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http://www.azom.com

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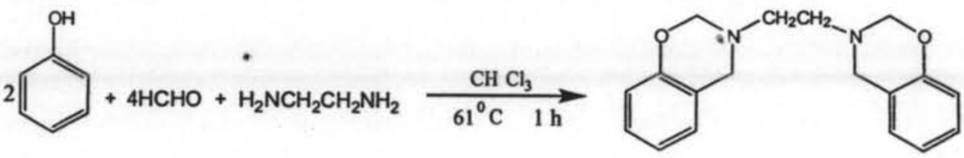
APPENDICES

Appendix A % yield of Benzoxazazine Monomer Calculation



Mole	0.06	0.12	0.03	0.03
M.W.	94	30	60	296
Weight	5.64	3.6	-	8.88
Vol.	-	-	2.007	-

Weight of monomer product = X g

$$\% \text{ yield} = \frac{X}{8.88} \times 100$$

$$\% \text{ yield} = Y \%$$

Table A1 Experimental data of precursors for benzoxazine synthesis

	Precursors			Product	Reaction time
	Phenol	Chloroform	Ethylenediamine	Diamine-based benzoxazine	
Mole	0.06	0.12	0.03	0.03	1 hour
Weight(g)	5.64	3.6	-	8.8	
Volume(ml)	-	-	2.007	-	

Table A2 Experimental data of precursors for benzoxazine synthesis

	Precursors			Product	Reaction time
	Phenol	Chloroform	Ethylenediamine	Diamine-based benzoxazine	
Mole	0.12	0.24	0.06	0.06	Half an hour
Weight(g)	11.28	7.2	-	17.76	
Volume(ml)	-	-	4.014	-	

Table A3 Experimental data of precursors for benzoxazine synthesis

	Precursors			Product	Reaction time
	Phenol	Chloroform	Ethylenediamine	Diamine-based benzoxazine	
Mole	0.18	0.36	0.09	0.09	15 minutes
Weight(g)	16.2	10.8	-	26.64	
Volume(ml)	-	-	6.021	-	

Appendix B Preparation of $Ba_{1-x}Sr_xTiO_3$ by Sol-Gel Process

Precursor materials

1. Barium acetate $Ba(CH_3COO)_2$, d = 2.468 g/cm^3
2. Strontium acetate $Sr(CH_3COO)_2$
3. Titanium tetra-n-butoxide $[(CH_3(CH_2)_3O)_4Ti$, d = 0.998 g/cm3
4. Methanol
5. Glacial acetic acid

Calculation of $Ba_{0.95}Sr_{0.05}TiO_3$

a. Barium acetate M.W. = 225, n = 0.95

g = M.W. x n = 255 x (0.95) = 242.25

- Strontium acetate M.W. = 206, n = 0.05

g = M.W. x n = 206 x (0.05) = 10.3

- Titanium tetra-n-butoxide M.W. = 340, n= 1, d = 0.998 g/cm^3

g = M.W. x n = 340 x (1) = 340

$$V = \frac{mass}{density} = \frac{340}{0.998}\frac{g}{cm^3} = 340.68 \ cm^3$$

From x = 0.05

Barium acetate	= 242.25 g
Strontium acetate	= 10.3 g
Titanium tetra-n-butoxide	= 340 g or 340.68 cm^3
Total weight	= 592.55 g

(% 47.404, Reduce to)

Total weight	= 12.5 g
Then	
Barium acetate	= 5.1103 g
Strontium acetate	= 0.2173 g
Titanium tetra-n-butoxide	= 7.1724 g or 7.1868 cm^3

Calculation of $BaTiO_3$

b. Barium acetate M.W. = 225, n = 1

g = M.W. x n = 255 x (1) = 255

- Titanium tetra-n-butoxide M.W. = 340, n= 1, d = 0.998 g/cm^3

g = M.W. x n = 340 x (1) = 340

$$V = \frac{mass}{density} = \frac{340}{0.998} \frac{g}{cm^3} = 340.68 \ cm^3$$

Then

Barium acetate	= 255 g
Titanium tetra-n-butoxide	= 340 g or 340.68 cm^3
Total weight	= 595 g

(% 47.404, Reduce to)

Total weight	= 12.55 g
Then	
Barium acetate	= 5.3793 g
Titanium tetra-n-butoxide	= 7.1724 g or 7.1868 cm^3

