

- 1. Don Biswas, Prolay Sharma & N S Panwar, Effect of Sintering on the Piezoelectric Properties and Microstructure of Lead Free (Ba_{1-x}Ca_xZr_{0.1}Ti_{0.9}O₃) (x = 0.065) Ceramics, Science of Sintering, 54, 201-209, 2022.**

ABSTRACT

In this work, pellet samples of barium calcium zirconate titanate (Ba_{1-x}Ca_xZr_{0.1}Ti_{0.9}O₃, x=0.065) were prepared using solid state reaction route with double sintering. The structural and piezoelectric properties were measured. Further, SEM and EDAX analysis were observed. With different sintering temperature, the density and grain size of the prepared pellet samples were changed and further, their effect in piezoelectric properties has been observed. For the prepared samples, the converse piezoelectric constant (d₃₃*) has been decreased with the increase in sintering temperature. The piezoelectric constant (d₃₃*) was measured highest (153 pm/V) at 1300 °C.

- 2. Don Biswas, Prolay Sharma & N S Panwar, Temperature Dependent Dielectric and Structural Properties of (Ba_{1-x}Ca_x)(Zr_{0.1}Ti_{0.9})O₃, (0.140 ≤ x ≤ 0.160) Ceramics, ECS Journal of Solid State Science and Technology, 11, 043007, 2022.**

ABSTRACT

Ceramic pellets of (Ba_{1-x}Ca_x)(Zr_{1-y}Ti_y)O₃, (x = 0.140 to 0.160, y = 0.9), were prepared via solid- state reaction method followed by double sintering. Dielectric properties (ε, tan δ, and σ) of the prepared compositions were measured, in the temperature range from RT (room temperature) to 450 °C, at various frequencies (12–1000 kHz). The dielectric measurements show a single phase transition, around 100 °C, for the prepared (Ba_{1-x}Ca_x)(Zr_{1-y}Ti_y)O₃ (BCZT) compositions, in the measured temperature range. The structural variation was studied using high temperature X- ray diffraction (HT- XRD) measurements of the compositions with x= 0.150 and 0.155. The HT- XRD results were found consistent with the dielectric measurements, showing structural anomaly at around 100 °C; showing tetragonal phase, between RT and around 100 °C; and cubic phase, above 100 °C, in the measured temperature range.

- 3. Don Biswas, Prolay Sharma & N S Panwar, Structural and Piezoelectric Properties of (Ba_{1-x}Ca_xZr_{0.1}Ti_{0.9})O₃ Ceramics, Near Morphotropic Phase Boundary (0.140 ≤ x ≤ 0.160), Indian Journal of Pure & Applied Physics, 60, 111-116, 2022.**

ABSTRACT

Ceramic pellet samples of (Ba_{1-x}Ca_xZr_{1-y}Ti_y)O₃ (x = 0.140- 0.160, y = 0.9), were prepared using the conventional solid state reaction method followed by double sintering. Structural and piezoelectric measurements of the prepared compositions were carried out at room temperature. For the compositions with x ≤ 0.150, the converse piezoelectric constant (d₃₃*), strain (%), coercive field (E_c) and remnant polarization (P_r), were found increasing with x, which were found anomalously to decrease with further increase in x above 0.150. Among the prepared compositions, maximum value of d₃₃* was found 342 pm/V, for the samples with x = 0.150. The measured maximum values of strain (%), piezoelectric constant (d₃₃*) and break in XRD peak shifting patterns of the prepared samples indicate composition dependent piezoelectric properties, showing morphotropic- like phase boundary (MPB), near x = 0.150 composition. The prepared compositions of lead- free BCZT ceramics will extend the possibilities to use this compound in the field of piezoelectric sensors.

- 4. Vishal Rohilla, Gambheer Singh Kathait, Don Biswas, Prashant Thapliyal, Bharti Ruhela, Estimation of Heavy Metals in Some Indian Black Tea Leaves by Inductively Coupled Plasma Mass Spectrometer (ICP-MS) and Associated Health Risks, Indian Journal of Agriculture Research, 55, 181-186, 2021.**

ABSTRACT

Background: Some of the heavy metals are considered beneficial, if intake of them is within permissible trace amount and some other are highly toxic even in trace amount. So, heavy metals intake is one of the major concerns. Heavy metals enter into body via air, water, food, clothing and some of them gets accumulate in body organs this leads to many disorders and causes life threatening diseases including cancer. All of our food comes from plants directly or indirectly. Tea the highly consuming beverage after water comes from the leaves of plant/shrub *Camellia Sinensis*.

Methods: Aim of the present work is to determine the elements present in Tea brew (Chai, boiling the Tea leaves in water) made from black Tea leaves of major brands available in local Indian market, more specifically heavy metals Cobalt (Co), Arsenic (As), Silver (Ag), Cadmium (Cd), Indium (In), mercury (Hg) and Lead (Pb). Total eleven samples were investigated with the instrument Perkin Elmer NexIon-300x Inductively Coupled Plasma Mass Spectrometer (ICP-MS).

Result: Results have shown that Cobalt, Arsenic, Cadmium, Indium and Lead were present in all samples. Cobalt concentration varies from lowest 71.9 $\mu\text{g/kg}$ to highest 214.3 $\mu\text{g/kg}$; Arsenic concentration varies from lowest 1.2 $\mu\text{g/kg}$ to highest 53.7 $\mu\text{g/kg}$; Cadmium concentration varies from lowest 15.4 $\mu\text{g/kg}$ to highest 75.03 $\mu\text{g/kg}$; Indium concentration varies from lowest 0.054 $\mu\text{g/kg}$ to highest 0.70 $\mu\text{g/kg}$; Lead concentration varies from lowest 61.0 $\mu\text{g/kg}$ to highest 2404.3 $\mu\text{g/kg}$. Mercury was present in two samples only in S9 and S11 with concentration 6.2 $\mu\text{g/kg}$ and 1.4 $\mu\text{g/kg}$ respectively; Out of eleven samples only seven samples have shown the presence of Silver its concentration varies from lowest 10.3 $\mu\text{g/kg}$ to highest 193.0 $\mu\text{g/kg}$; Samples S2, S7, S8 and S10 were shown the absence of Silver and Mercury; Lead was found to be most abundant with concentration 2404.3 $\mu\text{g/kg}$ and Indium was found to be least abundant with concentration 0.054 $\mu\text{g/kg}$.

- 5. Prashant Thapliyal, N.S. Panwar, G. Mohan Rao, Optical properties and current conduction in annealed $(\text{Ta}_2\text{O}_5)_{0.94} - (\text{TiO}_2)_{0.06}$ thin films, Superlattices and Microstructures, 158, 107008, 2021.**

ABSTRACT

By sputtering the mosaic assembly of tantalum (Ta) and titanium (Ti) metal targets in the oxygen environment, $(\text{Ta}_2\text{O}_5)_{1-x}(\text{TiO}_2)_x$, $x = 0.06$, thin films were deposited onto the quartz, and P/boron-silicon (1 0 0) substrates, at room temperature (RT). The RT deposited films were annealed for 1.5 h, from 500 to 800 °C. Formation of the crystal structure in the films was observed at and above 700 °C annealing. Optical transmittance data, measured with the UV-Vis spectrophotometer, were used to find out the extinction coefficient (k), refractive index (n_{opt}), and optical bandgap (E_g) of the prepared films. With the increasing annealing temperature, both the n_{opt} and E_g values were observed, decreasing from 2.218 to 2.160, and 4.23 to 4.02 eV, respectively. The extinction coefficient of amorphous films was observed lesser than the crystalline films. The current-voltage characteristics of the prepared film assisted metal-oxide-semiconductor (MOS) structures manifest different conduction, viz., ohmic at the lower electric fields; and Schottky, Poole-Frenkel, Fowler-Nordheim tunneling and space-charge-limited current, in the intermediate to higher fields, for different annealing treatments.

- 6. Prashant Thapliyal, N.S. Panwar, and G. Mohan Rao, Electrical and optical properties of $(\text{Ta}_2\text{O}_5)_{1-x}-(\text{TiO}_2)_x$ films, $x = 0.035$, prepared by sputtering of ceramic and mosaic (Ta, Ti) metal targets, *J. Appl. Phys.*, **130**, 035304, 2021.**

ABSTRACT

$(\text{Ta}_2\text{O}_5)_{1-x}-(\text{TiO}_2)_x$, with $x = 0.035$, thin films were deposited onto p-type silicon and quartz substrates following two different routes: first, by the sputtering of the ceramic target and, second, by sputtering of mosaic (Ta, Ti) metal target in the presence of oxygen (hereafter referred to as CT and MT, respectively). The deposited films were found to crystallize on annealing at and above 700 °C. The dielectric constant of the prepared films was found to increase with increasing annealing temperature, up to 700 °C, and on annealing at 800 °C, it was found to decrease. The dielectric constant of the CT was observed to be higher than that of the MT film structures at each annealing temperature. From the transmittance measurements, different optical parameters of the deposited crystalline films were calculated. The leakage current density of the CT films was found to increase with the annealing temperature, whereas in the MT films, it drastically decreased by an order of ~ 3 when the annealing temperature was increased from 700 to 800 °C. Different conduction mechanisms were observed in the different applied field regions in the prepared film structure. The observed electrical properties of the prepared film structure seem to depend on the status of the growing interfacial oxide layer on annealing.

