

LIST OF FIGURES

Figure 1.1:	Representation of energy bands	1
Figure 1.2:	Different material insulators (a) porcelain, (b) glass and (c) polymer insulator	2
Figure 1.3:	Porcelain insulators which provide insulation between the iron cap and steel.	3
Figure 1.4:	Location of different ceramics materials in the feldspar-quartz-clay Triaxial diagram	6
Figure 1.5:	Pin type insulator.	7
Figure 1.6:	Suspension type insulators.	8
Figure 1.7:	Strain type insulators	9
Figure 1.8:	Graph for temperature dependent resistance of the material.	9
Figure 1.9:	Factors involved in aging ceramic porcelain insulator.	10
Figure 1.10:	Different application of thermal insulator.	12
Figure 1.11:	Materials for sound insulators	13
Figure 1.12:	Electrical Porcelain insulator application	14
Figure 2.1:	Electronic balance for weight measurements of the powder materials.	25
Figure 2.2:	China crucible.	26
Figure 2.3:	Electrical oven	27
Figure 2.4:	Hydraulic press machine	28
Figure 2.5:	Electric silicon carbide furnace.	29
Figure 2.6:	X-ray powder diffraction (XRD) instrument.	30
Figure 2.7:	SEM/EDAX Analysis instrument.	32
Figure 2.8:	Water bath machine.	33
Figure 2.9:	Universal testing machine	34

Figure 2.10:	Force applied to a sample from both sides.	36
Figure 2.11:	Three-point flexural or bending test technique.	37
Figure 2.12:	Dilatometer used for measurement of thermal expansion of the sample.	38
Figure 2.13:	Voltage breakdown insulation test (1 to 150 KV).	39
Figure 2.14:	Novo control Alpha-A Frequency Analyzer with the furnace and the required interfaces.	40
Figure 2.15:	An instrument vector network analyzer used for measuring dielectric constant and loss tangent at a microwave frequency (1-20 GHz).	40
Figure 3.1:	Different shapes samples prepared using hydraulic press machine at 160 MPa load with holding time of 10 minute.	45
Figure 3.2:	The XRD patterns of a different samples code composition containing (0 to 20) wt. % SiO ₂ sintered at 1250 and 1350°C	47
Figure 3.3:	SEM/EDAX analysis of different composition sintered at different temperature, (a) At 1250°C and (b) at 1350°C	49
Figure 3.4:	Graph between B.D (in gm/cc), A.P (in %), with content of silica (0 to 20 wt. %) of different samples composition sintered at 1250 and 1350°C with soaking period for 2 hour.	51
Figure 3.5:	Graph between L.S (in %) and W.A (in %) with content of silica (0 to 20 wt. %) of different samples composition sintered at 1250 and 1350°C with soaking period for 2 hour.	52
Figure 3.6:	Relation between bending, tensile strength vs % content of silica.	54
Figure 3.7:	Graph between compressive strength v/s % content of silica.	55
Figure 3.8:	Thermal expansion behavior of the samples (A1, A2, A3, A4 and A5) sintered at different temperature.	56
Figure 3.9:	Behavior of AC dielectric constant and loss value of different composition (A1, A2, A3, A4 and A5) with temperature variation up to 300°C at different frequencies (1 kHz, 100 kHz, and 1 MHz).	58
Figure 3.10:	AC Dielectric constant and dielectric loss (loss tangent) versus frequency (GHz) at room temperature (30°C) is investigated for different sintered compositions.	60
Figure 3.11:	Show the graph for dielectric strength with zirconia	61