Table B1 Experimental data of precursors for barium strontium titanate synthesis

	Barium acetate	Strontium acetate	Titanium tetra-n-butoxide
$BaTiO_3$	5.3800g	-	7.20ml
$(Ba_{0.95}Sr_{0.05})TiO_3$	5.1103g	0.2173g	7.20ml
$(Ba_{0.70}Sr_{0.30})TiO_3$	4.4600g	1.5400g	8.52ml
$(Ba_{0.50}Sr_{0.50})TiO_3$	3.1875g	2.575g	8.50ml

Appendix C Dielectric Measurement

Calculation: Dielectric constant

$$C = \frac{K\varepsilon_o A}{t}$$

C = Capacitance (F)

K = Dielectric constant

ε_o = 8.8542 x 10^{-12} F/m

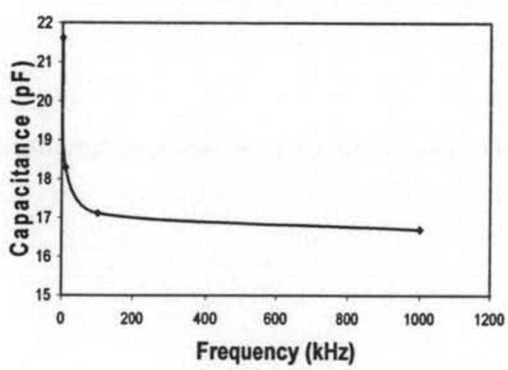
A = Area (m^2)

t = Thickness (m)

Barium Titanate

Table C1 Capacitance and dielectric constant of barium titanate

Frequency (kHz)	Cp (pF)	K
1	21.612	27.38406
10	18.292	23.17737
100	17.112	21.68222
100	16.699	21.15892



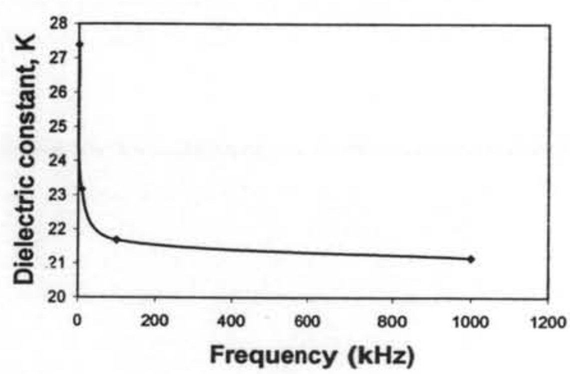


Figure C1 Capacitance and dielectric constant of barium titanate.

Barium Strontium Titanate

1. $(Ba_{0.95}Sr_{0.05})TiO_3$

Table C2 Capacitance and dielectric constant of $(Ba_{0.95}Sr_{0.05})TiO_3$

Frequency (kHz)	Cp (pF)	K
1	675	598.6787
10	658	583.6008
100	644	571.1838
100	636	564.0884

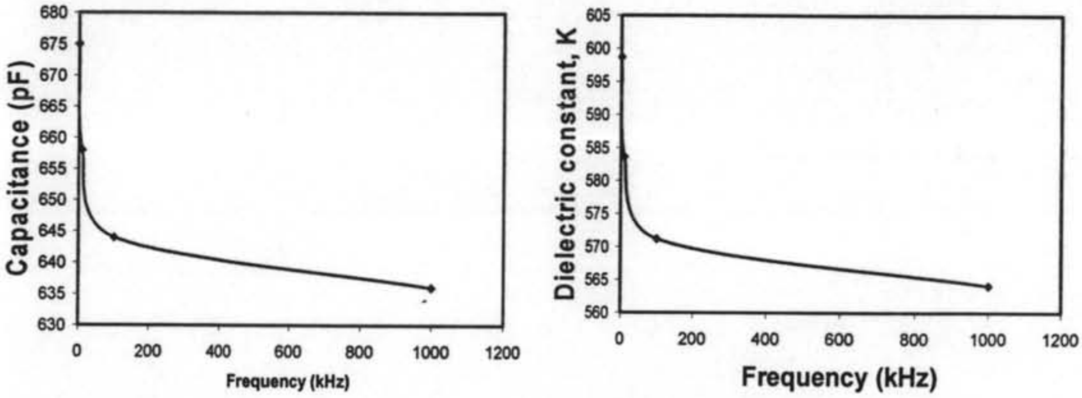


Figure C2 Capacitance and dielectric constant of $(Ba_{0.95}Sr_{0.05})TiO_3$.