- 7. Prashant Thapliyal, N.S. Panwar, G. Mohan Rao, Influence of post-deposition annealing on electrical and optical properties of $(\text{Ta}_2\text{O}_5)_{1-x}-(\text{TiO}_2)_x$ thin films, $x \leq 0.08$, *Ceramics International*, **47**, 16746–16751, 2021.**

ABSTRACT

Tantalum (Ta) and titanium (Ti) metal targets were direct current (DC) magnetron sputtered in the oxygen environment by varying its relative areas to deposit $(\text{Ta}_2\text{O}_5)_{1-x}-(\text{TiO}_2)_x$ (TTOx) thin films, with $x = 0, 0.03, 0.06, \text{ and } 0.08$, onto the boron-doped p-silicon (1 0 0) and optically polished quartz substrates, at room temperature; and were annealed at 500, 600, 700, and 800 °C, for 1.5 h. The thin films annealed at and above 600 °C show the Ta_2O_5 structure. The leakage current density and capacitance-voltage (C–V) characteristics were measured for TTOx, $x \leq 0.08$, assisted Ag/TTOx/p-Si metal–oxide–semiconductor (MOS) structures. The leakage current density was found minimum, for the films annealed at 800 °C, for all the prepared TTOx films, $x \leq 0.08$. The minimum leakage current density $1.6 \times 10^{-8} \text{ A/cm}^2$, at $3.5 \times 10^5 \text{ V/cm}$ electric field, was observed for $x = 0.03$, annealed at 800 °C, among the prepared compositions. The prepared TTO0.03 films, annealed at 700 °C show maximum dielectric constant 39, at 1 MHz. The optical parameters, viz., refractive index (n), extinction coefficient (k), and optical band gap (E_g) of the films, with $x = 0.03$, prepared on quartz substrates, were determined from their optical transmittance plots. The values of n and k of the crystalline films were observed increasing from 2.123 to 2.143, and 0.099 to 0.130, respectively, at 550 nm wavelength; and E_g decreasing from 3.95 to 3.89 eV with the increasing annealing temperature, from 600 to 800 °C. Ohmic emission, in the lower electric field; Schottky and space-charge-limited current conduction mechanisms, in the intermediate to higher electric fields, were generally envisaged from the current-voltage characteristics in the prepared Ag/TTO0.03/p-Si structures.

8. Prashant Thapliyal, Alok S. Kandari, Vijendra Lingwal, N.S. Panwar, G. Mohan Rao, Post deposition annealing dependent structural and C-V characteristics of $(\text{Ta}_2\text{O}_5)_{0.965}(\text{TiO}_2)_{0.035}$ thin films, *Materials Today: Proceedings*, 44, 3946–3950, 2021.

ABSTRACT

$(\text{Ta}_2\text{O}_5)_{1-x}(\text{TiO}_2)_x$ (TTO) thin films, with $x = 0.035$, were deposited onto the P/boron-silicon (100) semiconducting substrates by reactive direct current (DC) magnetron sputtering of mosaic Ta and Ti metal targets, at ambient temperature. As-deposited films have been passed through the process of annealing at the temperatures, ranging from 500 to 800 °C. X-ray diffraction measurements, generally, show the formation of Ta_2O_5 structure of the annealed films. Metal–oxide–semiconductor (MOS) structure of $\text{Ag}/(\text{Ta}_2\text{O}_5)_{1-x}(\text{TiO}_2)_x/\text{p-Si}$ ($\text{Ag}/\text{TTO}/\text{p-Si}$), with $x = 0.035$, was formed, and capacitance of the structure was measured, at room temperature and 1 MHz. Capacitance of prepared MOS structure was measured, and found generally, increasing with annealing temperature. Among the prepared films, maximum value of dielectric constant was found 45, at 1 MHz, for the films annealed at 700 °C. Frequency dependent behaviour of dielectric loss was observed, and was found minimum value of 0.022, at 200 kHz, for the films deposited at room temperature.

9. Prashant Thapliyal, Alok S. Kandari, Vijendra Lingwal, N.S. Panwar, G. Mohan Rao, Annealing temperature-dependent structural and electrical properties of $(\text{Ta}_2\text{O}_5)_{1-x}(\text{TiO}_2)_x$ thin films, $x \leq 0.11$, *Ceramics International*, 47, 12066–12071, 2021.

ABSTRACT

$(\text{Ta}_2\text{O}_5)_{1-x}(\text{TiO}_2)_x$ (TTO_x) thin films, with $x = 0, 0.03, 0.06, 0.08, \text{ and } 0.11$, were deposited using magnetron direct current (DC) sputtering method onto the P/boron-silicon (1 0 0) substrates by varying areas of Tantalum and Titanium metallic targets, in oxygen environment at ambient temperature. The as-deposited thin films were annealed at temperatures ranging from 500 to 800 °C. Generally, the formation of the Ta_2O_5 structure was observed from the X-ray diffraction measurements of the annealed films. The capacitance of prepared metal–oxide–semiconductor (MOS) structures of $\text{Ag}/\text{TTO}_x/\text{p-Si}$ was measured at 1 MHz. The dielectric constant of the deposited films was observed altering with varying composition and annealing temperature, showing the highest value 71, at 1 MHz, for the TTO_x films, $x = 0.06$, annealed at 700 °C. With increasing annealing temperature, from 700 to 800 °C, the leakage current density was observed, generally decreasing, from 10^{-5} to 10^{-8} A cm^{-2} , for the prepared compositions. Among the prepared compositions, films with $x = 0.06$, annealed at 800 °C, having the observed value of dielectric constant 48, at 1 MHz; and the leakage current density 2.7×10^{-8} A cm^{-2} , at the electric field of 3.5×10^5 V cm^{-1} , show preferred potential as a dielectric for high-density silicon memory devices.

10. Surendra Singh and N. S. Panwar, Effect of Li doping on dielectric properties of $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$, $x = 0.500$, morphotropic phase region, *Ferroelectrics*, 570, 122–131, 2021.

ABSTRACT

Li doped sodium-potassium niobate $(\text{Na}_{0.5}\text{K}_{0.5})_{1-y}\text{Li}_y\text{NbO}_3$ ceramic pellets, with $y = 0$ to 7 (mole) %, were prepared by solid state reaction method with double sintering. With varying lithium content (y), dielectric properties, and X-ray diffraction (XRD) peaks shifting pattern exhibit strong compositional dependence. Among the prepared Composition, a break in XRD

peaks shifting tendency, and maximum dielectric constant, electric conductivity were observed at the composition with $y = 0.06$.

- 11. Jyotsana Negi, N.S. Panwar, Structural and electrical properties of lead-free $\text{Na}_{0.685}\text{K}_{0.315}\text{Nb}_{1-y}\text{Ta}_y\text{O}_3$ ($0 \leq y \leq 0.05$) ceramics, *Journal of Physics and Chemistry of Solids*, **151**, 109853, 2021.**

ABSTRACT

Piezoceramic $\text{Na}_{0.685}\text{K}_{0.315}\text{Nb}_{1-y}\text{Ta}_y\text{O}_3$ (NKNT) (where $y \leq 0.05$) samples were prepared via a solid-state reaction using double sintering. The effects of Ta-doping on the phase structure and electrical properties of the NKNT ceramics were investigated. The temperature dependence of the dielectric constant, loss tangent, and dielectric conductivity of the prepared samples was measured from RT to 500 °C at 10 kHz and 1 MHz. High temperature X-ray diffraction (HT-XRD) measurements were carried out on the prepared samples between RT and ~200 °C, 200 and 380 °C, 380 and 460 °C, and above 460 °C, which showed monoclinic, tetragonal, tetragonal, and cubic phases, respectively. In $\text{Na}_{0.685}\text{K}_{0.315}\text{Nb}_{1-y}\text{Ta}_y\text{O}_3$, all the transition peaks were observed to gradually shift towards lower temperatures upon increasing the Ta concentration at $y \leq 0.05$ in the temperature range from RT to 500 °C.

