Page No.

Figure 1.1. A perovskite unit cell showing the off-centered titanium ion [Park & Shrout *et al.* (1997)]. 7

Figure 1.2. Atomic structure of $SrTiO_3$ a RT. [Marques (2009)]. 9

Figure 1.3. Atomic arrangements for the <100>, <110> and <111> axial direction in $SrTiO_3$ [Groot et al. (1989)]. 10

Figure 1.4. Schematic of the perovskite structure of $BaTiO_3$ (A) Cubic lattice (above Curie temperature, 120°C) (B) Tetragonal lattice (below Curie temperature, 120°C) [D. W.*Richerson, 1992*]. 13

Figure 1.5. Reversal in the direction of spontaneous polarization in $BaTiO_3$ by reversal of the direction of the applied field [Richerson (1992)]. 14

Figure 1.6. Crystal structure of CCTO compound [Subramanian *et al.* (2000)]. 16

Figure 1.7. Crystal structure of BCTO [Deng *et al.* (2017)]. 18

Figure 1.8. Polarized dielectric material [Seo *et al.* (2013)]. 27

Figure1.9. Typical response of the total polarizability of a crystal as a function of electric field Frequency [Singh *et al.* (2014)]. 30

Figure 1.10. Types of polarization mechanisms [Richerson, (1992), Rose *et al.*, (1971)]. 32

Figure 1.11. Simulated impedance spectroscopy (IS) data for two RC elements connected in series, presented in different formats: **(a)** Z" [Ω] vs frequency (f), **(b)** Z" [Ω] vs Z' [Ω] and **(c)** C' [Farad] vs frequency (f) Simulations were carried out with R_{Gb} = 10 MΩ, R_b = 1 MΩ, C_{Gb} = 10 pF and C_b = 1 pF. 38

Figure 1.12. Types of Magnatism. 41

Figure 1.13. Flow chart of Magnetism. 43

Figure 1.14. Ferromagnetic and Super paramagnetic. 48

Figure 2.1. Flow chart for the synthesis of materials by solid state route. 55

Figure 2.2. Powder XRD instrument, Rigaku Miniflex 600(Japan) 57

Figure 2.3. Braggs law of diffraction. 58

Figure 3.1. X-ray powder diffraction patterns of BTC nanocomposite sintered at 950 °C for (a) 3 h (b) 6 h (c) 9 h and (d) 12 h. 69

Figure 3.2. (a) Bright field TEM images and (b) SEAD pattern of BTC nanocomposite sintered at 950 °C for 12 h. 71

Figure 3.3. SEM micrographs of BTC nanocomposite sintered at 950 °C for (a) 3 h (b) 6 h (c) 9 h and (d) 12 h. 72

Figure 3.4. AFM images of BTC nanocomposite sintered at 950 °C for 12 h (a) 2 dimensional (b) 3D structure (c) depth histogram (d) bar diagram of particles size. 73

Figure 3.5. (a) Plots of the dielectric constant (ε_r) versus temperature and (b) tan δ versus temperature at 1 kHz for sintered at 950 °C for 3 h, 6 h, 9 h, 12 h. 75

Figure 3.6. (a) Plots of the dielectric constant (ε_r) versus frequency and (b) tan δ versus frequency at 50 °C for BTC nanocomposite sintered at 950 °C for 3 h, 6 h, 9 h and 12 h. 77

Figure 3.7. Plot of the AC conductivity vs. frequency at a temperature of 50 °C for BTC nanocomposite sintered at 950 °C for 3 h, 6 h, 9 h, and 12 h. 79

Figure 4.1 X-ray powder diffraction pattern of a CC-BT nanocomposite sintered at 950 °C for 12 h. 85

Figure 4.2. (a) Bright field TEM images, (b) SEAD pattern of a CC-BT nanocomposite sintered at 950 °C for 12 h. 86

Figure 4.3. SEM image of a CC-BT nanocomposite sintered at 950 °C for 12 h. 87

Figure 4.4. AFM images of CC-BT nanocomposite sintered at 950 °C for 12 h, (a) 2 dimensional, (b) 3D Structure, (c) bar diagram of particles size, (d) depth histogram. 88

