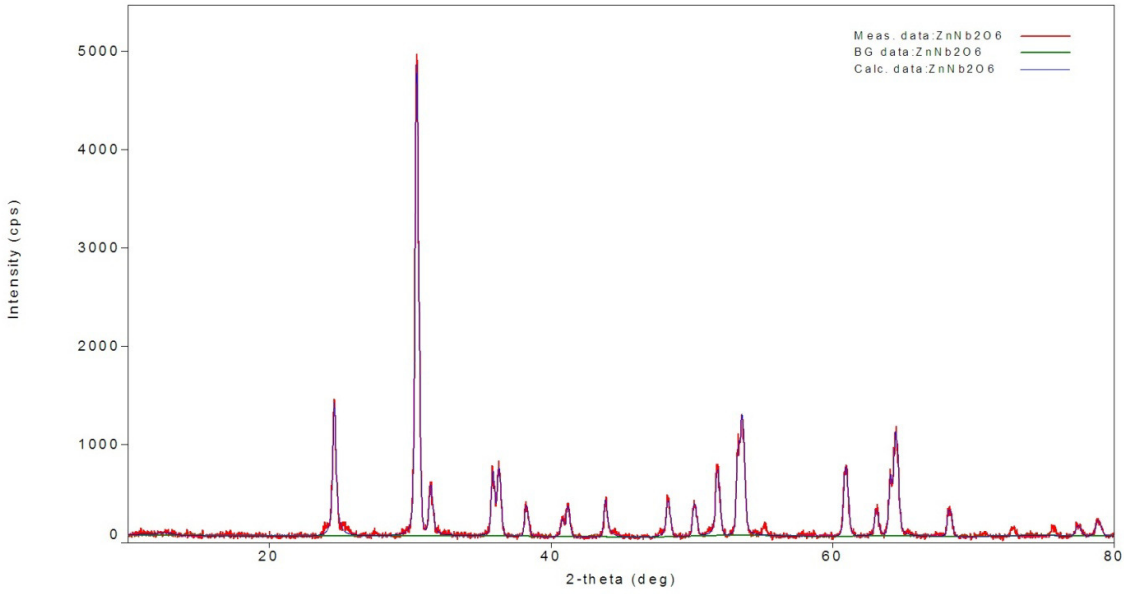

Figure No. 1 : XRD of prepared sample oxide at 1000^0C calcinations temperature.

3.2. $NiNb_2O_6$

Finally calcinations powder X-ray diffraction was conducted on a Phillips analytical XPERT diffractometer using a Cu Kα radiation (λ=1.54056A^0) in range 2θ and 10^0-80^0C.