- 12. Don Biswas, Surendra Singh, Prashant Thapliyal, Vishal Rohilla, G S Kathait, N S Panwar, Prolay Sharma, Investigation on Dielectric and Optical Properties of $\text{Ba}_{1-x}\text{Ca}_x\text{Zr}_{0.1}\text{Ti}_{0.9}\text{O}_3$ ($x = 0.150$) Ferroelectric Ceramics, *J. Mountain Res.*, **16(2)**, 279-286, 2021.**

ABSTRACT

Pellet samples of $(\text{Ba}_{1-x}\text{Ca}_x\text{Zr}_{1-y}\text{Ti}_y)\text{O}_3$ ($x = 0.150$, $y = 0.90$) were prepared using the solid-state reaction method following double sintering. The electrical and optical properties of $(\text{Ba}_{1-x}\text{Ca}_x\text{Zr}_{1-y}\text{Ti}_y)\text{O}_3$ ($x = 0.150$, $y = 0.90$) ceramics were studied. For $(\text{Ba}_{0.85}\text{Ca}_{0.15}\text{Zr}_{0.1}\text{Ti}_{0.9})\text{O}_3$ ferroelectric perovskite ceramics, the dielectric and structural properties were explored. The prepared composition of BCZT ceramics were calcined at 1100 °C. The sintering temperature was 1300 °C. Dielectric properties were observed from room temperature (RT) to 150 °C, at 1 MHz. The powder of the sintered samples has been taken for reflectance measurement at UV-Vis range. From the observed τ auc plot, the band-gap is calculated. The measured band-gap is 3.19 eV.

- 13. Don Biswas, Prolay Sharma, N. S. Panwar, Structural and electrical properties of lead free $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$ ($0.160 \leq x \leq 0.200$) ceramics, *Ceramics International*, **47**, 13814–13819, 2021.**

ABSTRACT

In this study, pellet samples of $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$ (NKN) ($0.160 \leq x \leq 0.200$) were prepared using the solid-state reaction method with double sintering. For the prepared compositions, the dielectric measurements were carried out from room temperature to 480 °C, at 10, 100, and 1000 kHz. Dielectric measurements of the prepared samples indicated anomalies around 210, 380, and 450 °C. High temperature X-ray diffraction (HT-XRD) measurements were carried out to analyze the structural properties of the samples, with $x = 0.175$. Consistent with the dielectric behavior, HT-XRD measurements of the prepared samples, with $x = 0.175$, indicated monoclinic phase, between room temperature and 210 °C; tetragonal phase, between 210 and 380 °C; tetragonal phase with a change in the lattice, between 380 and 460 °C; and cubic phase above 460 °C, in the measured temperature range.

14. Don Biswas, Prolay Sharma, and N. S. Panwar, Composition Dependent Electrical Properties of $(\text{Ba}_{1-x}\text{Ca}_x\text{Zr}_{0.1}\text{Ti}_{0.9})\text{O}_3$ Ceramics, Near Morphotropic Phase Boundary ($0.140 \leq x \leq 0.160$), ECS Journal of Solid State Science and Technology, 10, 033002, 2021.

ABSTRACT

In this work, pellet samples of $(\text{Ba}_{1-x}\text{Ca}_x\text{Zr}_{0.1}\text{Ti}_{0.9})\text{O}_3$, ($0.140 \leq x \leq 0.160$) were prepared using solid-state reaction route with double sintering. The dielectric and structural properties of the prepared samples were measured, from room temperature to 250 °C, at different frequencies, in the range 10–1000 KHz. A peak shifting anomaly in the X-ray diffraction peaks patterns, an anomalous change in the slope of c/a vs x plot, and the observed minimum values of dielectric constant, loss and conductivity of the prepared compositions show a strong compositional dependent dielectric and structural properties, indicating a morphotropic phase transition type behavior, at the composition with $x = 0.150$.

15. Don Biswasa, Prolay Sharmab, and N. S. Panwar, Dielectric properties of $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$ (NKN) ($0.160 \leq x \leq 0.200$) ceramics synthesized by double sintered method, Ferroelectrics, 571, 214–229, 2021.

ABSTRACT

In this study, pellet samples of $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$ (NKN) ($0.160 \leq x \leq 0.200$) were prepared using the solid- state reaction method with double sintering. Electric conductivity (σ), loss tangent ($\tan \delta$), and dielectric constant (ϵ) were observed for all the prepared compositions from room temperature (RT) to 480 °C, at 10, 100, and 1000 KHz. For the prepared compositions ($0.160 \leq x \leq 0.200$), XRD patterns were observed at room temperature. For the pellet samples ($0.160 \leq x \leq 0.200$), escaping of Na and K were found minimum for the compositions with $x = 0.175$. The EDAX confirms ‘p- type’ conductivity in $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$ ceramics. Further, the conductivity was found minimum due to less ‘A- site’ vacancy concentration, near MR region. The electrical conductivity (σ) and dielectric constant (ϵ) were found minimum for $x = 0.175$, among the prepared compositions.

16. Vishal Rohilla, Don Biswas, Prashant Thapliyal, Gambheer Singh Kathait & Surendra Singh, Estimation of some essential, non essential toxic and toxic elements in some Indian black tea sold in market by ‘ICP-MS’ and their risk assessment, Applied Innovative Research, 2, 226-230, 2020.

ABSTRACT

Tea ‘*Camellia sinensis*’ is the most consumed non essential, non alcoholic liquid in the world. Black Tea finds its place in Indian culture as well as a part of diet of Indian population. Tea is known for its relaxing effect and therapeutic use as it contains bioactive polyphenols, amino acids, caffeine, theophylline and volatile organic compounds. Significant research efforts have been carried out on Tea for its health benefits. However, some ill effects also have been reported. Present work has been carried out to determine the essential, non essential toxic and toxic elements namely Iron (Fe), Copper (Cu), Cobalt (Co), Chromium (Cr), Aluminum (Al), Arsenic (As) and Lead (Pb); health risks associated with them among adult population. For this, the twelve well known and most selling (most consumed) Tea brands available in local Indian market were selected and analyzed by sophisticated instrument ICP-MS.

17. Jyotsana Negi, Surendra Singh & N. S. Panwar, Electrical Properties of lead free ceramics $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$, at $x=0.305$, Indian Journal of Pure & Applied Physics, 58, 783-786, 2020.

ABSTRACT

By solid state reaction method, ceramic pellets of $\text{Na}_{0.695}\text{K}_{0.305}\text{NbO}_3$ have been prepared. X-ray diffraction, Piezo properties, scanning electron microscope, and temperature dependence of dielectric constant and loss tangent of the prepared samples have been studied. It has been observed that, at the transition temperature, dielectric constant peak shifts to lower temperature, and the dielectric constant and loss tangent peak heights decrease, with increasing frequency, and show three structural phase transitions.

18. Don Biswas, N. S. Panwar & Prolay Sharma, Converse piezoelectric properties of lead free $\text{Ba}_{1-x}\text{Ca}_x\text{Zr}_{0.1}\text{Ti}_{0.9}\text{O}_3$ ($x=0.055$) ceramics using double sintered method, Ferroelectrics, 568:1, 95-103, 2020.

ABSTRACT

The influence of double sintering temperature on the phase structure, micro-structure and piezoelectric properties of $\text{Ba}_{1-x}\text{Ca}_x\text{Zr}_{0.1}\text{Ti}_{0.9}\text{O}_3$ ($x = 0.055$) double sintered ceramics has been systematically studied. The pellet sample preparation and characterization have been reported in this paper. The converse piezoelectric properties of the $\text{Ba}_{1-x}\text{Ca}_x\text{Zr}_{0.1}\text{Ti}_{0.9}\text{O}_3$ ($x = 0.055$) were observed. Depending upon the sintering temperature, the grain size and density of BCZT ceramics have been changed. The P-E loops, strain%, and the polarization current were measured. The value of d_{33} was decreasing with the application of an electric field in case of double sintered pellets. For sample $x = 0.055$, the value of d_{33} at 1300, 1400 and 1450 °C temperature, was 173 (pm/V), 130 (pm/V), and 75 (pm/V), respectively, at applied field 29.33 kV/cm.

19. Surendra Singh, N. S. Panwar, Temperature-dependent dielectric and structural properties of Li-doped (Na, K) NbO_3 near the morphotropic phase region, Journal of Physics and Chemistry of Solids, 146, 109583-109583-8, 2020.

ABSTRACT

In this study, pellet samples of $(\text{Na}_{0.5}\text{K}_{0.5})_{1-y}\text{Li}_y\text{NbO}_3$, (NKLN) $y \leq 0.06$, were prepared using a conventional solid state reaction method with double sintering. The temperature-dependent dielectric constant and high temperature X-ray diffraction characteristics of the prepared compositions were observed. Four consistent distinct phases were determined according to the observations as follows. For the compositions where $y \leq 0.02$, the phases exhibited monoclinic symmetry between room temperature and about 200 °C, tetragonal between about 200 °C and 400 °C, tetragonal with different symmetry between about 400 °C and 460 °C (the so-called X phase), and cubic symmetry above about 460 °C. For the compositions with higher Li concentrations (y) between $0.03 \leq y \leq 0.06$, the X phase was not observed and two distinct phase transitions were observed from monoclinic to tetragonal at around 200 °C, and from tetragonal to cubic at around 460 °C.