Figure 4.5. (a) Variation of the dielectric constant (ε′), (b) dielectric loss (tan δ) with temperature for the CC-BT nanocomposite at a few selected frequencies**.** 89

Figure 4.6. (a) Variation of dielectric constant (ε′), (b) dielectric loss (tan δ) with frequency for the CC-BT nanocomposite at a few selected temperatures. 91

Figure 4.7. Impedance plane plots Z′ vs. frequency at a few selected temperatures of a CC-BT nanocomposite sintered at 950 °C for 12 h. 92

Figure 4.8. Impedance plane plots (Z′ vs. Z″) at a few selected temperatures of a CC-BT nanocomposite sintered at 950 °C for 12 h. 93

Figure 5.1. X-ray powder diffraction patterns of BT-BCT 5 nanocomposite sintered at 870 °C for (a) 4 h (b) 8 h (c) 12 h and (d) 16 h. 100

Figure 5.2. (a) Bright field TEM images and (b) SEAD pattern of BT-BCT 5 nanocomposite sintered at 870 °C for 12 h. 101

Figure 5.3. SEM micrographs of BT-BCT 5 nanocomposite sintered at 870 °C for (a) 4 h (b) 8 h (c) 12 h and (d) 16 h. 102

Figure 5.4. AFM images of BT-BCT 5 nanocomposite sintered at 870 °C for 12 h (a) 2 dimensional (b) 3D structure (c) depth histogram (d) bar diagram of particles size. 103

Figure 5.5. Plots of the dielectric constant (ε_r) versus temperature (T) of BT-BCT 5 nanocomposite sintered at 870 °C for (a) 4 h (b) 8 h (c) 12 h and (d) 16 h. 104

Figure 5.6. Plots of dielectric loss (tan δ) versus Temperature (T) of BT-BCT 5 nanocomposite sintered at 870 °C for (a) 4 h (b) 8 h (c) 12 h and (d) 16 h. 106

Figure 5.7. Plots of dielectric constant (ε_r) versus Frequency of BT-BCT nanocomposite sintered at 870 °C for (a) 4 h (b) 8 h (c) 12 h and (d) 16 h. 106

Figure 5.8. Plots of dielectric loss (tan δ) versus Frequency of BT-BCT 5 nanocomposite sintered at 870 °C for (a) 4 h (b) 8 h (c) 12 h and (d) 16 h. 108

Figure 6.1. X-ray powder diffraction pattern of a BC-BT nanocomposite sintered at 870 °C for (a) 4 h (b) 8 h (c) 12 h and (d) 16 h. 115

Figure 6.2(a) Bright field TEM images and **(b)** SEAD pattern of a BC-BT nanocomposite sintered at 870 °C for 12 h. 116

Figure 6.3. SEM image of a BC-BT nanocomposite sintered at 870 °C for (a) 4 h (b) 8 h (c) 12 h and (d) 16 h. 117

Figure 6.4. AFM images of BC-BT nanocomposite sintered at 870 °C for 12 h (a) 2 dimensional (b) 3D Structure (c) bar diagram of particles size (d) depth histogram. 119

Figure 6.5. (a) Temperature-dependent zero field cooled (ZFC) and field cooled (FC)magnetization measured at H=100 Oe, (b) magnetization (M) versus applied field (H) for the BC-BT composite ceramic. 121

Figure 6.6. (a) Variation of the dielectric constant (ε') and (b) tan δ with temperature of BC-BT nanocomposite at 1 kHz for sintered at 870 °C for 4 h, 8 h, 12 h and 16 h. 123

Figure 6.7. (a) Variation of the dielectric constant (ε') and (b) tan δ with frequency of BC-BT nanocomposite at 50 °C for sintered at 870 °C for 4 h, 8 h, 12 h and 16 h. 124

Figure 6.8. Plot of AC conductivity (σ_{AC}) vs. frequency at selected durations of BC-BT nanocomposite at 50 °C for sintered at 870 °C for 12 h. 126

Figure 6.9. Impedance plane plots (Z' vs. Z'') and inset shows the expanded view of impedance plane plots (Z' vs. Z'') of the 12 h sintered close to the origin of BC-BT nanocomposite sintered sat 870 °C for 4 h, 8 h, 12 h and 16 h at 50 °C. 128