2. $(Ba_{0.70}Sr_{0.30})TiO_3$

Table C3 Capacitance and dielectric constant of $(Ba_{0.70}Sr_{0.30})TiO_3$

Frequency (kHz)	Cp (nF)	K
1	2.26	3935.161
10	2.07	3680.517
100	1.95	3472.405
100	1.88	3309.127

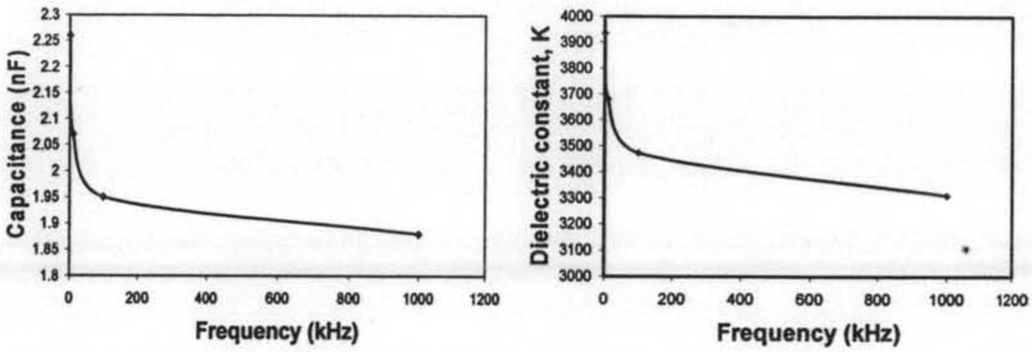


Figure C3 Capacitance and dielectric constant of $(Ba_{0.70}Sr_{0.30})TiO_3$.

3. $(Ba_{0.50}Sr_{0.50})TiO_3$

Table C4 Capacitance and dielectric constant of $(Ba_{0.50}Sr_{0.50})TiO_3$

Frequency (kHz)	Cp (nF)	K
1	1.129	1645.676
10	1.125	1639.845
100	1.123	1636.93
100	1.124	1638.388

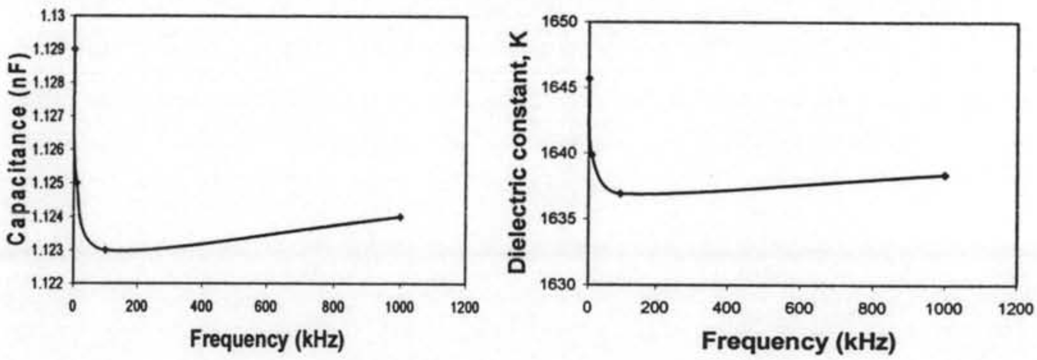


Figure C4 Capacitance and dielectric constant of $(Ba_{0.50}Sr_{0.50})TiO_3$.

Polybenzoxazine

Table C5 Capacitance and dielectric constant of Polybenzoxazine

Frequency (kHz)	Cp (pF)	K
1	21.612	9.75296
10	18.292	7.97394
100	17.112	7.90854
100	16.699	8.14232

