Synthesis and Characterisation of 0.45Ba($Zr_{0.2}Ti_{0.8}$) O_3-0.55($Ba_{0.7}Ca_{0.3}$) TiO_3 (BZT-BCT) Lead Free Ferroelectric Ceramic.

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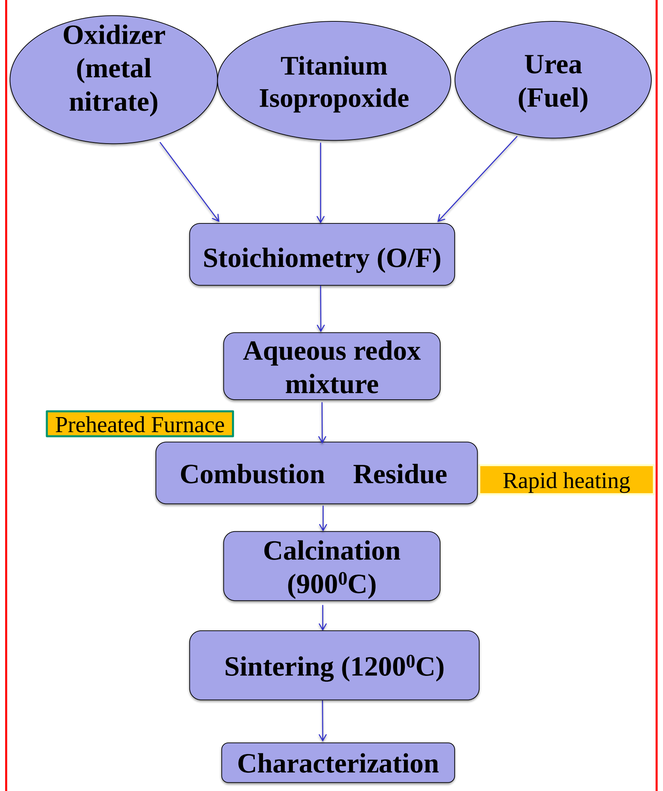
Abstract

The lead free polycrystalline ferroelectric samples of 0.45Ba($Zr_{0.2}Ti_{0.8}$) O_3-0.55($Ba_{0.7}Ca_{0.3}$)TiO_3 have been synthesized using auto combustion technique. The room temperature XRD pattern reveals the formation of single phase compound. The sample shows a saturated ferroelectric behaviour for both poled and unpoled case. From P-E hysteresis loop, the remnant polarisation ($2P_r^0$) and coercive field (E_c^0) are found to be 5.39μC/cm², 4.672 kV/cm (poled sample) and 3.44 μC/cm², 3.893 kV/cm (unpoled sample) respectively. The I-V characteristic shows a symmetric behaviour for both positive and negative applied electric field. The temperature dependent dielectric measurement for both poled and unpoled sample has been carried out. The temperature dependent dielectric properties shows a high dielectric constant (ε_r) value of 5880 around T_c =95^{0}C (for poled) and 5869 around T_c =89^{0}C (for unpoled) sample.

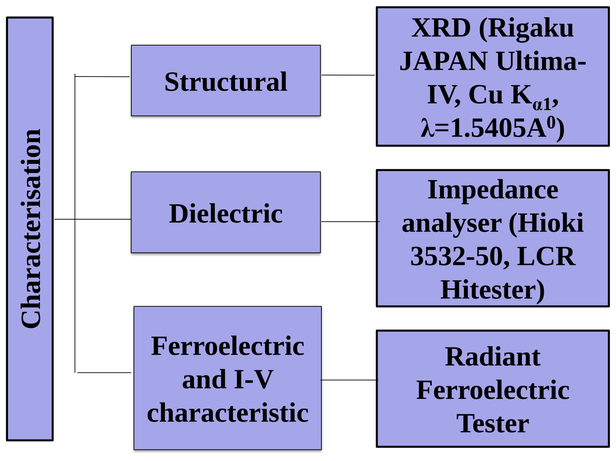
Introduction

- **Recently, lead-free $BaTiO_3$ based solution i.e., *(1-x)*Ba($Zr_{0.2}Ti_{0.8}$)O_3 - *x*($Ba_{0.7}Ca_{0.3}$)TiO_3 (BZT-BCT) for *x*=0.5 received significant attention because of it's high dielectric constant and large piezoelectric properties (d_{33}=560-620 pC/N) near morphotropic phase boundary (MPB).**
- **The synthesis method for BZT-BCT required very high temperature(1300-1400^{0}C) to get a phase pure material.**
- **To improve the physical properties from application point of view, synthesis of high quality stoichiometric ceramics powder at lower temperature synthesis conditions and improved microstructure is one of the essential requirements.**
- **Microwave sintering (MW) process often involved in densification of pellets without grain growth, reduction in sintering temperature, shorten the sintering time to get fine, and uniform grains with improved microstructure in comparison to conventional sintering (CS) process.**
- **It is reported that the dielectric, piezoelectric and ferroelectricity for MW sintered samples were observed to be more as compared to CS ceramics.**
- **These ferroelectric materials have wide range of device applications such as sensors, actuators, capacitors, RAM, detectors etc.**

