Effect of Poling on Ferroelectric Properties and Leakage Current Behavior of $0.7Ba(Zr_{0.2}Ti_{0.8})O_3$-$0.3(Ba_{0.7}Ca_{0.3})TiO_3$ Lead Free Ceramics

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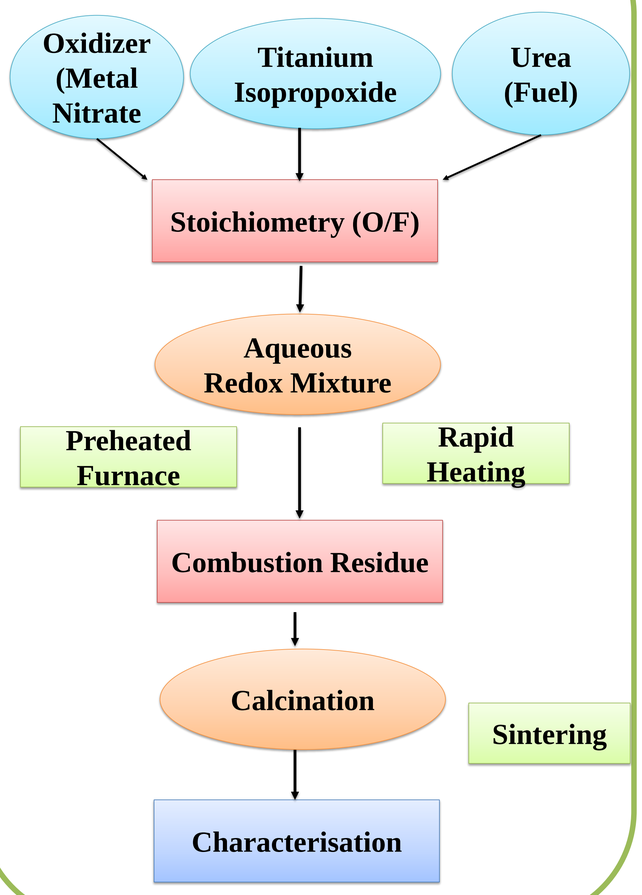
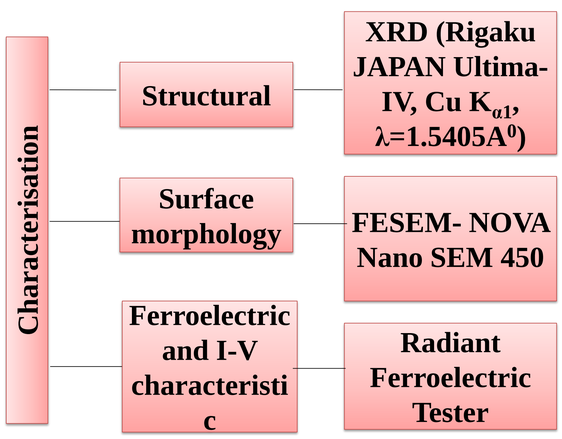
Introduction

- $BaTiO_3$ (BT) is one of the important ferroelectric material and its properties can be easily tailored by suitable modification on A-site and/or B-site [1]. It also doesn't contain any volatile element.
- Substitutions at the Ba-site or Ti-site of $BaTiO_3$ have a significant effect on the Curie temperature (T_c) and its electrical properties .
- The substitution of Ca increases the stability of the tetragonal phase and also helps in excluding the formation of the unwanted hexagonal phase of $BaTiO_3$ (BT) [2]. However, addition of Ca doesn't affect the Curie temperature of BT rather it lowers the polymorphic phase transition (PPT).
- The addition of Zr at the Ti-site increases the chemical stability of the material [3].
- A BT based solid solution, $0.7BaZr_{0.2}Ti_{0.8}O_3$-$0.3(Ba_{0.7}Ca_{0.3})TiO_3$ (BZT-BCT), has attracted great attention due to its high ferroelectric and piezoelectric properties.
- To improve the physical properties from application point of view, synthesis of high-quality stoichiometric ceramics powder at lower temperature synthesis conditions with improved microstructure is required.
- To get the desired piezo and ferroelectric properties for a polycrystalline material, electrical poling (E-poling) is one of the essential requirement.