- 20. Jyotsana Negi, Surendra Singh & N. S. Panwar, Electrical properties of, $\text{Na}_{1-0.315\text{K}0.315\text{Nb}_{1-y}\text{Ta}_y\text{O}_3$ ($0 \leq y \leq 0.05$) system, *Ferroelectrics*, 558:1, 117-127, 2020.**

ABSTRACT

$\text{Na}_{0.685\text{K}0.315\text{Nb}_{1-y}\text{Ta}_y\text{O}_3$ (where $y = 0, 0.01, 0.02, 0.03, 0.04, 0.05$) based ceramics were synthesized by the conventional solid-state reaction process. The effects of (Ta) – doping on the phase structure and electrical properties of (NKNTaO₃) were observed. The cell parameters were refined by High Score Plus software, using Rietveld method, The monoclinic Pm(6) space group was chosen in these refinements. X-ray diffraction analysis shows that the crystal structure of the ceramics, without and with Ta-doping possessed monoclinic symmetry. Among the prepared compositions, a break in the XRD peaks shifting tendency was observed at $y = 0.03$, and also maximum dielectric permittivity, loss tangent and electrical conductivity observed at the composition with $y = 0.03$.

- 21. Surendra Singh & N. S. Panwar, Piezoelectric properties of $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$, near $x = 0.500$ morphotropic phase region, *Ferroelectrics*, 558:1, 240-245, 2020.**

ABSTRACT

Sodium-potassium niobate ($\text{Na}_{1-x}\text{K}_x\text{NbO}_3$) ceramic pellets were prepared, near equimolar Na-K composition, by solid state reaction method with double sintering. Remnant polarization, coercive field, polarization current and converse piezoelectric coefficient (d_{33}) of the prepared samples were measured. The observed properties exhibit strong composition dependence- a morphotropic phase transition type behavior, showing extremal piezoelectric properties for potential lead free transducer applications, at the composition with $x = 0.500$.

- 22. Gambheer Singh Kathait, M. K. Panda & N. S. Panwar, Preparation of potassium tantalum niobate–barium titanate (KTN-BT) solid solution system ceramics and their piezoelectric properties, *Ferroelectrics*, 555:1, 109-117, 2020.**

ABSTRACT

Potassium tantalum niobate ($\text{KTa}_{1-y}\text{Nb}_y\text{O}_3$, KTN)-barium titanate (BaTiO_3 , BT) solid solution system 0.02[KTN]-0.98[BT] ceramics with various microstructures were prepared by modified two-step sintering method, and their dielectric and piezoelectric properties were observed. For 0.02K($\text{Ta}_{0.5}\text{Nb}_{0.5}$) O_3 -0.98 BaTiO_3 ceramics ferroelectric tetragonal crystalline structure was found for sintering temperature 1230, 1240, 1250, 1260, and 1270 °C. A large grain growth was observed for the BT grains of the samples. By observing the strain vs. electric field curves slope apparent piezoelectric constant d_{33}^* was investigated. The piezoelectricity d_{33} is found in proportional to escaping weight % of potassium at increasing sintering temperatures. Enhanced piezoelectric constant d_{33}^* of value 391 pm/V was found for sintering temperature 1240 °C.

- 23. Gambheer Singh Kathait & N. S. Panwar, Two-step sintering affecting the escaping of Na and K and its impact on dielectric properties and morphology of lead-free $\text{Na}_{0.92}\text{K}_{0.08}\text{NbO}_3$ ceramics, *Ferroelectrics*, 554:1, 187-196, 2020.**

ABSTRACT

Lead-free $\text{Na}_x\text{K}_{1-x}\text{NbO}_3$ (NKN) ceramics with $x = 0.08$ were prepared by a conventional solid-state reaction method. A two-step sintering technique was used for the sintering of ceramics. In this study, the influence of escaping of Na and K on the physical properties of prepared samples is investigated. It has been observed that the NKN ceramics with sintering temperature 1150 C, 1200 C and 1250 °C exhibit quite different microstructures from those with single sintering

temperature. The lattice parameter discontinuity previously reported at $x = 0.475$ has not been confirmed. The permittivity, piezoelectric constant d_{33} , show broad peaks at the sintering temperature $1200\text{ }^{\circ}\text{C}$, where permittivity and d_{33} are maximum and dependent on the escaping of Na and K. Further, all the ceramics sintered at $1200\text{ }^{\circ}\text{C}$ have the high permittivity ($\epsilon_c = 3175$) and piezoelectric values ($d_{33} = 192\text{ pm/V}$). From the analyses, we suggest that the high permittivity and piezoelectric properties for the NKN ceramics near $1200\text{ }^{\circ}\text{C}$ are closely related to their escaping of Na and K and microstructures of well-faceted and uniformly distributed large grains rather than the widely believed morphotropic phase boundary effect of lattice parameter discontinuity.

24. Gambheer Singh Kathait, M. K. Panda, N. S. Panwar, Effect of Modified Two-step Sintering Approaches on Potassium Tantalum Niobate–Barium Titanate (KTN–BT) Ceramics and Their Dielectric and Piezoelectric Properties, Science of Sintering, 52, 97-107, 2020.

ABSTRACT

The Potassium Tantalum Niobate-Barium Titanate (KTN–BT) solid solution system ceramics with the composition $0.02\text{K}(\text{Ta}_{0.5}\text{Nb}_{0.5})\text{O}_3\text{-}0.98\text{BaTiO}_3$ were prepared by a two-step sintering mechanism, for different sintering durations. Crystalline and microstructure analyses of the prepared samples were performed. Dielectric and piezoelectric properties were also investigated. Moreover, apparent piezoelectric constant d_{33} was measured using the slope of strain vs. electric field curves for these ceramics. It was observed that the high values of density, electrical conductivity, relative dielectric permittivity ($\epsilon_r = 3615.983$), piezoelectric coefficient ($d_{33} = 315\text{ pm/V}$) and remnant polarization ($P_r = 9.53\text{ }\mu\text{C/cm}^2$) were obtained for ceramics prepared through a new variation of the conventional two-step sintering method. Finally, the relationship between sintering mechanism, microstructure and piezoelectricity was discussed for the $0.02\text{K}(\text{Ta}_{0.5}\text{Nb}_{0.5})\text{O}_3\text{-}0.98\text{BaTiO}_3$ ceramics.

25. Sidharth Kashyap, S.C. Bhatt, Manish Uniyal, Gambheer Singh Kathait, Structural and dielectric properties of Lead Magnesium Niobate and Ti-doped Lead Magnesium Niobate at room temperature, Materials Today: Proceedings 28, 28–31, 2020.

ABSTRACT

Lead based relaxor ferroelectric like Lead Magnesium Niobate and their binary solid solutions with Lead Titanate have great interest of research because of their significant and excellent dielectric, piezoelectric and electrostrictive properties. In the present work, the Lead Magnesium Niobate (PMN) and Lead Magnesium Niobate-Lead Titanate (0.75PMN-0.25PT) were prepared through solid state reaction method with double sintering process at $1200\text{ }^{\circ}\text{C}$ for 6 hr. XRD data shows the perovskite structure of the prepared sample. SEM report of PMN and 0.75PMN-0.25PT shows the different microstructure with dense grains. Dielectric study of PMN and 0.75PMN-0.25PT shows the effect of addition of PT content on electrical properties at room temperature.

26. Gambheer Singh Kathait, Prashant Thapliyal, Don Biswas, Vishal Rohilla & Surendra Singh, Influence of escaping of Na & K on physical properties in lead-free $\text{Na}_{0.92}\text{K}_{0.08}\text{NbO}_3$ ceramic, Ferroelectrics, 551:1, 40-46, 2020.

ABSTRACT

Lead-free $\text{Na}_x\text{K}_{1-x}\text{NbO}_3$ (NKN) ceramic with $x = 0.08$ was prepared by a conventional solid-state reaction method to investigate the influence of the Escaping of Na & K on their physical

properties. It has been found that the NKN ceramics with $x = 0.08$ exhibit pure perovskite (ABO₃) structure. The pure phase NKN was achieved for all sintering temperatures of 1100 °C, 1150 °C, 1200 °C and 1250 °C. Change in microstructure, indicates that the grain size increases with the increasing sintering temperatures. The dielectric constant was dependent of the Escaping of Na & K. From the analyses, we suggest that the high dielectric constant for the NKN ceramics near sintering temperature 1150 °C are closely related to their low escaping of Na & K and microstructures of uniformly distributed large grains rather than the widely believed morphotropic phase boundary effect of lattice parameter discontinuity.

27. Gambheer Singh Kathait, N. S. Panwar, Prashant Thapliyal, Don Biswas, Vishal Rohilla, Surendra Singh, Sintering Effect on Electrical Properties and Morphology of Lead-Free Na_{0.92}K_{0.08}NbO₃ Ceramics, Science of Sintering, 51, 421-428, 2019.

ABSTRACT

Sodium potassium niobate (NKN) powders were synthesized by the solid-state reaction method. The NKN ceramics for composition Na_{0.92}K_{0.08}NbO₃ (NKN) were then fabricated by a two-step sintering technique. The effects of the two-step sintering on the properties of the ceramics were investigated. The pure phase NKN was achieved for all sintering temperatures of 1100, 1150, 1200 and 1250 °C. The observed change in the microstructure indicates that the grain size increases with the increasing sintering temperatures. Also, the two-step sintering technique produced a higher value of K/(K+Na) weight-% ratio and peak dielectric constant for sintering temperatures 1100, 1150 and 1200 °C. However, further increasing of the sintering temperatures at 1250 °C, reduces the K/(K+Na) weight-% ratio and the peak dielectric constant (ϵ_c).