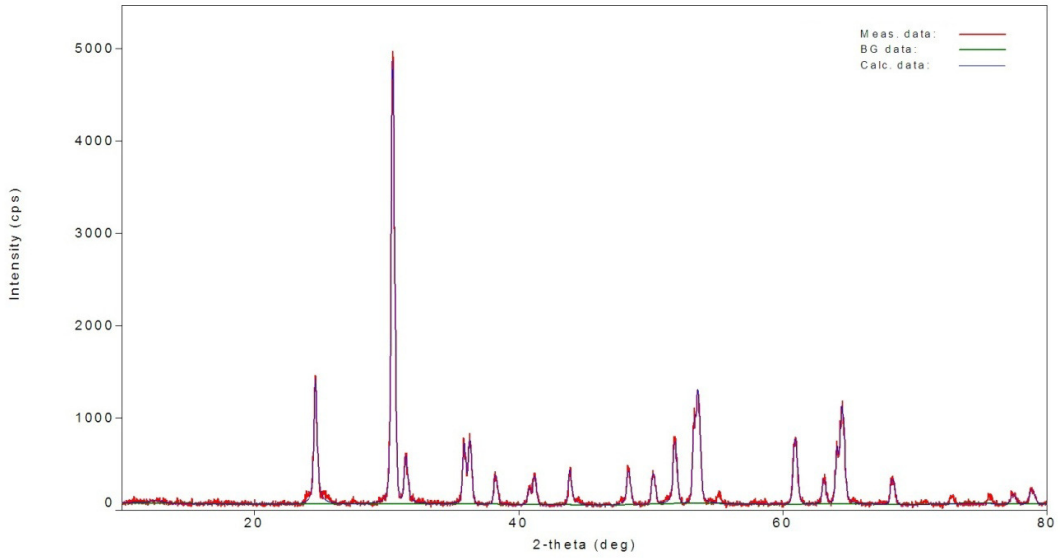

Figure No. 2 : XRD of prepared sample oxide at 1000^0C calcinations temperature.

3.3. $CoNb_2O_6$

Final calcinations powder X-ray diffraction was conducted on a Phillips analytic XPERT differectometer using a Cu Kα radiation (λ=1.54056A^0) in range 2θ and 10^0- 80^{0}C.

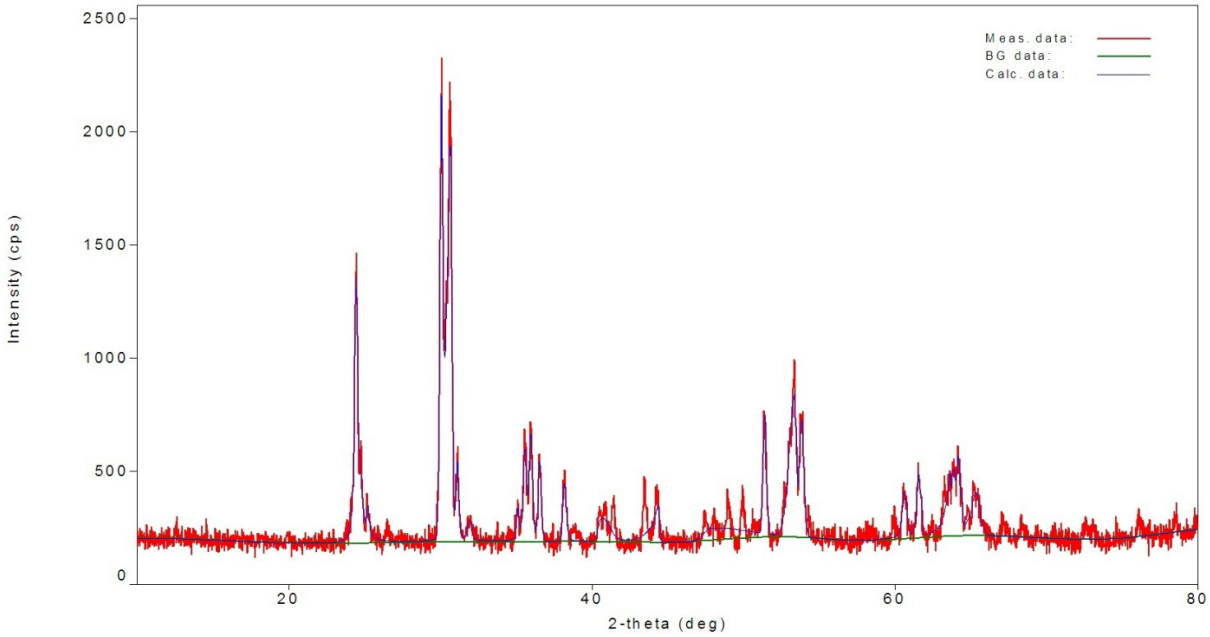

Figure No. 3 : XRD of prepaid sample oxide at 1000^{0}C calcinations temperature.

The calcinations powder were analyzed by X-ray diffraction (XRD) to check the formed phases.

4. CONCLUSION

Pure clumbite MNb_2O_6 (M = Zn, Co, Ni) phase was obtained successfully by chemical reaction process. After 1000^{0}C sintering for 2 hours, a density 4.37 g/cm^3 were obtained.

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