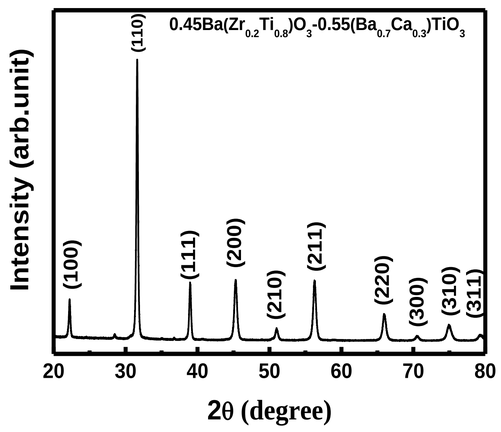
Sample Synthesis



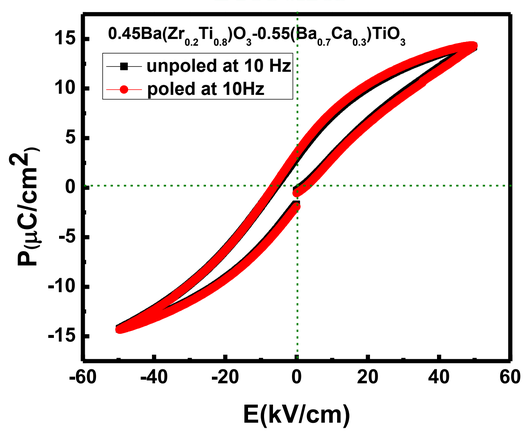
Characterisation Technique



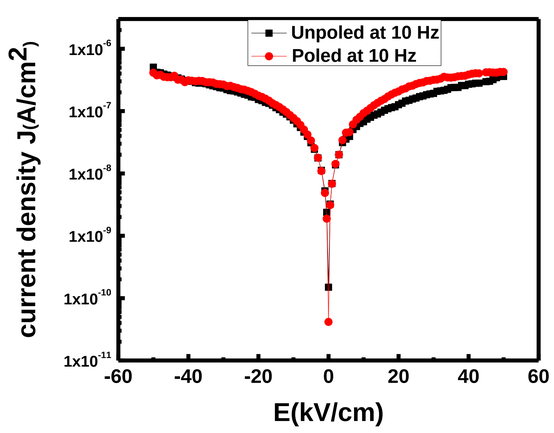
Results



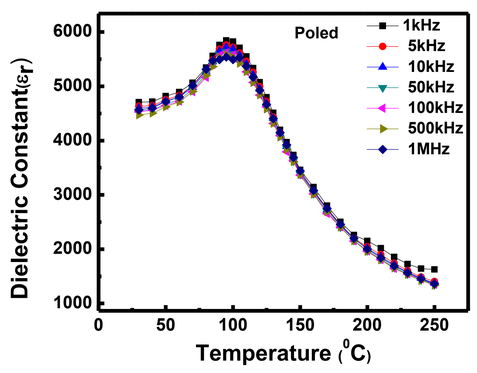
The XRD pattern shows the formation of single phase compound without the presence of any trace of impurity.

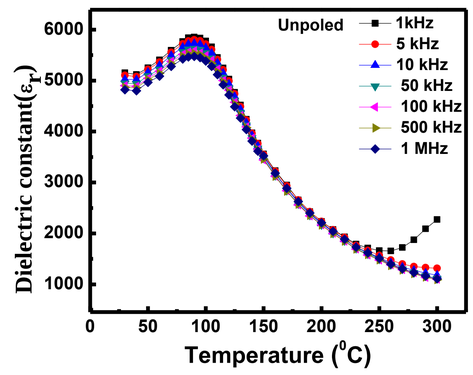


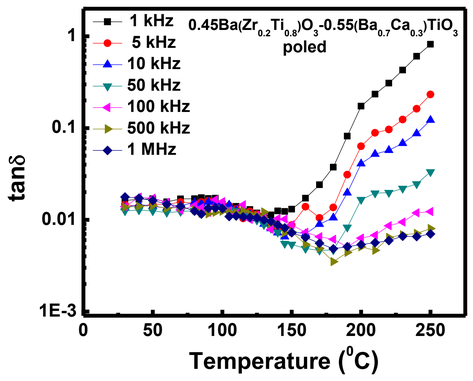
A well defined ferroelectric hysteresis loop is observed for both poled and unpoled sample. From P-E loop, the ferroelectric parameters are derived.



The I-V characteristic shows the similar behaviour for both positive and negative applied electric field.







- **The temperature dependent dielectric constant shows a transition from Ferroelectric to Paraelectric phase.**
- **For poled sample of 0.45BZT-0.55BCT, shows a higher dielectric constant around T_C as compare to unpoled sample.**

The dielectric loss for poled sample is nearly constant from room temperature to 150^{0}C.

Conclusions

- **0.45Ba($Zr_{0.2}Ti_{0.8}$)O_3-0.55($Ba_{0.7}Ca_{0.3}$)TiO_3 is synthesized by auto combustion technique and sintered using Microwave sintering technique.**
- **XRD pattern confirms the formation of single phase of compound at room temperature.**
- **The phase transition temperature of the poled sample (as determined from the dielectric versus temperature curve) is T_c~95^{0}C where as for unpoled sample T_c~89^{0}C. The poled sample shows a higher dielectric constant as compare to unpoled sample. From tangent loss curve, a low loss is observed around T_c i.e. tanδ<0.03.**
- **A saturated ferroelectric behaviour for both poled and unpoled samples is observed. Low coercive field is observed from PE loop.**
- **The I-V characteristic shows the symmetric behaviour for both poled and unpoled sample.**

References

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