28. Don Biswas, Gambheer Singh Kathait, Prashant Thapliyal, Vishal Rohilla, Surendra Singh & Jyotsana Negi, Converse piezoelectric properties of K and Namodified (Na_{1-x}K_x) NbO₃ lead free ceramics for $x = 0.08$ and 0.17 , Ferroelectrics, 550:1, 228-232, 2019.

ABSTRACT

The effect of potassium content on the structure and piezoelectric properties of the Na_{1-x}K_xNbO₃ ($x = 0.08$ and 0.17) (SPN) ceramics has been systematically studied. The pellets preparation and characterization have been reported earlier. The piezoelectric properties of the Na_{1-x}K_xNbO₃ ($x = 0.08$ and 0.17) were observed. The P-E loops, strain%, and the polarization current were observed. The value of d_{33}^* increasing with the application of Electric field, the rate of increasing value of d_{33}^* for $x = 0.08$ was faster than compared to $x = 0.17$. The value of d_{33}^* for $x = 0.08$ and $x = 0.17$ are 144 (pm/V), 136 (pm/V) respectively at the applied field 44 kV/cm.

29. Don Biswas, Kuldip Kumar, Vishal Rohilla, Gambheer Singh Kathait, Prashant Thapliyal, Arun Shekhar Bahuguna, Yogendra Pundir, Vinay Prasad tamta, Microcontroller based data acquisition system using error reduction technique, International Journal of Engineering, Science and Technology, Vol. 11, No. 3, pp. 40-48, 2019.

ABSTRACT

The application of high-speed real-time data acquisition is becoming increasingly wide spread in industrial field, and its measurement accuracy is also increasing. In the present study, the development of a USB based data acquisition system is presented here, where a microcontroller

based standalone embedded system is used as data collection and also field control device. The data acquisition system has been calibrated in terms of output voltage generated in signal conditioner. The USB device system also calibrated for the error in the output result. Here USB device has been programmed as Human Interface Device (HID) class, hence not requiring any kind of device specific driver. This data acquisition system is utilized to measure the flow of a channel. The flow of water is not acidic.

- 30. V. Lingwal, Binod Kumar Bhadri, A. S. Kandari, and N. S. Panwar, Temperature Dependence of Dielectric Conductivity in $K\text{TaxNb}_{1-x}\text{O}_3$ System for $x \leq 0.5$, International Journal of Advanced Science and Technology, Vol. 28, No. 20, pp. 698 – 705, 2019.**

ABSTRACT

Pellet samples of mixed potassium tantalate niobate ($K\text{TaxNb}_{1-x}\text{O}_3$), for compositions $x = 0, 0.1, 0.2, 0.3, 0.4$ and 0.5 were prepared by solid-state reaction method. The calcined mixture was pressed at 0.2 GPa and sintered in a closed furnace to form 8 mm diameter pellets. Temperature variation of dielectric conductivity of the prepared samples has been studied in the frequency range from 0.1 KHz to 1 MHz. Dielectric conductivity has been observed increasing with increasing frequency and with increasing x values, for $x \leq 0.4$; for $x = 0.5$, conductivity decreases at $0.1, 1$ and 10 KHz. At 100 and 1000 KHz conductivity decreases for $x = 0.3$, showing the MPT region. Anomalies have been observed near the transition temperatures of the samples in temperature-dielectric conductivity curves.

- 31. Surendra Singh, Jyotsana Negi, N.S. Panwar, Temperature dependent dielectric properties of $(\text{Na}, \text{K})\text{NbO}_3$, near equimolar composition, Ceramics International 45, 13067-13071, 2019.**

ABSTRACT

Pellet samples of $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$ ($0.490 \leq x \leq 0.510$) were prepared using solid state reaction method with double sintering. Dielectric measurements were carried out on the prepared samples, from 30 to 500 °C, at 1 MHz. Dielectric constant and electrical conductivity were found minimum, for $x = 0.500$ among all the prepared compositions, at room temperature and at all the measured frequencies. Three distinguished phase transitions, at $200, 380$ and 460 °C, were observed in dielectric measurements of the prepared compositions. The high temperature X-ray diffraction (HT- XRD) of the samples with $x = 0.500$, shows monoclinic phase between room temperature and 200 °C, tetragonal between 200 and 380 °C, tetragonal with increased lattice parameters, between 380 and 460 °C, and cubic phase beyond 460 °C. The tetragonal to tetragonal phase transition at 380 °C, and tetragonal to cubic at 460 °C was distinctly observed from dielectric and HT- XRD measurements in the present study.

- 32. Jyotsana Negi, Surendra Singh & N. S. Panwar, Structural and dielectric anomaly in $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$, at $x = 0.315$, Phase Transitions, <https://doi.org/10.1080/01411594.2018.1563789>, 2019.**

ABSTRACT

Structural and dielectric properties of sodium-potassium niobate ($\text{Na}_{1-x}\text{K}_x\text{NbO}_3$) ($0.250 \leq x \leq 0.350$) ceramics, prepared by the solid-state reaction method were investigated. Observed dielectric properties show a strong compositional dependence, at all the measured temperatures (from room temperature to 150 °C) and frequencies (from 1 to 1000 kHz). In the prepared compositions, the lowest values of dielectric permittivity, loss tangent and electrical conductivity were found, and an anomaly in the shifting pattern of X-ray diffraction (XRD) peaks and change

in the slope of a/c vs. x plot were observed at $x = 0.315$. The observed structural and dielectric anomaly gives a morphotropic phase boundary-like indication, in $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$ system, at $x = 0.315$.

- 33. Vijendra Lingwal, A S Kandari & N S Panwar, Theoretical Investigation of Dielectric Properties of Potassium Mixed Sodium Niobate Crystals, International Journal of Management, Technology And Engineering, Vol. 8, Issue IX, 1793-1799, 2018.**

ABSTRACT

Using experimental observed dielectric and loss behavior of potassium mixed sodium niobate crystals the temperature dependence of soft mode frequency, width, relaxation time, order parameter, fourth order coupling coefficients and anharmonic constants have been calculated. Anomaly has been observed in the behavior of soft mode frequency, width, relaxation time, and order parameter, near the transition temperatures in this compound.

- 34. Vijendra Lingwal, A S Kandari & N S Panwar, Temperature Dependence of Dielectric Properties in Doped Perovskites, International Journal of Management, Technology and Engineering, Vol. 8, Issue IX, 797-804, 2018.**

ABSTRACT

Pellet samples of mixed sodium-potassium tantalate ($\text{Na}_{1-x}\text{K}_x\text{TaO}_3$), for compositions $x = 0, 0.2$ and 0.5 were prepared by solid-state reaction method. The calcined mixture was pressed at 0.02 MPa and sintered in a closed furnace to form 6 mm diameter pellets. Temperature variation of dielectric constant and loss tangent of the prepared samples has been studied in the frequency range from 10 KHz to 1 MHz. Dielectric anomalies have been observed near the transition temperatures of the samples. Dielectric constant and loss tangent peak heights were observed decreasing with increasing frequency, for all the compositions, which show relaxational behavior of the material.

- 35. Surendra Singh, Jyotsana Negi, N.S. Panwar, Dielectric properties of $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$, near $x = 0.5$ morphotropic phase region, Journal of Physics and Chemistry of Solids, 10.1016/j.jpcs.2018.08.018, 2018.**

ABSTRACT

Sodium-potassium niobate ($\text{Na}_{1-x}\text{K}_x\text{NbO}_3$) ceramic pellets, with $x = 0.490, 0.495, 0.500, 0.505$ and 0.510 , were prepared by solid state reaction method with double sintering. With varying potassium content (x), dielectric properties and X-ray diffraction (XRD) peaks shifting pattern exhibit strong compositional dependence. Among the prepared compositions, a break in the XRD peaks shifting tendency, and minimum dielectric constant, loss tangent and Electric conductivity indicate a morphotropic phase transition type behavior, at the composition with $x = 0.500$.

- 36. Don Biswas, Gambheer Singh Kathait, Prashant Thapliyal, Vishal Rohilla & Surendra Singh, Temperature dependence of dielectric properties of sodium potassium niobate ceramics for different values of x ($\text{Na}_{1-x}\text{K}_x\text{NbO}_3$), Ferroelectrics, 526:1, 168- 175, 2018.**

ABSTRACT

Dielectric constant, loss tangent and electrical conductivity of $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$ ($X = 0.08$ and 0.17)(SPN) ceramic pellets have been measured at $10, 100$ and 1000 kHz frequencies and at

temperature varying from room temperature to 425°C. The dielectric constant increases with increase of temperature up to 400°C at all the three frequencies, and thereafter, it decreases with further increase of temperature, i.e., it shows a structural transition at about 400°C. The loss tangent also shows similar behaviour as dielectric constant shows. Some variations may be due to relaxation effects and impurities etc. around the sensitive transition region, which are seem to play prominent role in this soft mode region. Electrical conductivity increases with increase in temperature at all the three frequencies.