	concentration.	
Figure 4.1:	Different shapes Samples sintered at different temperature (a) 1250°C and (b) 1350°C at the rate of 5°C/min with the soaking period for 2 hours.	66
Figure 4.2:	An instrument Impedance network analyzer used for measuring electrical characterization at operation frequency (20 Hz to 1MHz).	69
Figure 4.3:	Schematic diagram for AC dielectric strength measurements.	71
Figure 4.4:	DTA/TGA curves of different samples with heating rate of 50°C/min (a) Sample S1 and (b) Sample S4	72
Figure 4.5:	The XRD patterns of a different sample containing (0 to 30) wt. % ZrO ₂ sintered at 1250 and 1350°C (where t-tetragonal and m-monoclinic).	75
Figure 4.6:	SEM/EDAX analysis of different samples sintered at different temperatures with soaking time for 2 hours. (a) 1250°C and (b) 1350°C (where S1 = 0, S2 = 10, S3 = 20 and S4= 30 wt. % ZrO ₂).	77
Figure 4.7:	Graph of Linear thermal expansion coefficient for different sintered samples with temperature.	78
Figure 4.8:	Graph between B.D (in gm/cc), A.P (in %), and W.A (in %) with the content of zirconia (0 to 30%) of different samples composition sintered at 1250 and 1350°C with soaking time for 2 hours.	79
Figure 4.9:	Modulus of rupture (MOR) and compressive strength on the addition of zirconia (in wt. %).	81
Figure 4.10:	Variation of tensile strength with the Zirconia (wt. %) content.	83
Figure 4.11:	Dielectric constant and dielectric loss versus frequency variation (Hz to MHz) at room temperature (30°C) is investigated for different samples sintered at 1350°C.	84
Figure 4.12:	Dielectric loss factor (ϵ'') versus frequency for the samples sintered at 1350°C.	85
Figure 4.13:	AC electrical resistivity and conductivity versus frequency (in Hz) for all the sample sintered at 1350°C.	86
Figure 4.14:	Dielectric constant and dielectric loss versus frequency (GHz) at room temperature (30°C) is investigated for different samples sintered at 1350°C.	89

Figure 4.15:	Dielectric constant and dielectric loss versus temperature (30 to 190°C) is investigated for different samples sintered at 1350°C (a) For 5GHz and (b) 20 GHz.	90
Figure 4.16:	Show the graph for dielectric strength with zirconia content.	91
Figure 5. 1:	Prepared samples of different compositions sintered at 1350°C with their batch codes.	97
Figure 5. 2:	XRD pattern of samples (D1, D2, D3, D4 and D5) sintered at 1350°C.	101
Figure 5. 3:	SEM micrograph of the different samples (D1, D2, D3, D4 and D5) was investigated.	103
Figure 5. 4:	Variation of the coefficient of thermal expansion with temperature after addition of zirconia (0 to 10 wt. %) content in porcelain composition.	105
Figure 5. 5:	Graph between B.D (in g/cc), A.P (in %), L.S (in %), W.L (in %) and W.A (in %) with content of zirconia (0–10 wt. %) sintered at 1350°C with soaking period for 2 hours.	108
Figure 5. 6:	Graph between B.S, T.S and C.S (in MPa) versus zirconia wt. %, for the samples sintered at 1350°C.	109
Figure 5. 7:	Dielectric constant (ϵ') and loss versus frequency (in Hz) for all the sample sintered at 1350°C (where notation $k \sim 10^3$ and $M \sim 10^6$).	110
Figure 5. 8:	Resistivity and conductivity versus frequency (in Hz) for all the sample sintered at 1350°C (where notation $k \sim 10^3$ and $M \sim 10^6$).	111
Figure 5. 9:	Ac dielectric and loss analysis at microwave frequency with frequency variation up to 20 GHz.	115
Figure 5. 10:	Ac dielectric and loss tangent analysis at microwave frequency with temperature variation (50°C, 150°C and 200°C).	117
Figure 5. 11:	Show the graph for dielectric strength with zirconia content	119
Figure 6. 1:	Prepared samples of different compositions sintered at 1350°C.	125
Figure 6. 2:	XRD pattern of samples (E1, E2, E3, and E4) sintered at 1350°C.	128
Figure 6.3:	SEM micrograph of the different samples (E1, E2, E3 and E4) was investigated.	130
Figure 6.4:	Variation of the coefficient of thermal expansion with temperature after addition of BaTiO ₃ (0 to 2 wt. %) content in	131

	porcelain composition.	
Figure 6. 5:	Physical behavior testing of the different sintered samples at 1350 °C.	133
Figure 6. 6:	Graph between B.S, T.S (in MPa) versus BaTiO ₃ wt. %, for the samples sintered at 1350°C.	135
Figure 6. 7:	Graph of C.S (in MPa) versus BaTiO ₃ wt. %, for the samples sintered at 1350°C.	135
Figure 6. 8:	Graph between dielectric constant and loss with frequency (1Hz to 1 MHz).	137
Figure 6. 9:	Resistivity or specific resistance and conductivity versus frequency (in Hz) for all the sample sintered at 1350°C.	139
Figure 6. 10:	AC Dielectric permittivity versus frequency (GHz) variation of sintered samples investigated at room temperature.	140
Figure 6. 11:	AC dielectric loss (loss tangent) versus frequency (GHz) variation of sintered samples investigated at room temperature.	140
Figure 6. 12:	Show the graph for dielectric strength with BaTiO ₃ concentration.	141