Sample Preparation



Characterisation



Results and Discussion

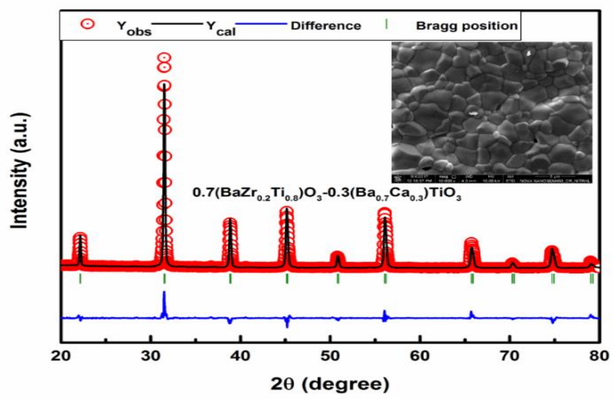


Fig. 1: XRD pattern shows the formation of single phase perovskite material. Rietveld refinement of XRD pattern shows rhombohedral structure with space group *R3m*(a=b=5.6770(3) Å, c=6.9509(6) Å, $\chi 2$=3.89). Inset figure shows the FESEM micrograph with dense microstructure.

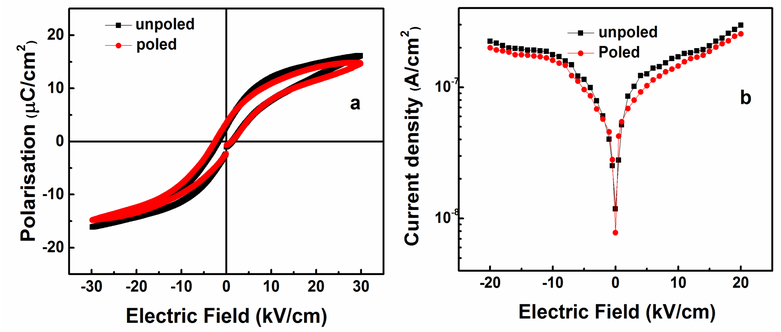


Fig. 2: (a) A well defined ferroelectric hysteresis loop is observed for both poled and unpoled sample. From P-E loop, the ferroelectric parameters are derived. (b) The I-V characteristic shows the similar behaviour for both positive and negative applied electric field.

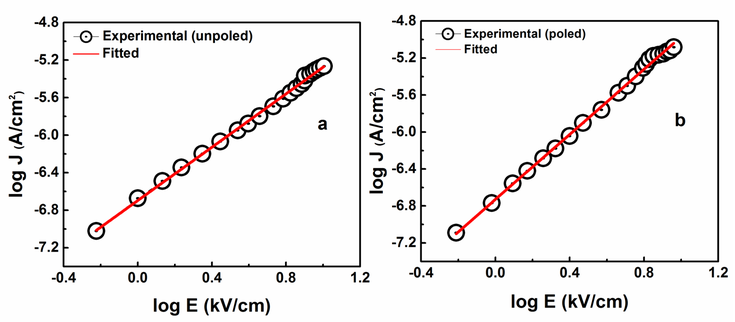


Fig. 3: The leakage current density of the materials obeys the space charge limited conduction (SCLC) mechanism for both poled and unpoled sample.

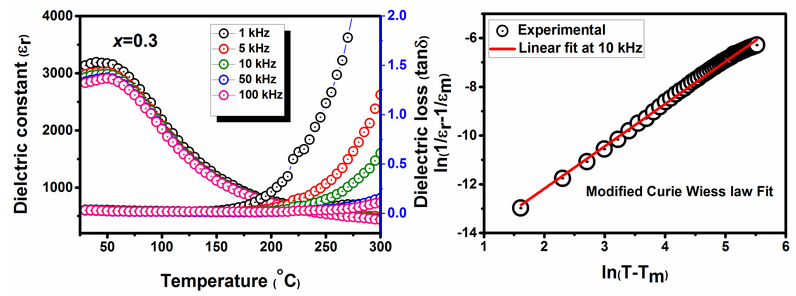


Fig. 4: (a) The temperature dependent dielectric constant shows a broad peak with a phase transition around 50 °C(b) Modified Curie Wiess law has been fitted . The value of γ=1.7.

Conclusions

- The auto combustion technique has been used to synthesized a single phase 0.7BZT-0.3BCT ceramics.
- The XRD pattern shows a single phase perovskite structure without any secondary phase. Rietveld refinement reveals that the material possess rhombohedral structure with space group *R3m.*
- A broad peak has been observed around Tc≈50°C from temp. dependent dielectric properties. Highly dense microstructure is formed with a grain size around 2 μm.
- Electrical poling improves the shape of the hysteresis loop and reduces leakage current.

Publication

1. Smaranika Dash *et al.*, J. Mater. Sci. Mater. Electron., 29[24] 20820 (2018).

References

1. J. Rodel *et al.*, J. Am. Ceram. Soc., 92 [6] 1153 (2009) .
2. T. Mazon, J. Appl. Phys. 97, 104113 (2005).
3. V. S. Puli, J. Phys. D: 44, 395403 (2011)

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