37. Don Biswas, Arun Shekhar Bahuguna, To Measure Physical Signal from Sensor and Control through Data Acquisition System, International Journal of Advanced Research in Computer Science and Software Engineering, Volume 7, Issue 5, 377-388, 2017.

ABSTRACT

The objective of this paper is to acquire data from the sensor or transducer. Also the command signal has been send to the sensor to acquire the data from time to time when the computer needs it. The acquisition system has been modified and it can control the deviated data or output. For this measurement system we develop software using visual basic software. The sensor output has been calibrated into corresponding electrical signal. The measured and acquired data (output of sensor) has been processed through USB based data acquisition system. If there any deviation in the desired output then we can use the control signal to control (computer generated signal) and set it to a desired value. An approach to develop a USB based data acquisition system is presented; where a PIC microcontroller (Microchip's 18F2550) based standalone embedded system is used as a front-end data collection and also field control device. The developed USB based device continuously scans its input analog and digital channels sequentially and updates the PC with these values, which are updated in a Visual BASIC based application GUI (Graphical User Interface). Here USB device has been programmed as Human Interface Device (HID) class, which provides an additional advantage of not requiring any device specific driver. The firmware used in the microcontroller is developed in PicBASICPro platform. A second Generation JDM programmer has been developed, which is used along with WINPIC800 to program the microcontroller. This device can accept an analog input voltage between 0 – 5Vdc from any real life sensor(s) and generate digital output (8 bits) as control action.

38. Vishal Rohilla, Don Biswas, Gambheer Singh Kathait, Prashant Thapliyal, Bharti Ruhela, Estimation of REEs in Some Selected Green /Organic/ Herbal Tea Available in Indian Market, International Journal for Research in Applied Science & Engineering Technology (IJRASET), Volume 5, Issue VIII, 1226-1229, 2017.

ABSTRACT

Tea is one of the most consuming and cheap beverages after water all over the world. Tea is a potent stimulant of gastric acid excessive intake cause more acidity in stomach. Most of the population of India is switching from black tea to other herbal products that are marketed in India with name of Green /Organic/ Herbal tea. Studies in the past have shown that Oxides, Nitride and Chloride forms of Rare Earth Elements have adverse effect on human health. Aim of our study is to determine qualitatively as well as quantitatively REEs that present in the Green /Organic/ Herbal tea. To provide an overview of exposure to REEs people are getting by consuming such type of tea. For present work eleven Green /Organic/ Herbal tea samples were procured form local store brew was made and analysis was done on Perkin Elmer NexIon-300x Inductively Coupled Plasma Mass Spectrometer (ICP-MS). Ce was the most abundant element its concentration varied from highest 964.764 µg/L to lowest 73 ng/L. second most abundant elements were Nd, La and Y for some samples. Concentrations of Gd and Dy were found almost

similar same was true for Tm and Lu. Lu was found to be least abundant highest 9.336 µg/L and lowest 1 ng/L. Results were observed different from the Black tea in which Ce was found most abundant and La was second most abundant. Keywords: Rare Earth Elements; ICPMS; Herbal tea; Green tea; Organic tea.

39. Vijay Singh Bist and Narayan Singh Panwar, Soft Mode Dynamics of Order-Disorder Type Crystals, Chemical Science Transactions, 6(1), 107-113, 2017.

ABSTRACT

The soft mode dynamics and related properties of order-disorder type crystals have been studied. The phonon width and shift have been calculated, which lead to the renormalization of the relaxation soft-mode. The dielectric properties are directly related to the relaxational soft mode behavior of stochastic motion of H₂PO₄ groups in order-disorder (KDP-system) crystals. The analysis of the temperature dependence of microwave loss tangent and dielectric constant explain the experimental results.

40. V. Lingwal, A. S. Kandari, N. S. Panwar, Optical properties of sodium niobate thin films, NANOSYSTEMS: PHYSICS, CHEMISTRY, MATHEMATICS, 7 (4), 583–591, 2016.

ABSTRACT

NaNbO₃ thin films were deposited under different conditions by rf magnetron sputtering of ceramic target. Spectral transmission of the deposited films was measured in the UV-Visible-near IR range. Films deposited at 300 °C showed more absorption, and films annealed at 300 °C showed less absorption than those deposited at room temperature (RT), which was found to be consistent with their X-ray diffraction (XRD) patterns. From the observed transmission spectra, refractive index, optical band gap, absorption coefficient, extinction coefficient and film thickness were calculated for the deposited films. Refractive index at 550 nm wavelength was found to be 2.11, 2.01 and 2.34 for the films deposited at RT, 300 °C and annealed at 300 °C, respectively. The refractive index was found to be almost constant with respect to frequency for the films annealed at 300 °C. Optical band gap was found 3.82, 3.7 and 3.81 eV for the films deposited at RT, 300 °C, and annealed at 300 °C, respectively. Film thickness was shown to decrease with annealing. Absorption and extinction coefficients decreased with increasing wavelength, in all the samples. Band gaps associated with different interactions have been calculated for the deposited films. Phonon assisted indirect forbidden transition was most favorable in the deposited films.

41. V S Bist and N S Panwar, Dielectric Constant and Tangent Loss in Paraelectric Phase for KH₂PO₄, International Journal of Emerging Technology and Advanced Engineering, Volume 6, Issue 11, 78-84, 2016.

ABSTRACT

By adding third and fourth order phonon anharmonic interaction terms in the four particle cluster model Hamiltonian for the stochastic motion of H₂PO₄⁻ groups and using double-time temperature dependent Green's function method and Dyson's equation techniques, expressions for the dielectric constant and dielectric tangent loss have been derived and discussed for KH₂PO₄. Using model parameters given by Ganguli S, Nath D and Chaudhary B K (Phy. Rev., 1980 B21, 2937) the transverse dielectric constant and observed dielectric constant have been calculated for KH₂PO₄ in its paraelectric phase. The temperature dependence of this dielectric constant for KH₂PO₄ have been calculated and compared with experimental results of Raman Intensity (Ferroelectrics, 1983, 52, 91), Bush G (Phys. Acta., 1938,11, 265) and Kaminow I P

and Harding G O (Phys. Rev., 1963,129, 1562)], and Deguchi K. and Nakamura E (J. Phys. Soc. Jpn., 1980,49, 1887). The observed dielectric constant explains the Curie-Weiss behaviour of dielectric constant along the c-axis of KH₂PO₄ crystal in the paraelectric phase. Also the temperature dependence of tangent loss in paraelectric phase for KH₂PO₄ at 9.2 GHz for field along the a-axis, and c-axis have been calculated and compared with experimental results of Kaminow I P and Harding G O (Phys. Rev., 1963,129, 1562). A good agreement has been found. At higher temperature the loss deviates from the Curie-Weiss type behaviour and increases linearly with temperature. This behaviour suggests that at higher temperature the phonon anharmonicity contributes significantly in the observed loss.

42. Vijay Singh Bist and Narayan Singh Panwar, Study of Dielectric Properties and Ultrasonic Attenuation in KDP-Type Ferroelectrics, Hindawi Publishing Corporation Physics Research International, <http://dx.doi.org/10.1155/2016/9475740>, Volume 2016.

ABSTRACT

The soft mode dynamical model has been used to study dielectric properties and ultrasonic attenuation in KDP-type ferroelectric crystals. The model Hamiltonian proposed by Blinc and Zeks has been modified by considering lattice anharmonicity up to fourth-order. The correlations appearing in the dynamical equation have been evaluated using double-time thermal retarded Green's functions method and Dyson's equation. Without any decoupling, the higher order correlations, appearing in the dynamical equation, have been evaluated using the renormalized Hamiltonian. The expressions for collective frequencies, width, dielectric constant, ultrasonic attenuation, and tangent loss have been calculated. The dielectric properties and ultrasonic attenuation strongly depend on the relaxational mode behavior of stochastic motion of H₂PO₄ group in KDP-type ferroelectrics. By fitting model values of physical quantities, the temperature dependence of $\langle Sqz \rangle$ and $\langle Sqx \rangle$ for different value of four-body coupling coefficient and dielectric constant and loss tangent has been calculated. The calculated and observed results have been found in good agreement.

43. Aradhana Bhandari, M. K. Agrawal, N. S. Panwar, Temperature Dependent Dielectric Properties of Monoclinic (H) – Phase [Ta₂O₅]_{1-x} – [TiO₂]_x, (0.078 ≤ x ≤ 0.085), IJIRST –International Journal for Innovative Research in Science & Technology, Volume 1, Issue 10, 118-121, 2015.

ABSTRACT

Observed temperature dependence of dielectric constant, loss tangent and dielectric conductivity of H- phase [Ta₂O₅]_{1-x}- [TiO₂]_x, (0.078 ≤ x ≤ 0.085) pellets, prepared by solid state reaction method, has been presented. Dielectric constant was observed slowly increasing with temperature showing strong transition peaks at 495, 505, 510 and 520 °C for the compositions with x = 0.078, 0.080, 0.082 and 0.085, respectively. Dielectric loss and conductivity also show anomalous increase near the transition temperature, for all the prepared compositions. Near the transition temperature, anomalous dielectric behavior may be associated with the softening of the active phonon mode.

- 44. Aradhana Bhandari, M. K. Agrawal, Alok S. Kandari, Vijendra Lingwal, N. S. Panwar, Dielectric Properties of H- Phase [Ta₂O₅]_{1-x} – [TiO₂]_x, (0.078 ≤ x ≤ 0.085), IJIRST –International Journal for Innovative Research in Science & Technology, Volume 1, Issue 10, 102-108, 2015.**

ABSTRACT

Composition (0.078 ≤ x ≤ 0.085), frequency (1 KHz – 1 MHz) and temperature (30 – 600 °C) dependence of dielectric constant, loss tangent and dielectric conductivity of [Ta₂O₅]_{1-x}-[TiO₂]_x pellets, prepared by solid state reaction method, has been presented. The x-ray diffraction patterns and dielectric constant measurements show the occurrence of high- phase. Among the prepared compositions, dielectric constant was observed maximum for the composition with x = 0.080, at all the measured frequencies and temperatures (except near transition temperature). Dielectric properties were observed dominantly driven by composition rather than the frequency or temperature, in the present system. Dielectric constant was observed slowly increasing with temperature showing strong transition peaks at 495, 505, 510 and 520 °C for the compositions with x = 0.078, 0.080, 0.082 and 0.085, respectively. Dielectric loss and conductivity also show anomalous increase near the transition temperature, for all the prepared compositions. Near the transition temperature, anomalous dielectric behavior may be associated with the softening of the active phonon mode.

- 45. V S Bist, N S Panwar, B S Semwal, Relaxation Time in KDP-Type Ferroelectrics Above T_c, International Journal of Emerging Technology and Advanced Engineering, Volume 5, Issue 10, 317-322, 2015.**

ABSTRACT

Using the modified four-particle cluster model Hamiltonian, Green's function method and Dyson's equation techniques. The theoretical expressions for relaxation time, ultrasonic attenuation, dielectric constant and loss have evaluated and discussed for KDP-type ferroelectrics above T_c. From the ultrasonic data the relaxation time has been calculated and compared with the results measured from the other methods. The calculated and observed results have been found in good agreement. By fitting the parameter values the relaxation times obtained from the loss tangent data have been compared with those obtained from the attenuation data. It is observed that these results are in good agreement with each other and with the results obtained by other methods.

- 46. Vijay Singh Bist, Narayan Singh Panwar and Birendra Singh Semwal, Phase Transitions in KDP-Type Crystals, Chemical Science Transactions, 4(4), 1131-1138, 2015.**

ABSTRACT

Curie temperature is determined by investigating the variation of order-parameter $\langle S_q^z \rangle$ with temperature. The model Hamiltonian proposed by Blinc and Zeks has been modified by considering the lattice anharmonicities up to fourth order. The correlations appearing in the dynamical equation have been evaluated using double-time thermal retarded Green's function and Dyson's equation. The expressions for shift, width, renormalized soft mode frequency, Curie temperature, the expectation value of the proton collective mode components at site q ($\langle S_q^z \rangle$, and $\langle S_q^x \rangle$) have been derived and discussed in KDP - type crystals. By fitting model values of physical quantities, the temperature dependence of $\langle S_q^z \rangle$, and $\langle S_q^x \rangle$ for different value of four-body coupling have been calculated. The theoretical results are found in good agreement with the experimental results.

47. V. S. Bist & N. S. Panwar, Temperature Dependence of Dielectric Loss Tangent in KDP (KH₂PO₄) Type Crystals, Global Journal of Science Frontier Research: A Physics and Space Science, Volume 15, Issue 5, 13-20, 2015.

ABSTRACT

Considering third- and fourth-order phonon anharmonic interactions terms in the four particle cluster model Hamiltonian proposed by Blinc *et al* [1982 *J Phys*, C15 4661] for the stochastic motion of - H₂PO₄ groups for KDP (KH₂PO₄) type ferroelectrics, expressions for soft mode frequency and loss tangent are evaluated. For the calculations, method of double time temperature dependent Green's function has been used. By fitting model values of physical quantities, the dielectric loss in paraelectric phase of KDP (KH₂PO₄) crystal at 9.2 GHz for field along the a-axis δa) (tan, and c-axis δc) (tan have been calculated which compare well with experimental results of Kaminow *et al* [1963 *Phy Rev*, 129 1562]. A good agreement has been found. In the microwave frequency range, an increase in frequency is followed by an increase in transverse and longitudinal dielectric loss tangent. The loss decreases with increase in temperature for KDP (KH₂PO₄) crystal, in their paraelectric phase. This shows Curie-Weiss type behavior of the dielectric loss tangent.

48. Mahesh Kumar Agarwal, Aradhana Bhandari, Y. Singh, N. S. Panwar, Optical Properties of Amorphous [Ta₂O₅]_{1-x}-[TiO₂]_x (x=0.08) Thin Films, International Journal of Research and Innovations in Science and Technology, Volume 1, Issue 1, 23-29, 2014.

ABSTRACT

Thin films of [Ta₂O₅]_{1-x}-[TiO₂]_x film deposited by RF sputtering method. The spectral transmissions of the [Ta₂O₅]_{1-x}- [TiO₂]_x (x = 0.08) films were measured in UV-visible range. Films shows good transmittance for as- deposited and sample annealed at 400, 500 and 600 0C. From the observed transmission spectra, refractive index, optical band gap, absorption coefficient, extinction coefficient, and thickness of prepared [Ta₂O₅]_{0.92}-[TiO₂]_{0.08} films, have been calculated by Swanepoel's envelope technique. Refractive index (n), absorption coefficient (α), and extinction coefficient of the films were observed, generally, decreasing with increasing photon wavelength. The value of refractive index was found 2.29 for sample annealed at 4000C. To understand the associated mechanisms, the energy band gap calculated for all the prepared samples. For the as- deposited films the direct allowed energy band gap was obtained as 4.45 eV; and 4.48, 4.52 and 4.45 eV for the films annealed at 400, 500 and 600 0C, respectively. The observed variation of optical band gap, as a function of annealing temperature, shows that the band gap widens (blue shift) for the films annealed at higher temperatures.

49. V. S. Bist & N. S. Panwar, Temperature Dependence of Inverse Dielectric Susceptibility in KDP-Type Crystals, Global Journal of Science Frontier Research Physics and Space Science, Volume 13, Issue 6, 23-28, 2013.

ABSTRACT

By using four particle cluster model Hamiltonian along with third and fourth order phonon anharmonic interaction terms for KDP-type crystals, expressions for renormalized soft mode frequency, and inverse dielectric susceptibility have been obtained. The method of double time temperature dependent Green's function has been used for calculation. Fitting the values of model parameters, the temperature dependence of soft mode frequency and inverse dielectric susceptibility has been evaluated. The inverse dielectric susceptibility was observed increases linearly with temperature, for KDP crystal, in its paraelectric phase. Theoretical results are compared with experimental results of Kim *et al* [Physics Review B73, 134114 (2006), and

Current Applied Physics 9(2009) 1307]. A good agreement has been found between the reported and present results.

50. V. S. Bist & N. S. Panwar, Temperature Dependence of Relaxation Rate in KH₂PO₄ above T_c, Global Journal of Science Frontier Research Physics and Space Science, Volume 13, Issue 1, 35-38, 2013.

ABSTRACT

With the help of the modified four-particle cluster model Hamiltonian [GJSFR, 10, 18(2010)], the theoretical expressions for the relaxation rate of polarization fluctuation have been evaluated and discussed for the KH₂PO₄ (KDP)- type crystals by using the double-time thermal dependent retarded Green's functions techniques and Dyson's equation treatment. The correlations appearing in the dynamic equation have been evaluated using double-time thermal dependent retarded Green's functions techniques and Dyson's equation treatment. Without any decoupling the higher order correlations have been evaluated using the renormalized Hamiltonian. By fitting model values in the theoretical expressions, temperature dependence of relaxation rate is calculated for the KH₂PO₄ (KDP)-type crystals. Theoretical results are compared with experimental result of Garland and Novotny [1969 Phys Rev. 177 971]. A good agreement has been found.

51. V. S. Bist & N. S. Panwar, Dielectric Properties of Order-Disorder Type Crystals, Global Journal of Science Frontier Research Mathematics and Decision Sciences, Volume 12, Issue 7, 43-56, 2012.

ABSTRACT

The soft mode dynamical model has been used to study the dielectric properties of orderdisorder-type crystals. Using the model Hamiltonian proposed by Blinc [Advances in Phys, 29 (1972) 701] and has been modified by Bist et al [GJSFR,10,18(2010)], the expressions for the dielectric constant and tangent loss have been derived and discussed for order-disorder, KH₂PO₄ type-crystals with the help of double time temperature dependent Green's function techniques and Dyson's equation treatment. Using appropriate parameters given by Ganguli et al [Phys Rev. B21, 2937 (1980)] the transverse dielectric constant and observed dielectric constant have been calculated and compared with experimental results of Raman Intensity[Ferroelectrics 52, 91 (1983)], Busch [Helv. Phys. Acta. 11, 265 (1938)], Kaminow et al [Phys. Rev. 138A, 1539 (1963)], and Deguchi et al [J. Phys. Soc. Jpn. 49, 1887 (1980)]. The observed dielectric constant explains the Curie-Weiss behaviour of dielectric constant along the c-axis of KH₂PO₄ crystal in the paraelectric phase. Also the temperature dependence of tangent loss in paraelectric phase for KH₂PO₄ at 9.2 GHz for field along the a-axis, and the c-axis have been calculated and compared with experimental results of Kaminow et al [Phys. Rev. 138A, 1539 (1963)]. It is observed that these results are in good agreement with each other and with the results obtained by other methods. At higher temperature the loss deviates from the Curie-Weiss type behaviour and increases linearly with temperature. This behaviour suggests that at higher temperatures the phonon anharmonicity contributes significantly in the observed loss.

52. V S Bist , N S Panwar, Relaxation processes and ultrasonic attenuation in KDP type ferroelectrics, Global Journal of Science Frontier Research, Volume 11, Issue 9, 25-30, 2011.

ABSTRACT

The anharmonic four-particle cluster model Hamiltonian for stochastic motion of H₂PO₄⁻ groups has been used to study the physical properties of KDP type ferroelectrics. Using Green's

function method and Dyson's equation the renormalized frequency of the coupled system and collective wave half width have been evaluated with the help of model Hamiltonian by considering the anharmonicity upto fourth order. The higher order correlations have been decoupled using symmetric decoupling scheme at the later stage after applying the Dyson's treatment and have been evaluated using the renormalized Hamiltonian. The relaxational behaviour and ultrasonic attenuation have been related to the width of collective mode. The temperature dependence of ultrasonic attenuation coefficient, dielectric constant and loss tangent has been discussed in terms of a relaxational soft mode.

53. V S Bist, S C Bhatt, N S Panwar, Temperature dependence of $\langle S_q^z \rangle$ and $\langle S_q^x \rangle$, collective proton frequency width, collective phonon mode frequency, in paraelectric phase for KH₂PO₄, Global Journal of Science Frontier Research, Vol. 10, Issue 3, 18-29, 2010.

ABSTRACT

The model Hamiltonian proposed by the [Blinic and Zeks advances in Physics, 29, (1972) 159] has been modified by considering the lattice anharmonicity upto fourth order for the stochastic motion of groups. The correlations appearing in the dynamic equation have been evaluated using double time thermal retarded Green's functions and Dyson's equation. The proton Green's function and phonon Green's function have been evaluated for the collective motion of the system, using model Hamiltonian. The higher order correlations in the proton Green's function have been evaluated using the symmetrical decoupling scheme, after applying the Dyson's treatment. The expressions for the proton renormalized frequency of the coupled system and collective proton wave half widths have been calculated. The higher order correlations in the phonon response function have been calculated without any decoupling and using renormalized Hamiltonian. The expressions for the renormalized phonon frequency and acoustic phonon widths and shifts have been calculated. Using expectation value of the proton collective mode components at site q [Blinic and Zeks advances in Physics, 29, (1972) 159] the temperature dependence of $\langle S_q^z \rangle$ and $\langle S_q^x \rangle$ for different values of, have been calculated. This shows the order of phase transition. In paraelectric phase the value of decreases when temperature increases from transition temperature (TC). Our theoretical results fairly agree with experimentally reported 55-77 result within experimental errors.

54. Aradhana Bhandari, Alok S. Kandari, M. K. Agarwal, Vijendra Lingwal & N. S. Panwar, Sintering Process Dependent Dielectric Properties of [Ta₂O₅]_{1-x}[TiO₂]_x, for the Compositions Near x = 0.08, Ferroelectrics Letters Section, 37:3, 43-54, 2010.

ABSTRACT

Pellet samples of [Ta₂O₅]_{1-x}[TiO₂]_x, (x = 0.078, 0.080, 0.082 and 0.085) were prepared by solid state reaction method. The X-ray diffraction patterns and dielectric constant measurements show the occurrence of low-, mixed- and high-phases with varying sintering processes. The enhanced dielectric constant may be associated with the appearance of monoclinic H-phase. In all the three phases dielectric constant was observed maximum for the composition with x = 0.080, among the prepared compositions. For the Ti modulated Ta₂O₅ structure the lowest value of the active mode frequency may be held responsible for the observed highest value of dielectric constant for the composition with x = 0.080.

- 55. Alok Singh Kandari, Vijendra Lingwal, N. S. Panwar, Morphotropic phase boundary in $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$, near $x = 0.32$, Solid State Communications 150, 74–77, 2010.**

ABSTRACT

Pellet samples of $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$ with $x = 0.28, 0.30, 0.32, 0.325$ and 0.40 were prepared by a solid state reaction method. X-ray diffraction and dielectric measurements were carried out on the prepared samples. With varying composition (x), a break was observed in the X-ray diffraction peaks shifting tendency; a slope change anomaly in the a/b vs. x plot; and minimum values of dielectric constant, loss tangent and dielectric conductivity, at all the measured frequencies and temperatures, showing a strong compositional dependence of structural and dielectric properties — a morphotropic phase transition, at $x = 0.32$. The observed minimum values of dielectric parameters may be associated with the increased Na-site vacancies and structural anomaly, at $x = 0.32$.

- 56. Alok Singh Kandari, Vijendra Lingwal & N. S. Panwar, Morphotropic Region in $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$, Between $x = 0.17$ and 0.18 , Ferroelectrics, 396:1, 18-26, 2010.**

ABSTRACT

Pellet samples of $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$ ($0.12 \leq x \leq 0.20$) were prepared by solid state reaction method. With varying composition, the observed break in the X-ray diffraction peak shifting tendency, the slope change anomaly in the c/a vs. x plot, and the anomalous change in the dielectric properties identify a morphotropic region in the composition range between $x = 0.17$ and 0.18 .

- 57. Alok Singh Kandari, Karuna Kandari, Vijendra Lingwal, A. A. Bourai & N. S. Panwar, Composition Dependent Dielectric Anomaly in $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$, at $x = 0.475$, Ferroelectrics, 393:1, 121-129, 2009.**

ABSTRACT

Sodium-potassium niobate ($\text{Na}_{1-x}\text{K}_x\text{NbO}_3$) pellet samples, with $x = 0.40, 0.47, 0.475, 0.48$ and 0.50 , were prepared by solid state reaction method. With varying composition (x), X-ray diffraction patterns show a break in the peak shifting tendency, at $x = 0.475$. Lattice parameters calculated from X-ray diffraction patterns show a slope change anomaly, in the a/b vs. x plot, from positive to negative, at $x = 0.475$. Dielectric constant, loss tangent and dielectric conductivity were found minimum for the composition with $x = 0.475$, among the prepared compositions, at all measured frequencies and temperatures. The observed results show a strong compositional dependence of dielectric properties, in this system. Observed minimum values of dielectric parameters may be associated with increased Na site vacancies and structural anomaly—a morphotropic type phase transition, at the composition with $x = 0.475$.

- 58. Alok Singh Kandari, Aradhana Bhandari, A. A. Bourai, and N. S. Panwar, Electrical Properties of $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$ ($0.28 \leq x \leq 0.40$), Ferroelectrics, 386, 139–151, 2009.**

ABSTRACT

Sodium potassium niobate ($\text{Na}_{1-x}\text{K}_x\text{NbO}_3$) pellet samples, with $x = 0.28, 0.30, 0.32, 0.325$ and 0.4 , were prepared by solid state reaction method. In the XRD patterns a break in the peak shifting tendency was observed for the composition with $x = 0.32$. Dielectric constant, loss tangent and dielectric conductivity of the prepared samples were measured in the frequency range from 10 to 1000 KHz, and in the temperature range from 30 to 500°C. Transition temperatures determined from the dielectric constant measurements were found independent of

the measured frequencies, and no relaxator type behavior was observed for the presently prepared compositions. Dielectric constant and loss tangent were observed decreasing, and dielectric conductivity increasing with increasing frequency. Weak loss tangent anomalies were observed, near the transition temperatures. Transition anomalies observed from the dielectric conductivity measurements were consistent with those from the dielectric constant measurements. Among the prepared compositions dielectric constant, loss tangent and dielectric conductivity were observed minimum for $\text{Na}_{0.68}\text{K}_{0.32}\text{NbO}_3$, at different frequencies and temperatures, which indicate a strong composition dependence of the electrical properties. Among the prepared n-type $\text{Na}_{1-x}\text{K}_x\text{NbO}_3$ compositions, an increase in the Na site vacancies and structural anomaly may be held responsible for the observed minimum dielectric conductivity of the composition with $x = 0.32$.