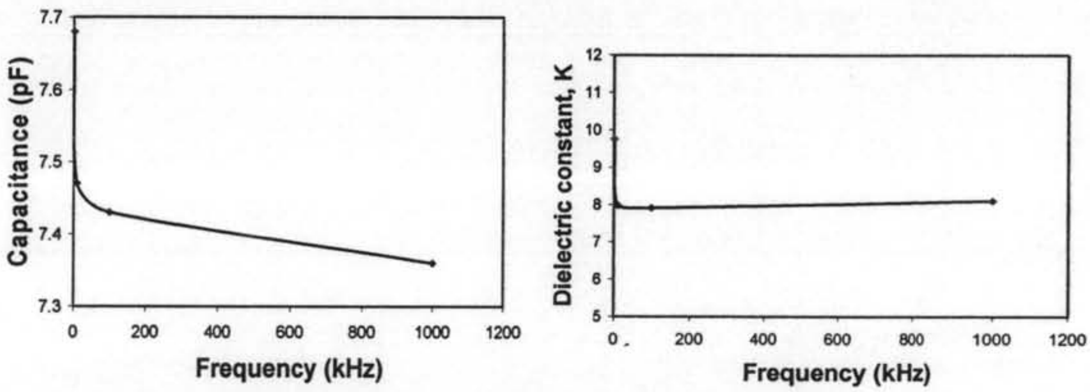


Figure C4 Capacitance and dielectric constant of Polybenzoxazine.

Composites

1. 1% Barium titanate + polybenzoxazine

Table C6 Capacitance and dielectric constant of 1% Barium titanate + polybenzoxazine

Frequency (kHz)	Cp (pF)	K
1	9.55	7.991884
10	8.99	10.48535
100	8.75	9.946239
100	8.62	8.183689

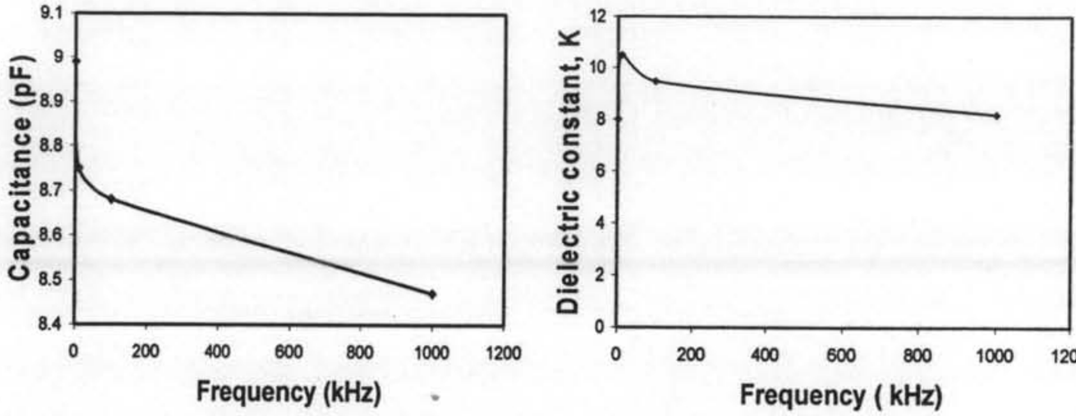


Figure C6 Capacitance and dielectric constant of 1% Barium titanate + polybenzoxazine.

2. 5% Barium titanate + polybenzoxazine

Table C7 Capacitance and dielectric constant of 5% Barium titanate + polybenzoxazine

Frequency (kHz)	Cp (pF)	K
1	12.41	14.29408
10	12.10	9.741065
100	11.89	10.41368
100	11.72	9.065425

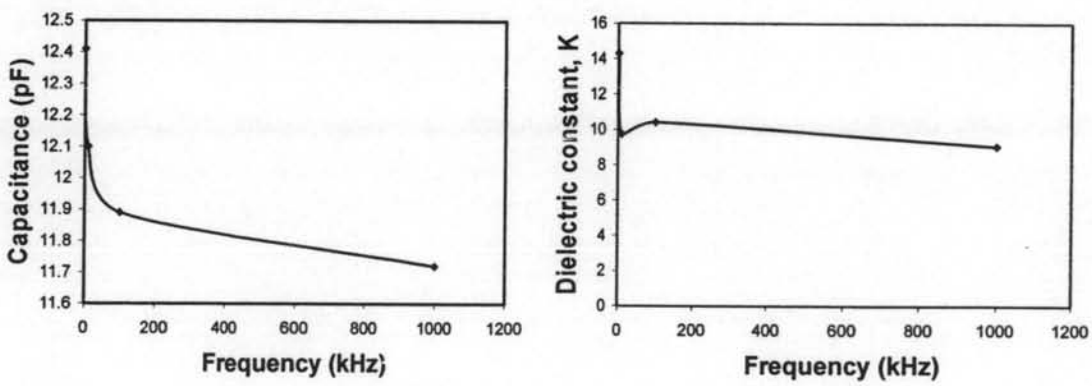


Figure C7 Capacitance and dielectric constant of 5% Barium titanate + polybenzoxazine.

3. 1% $(Ba_{0.50}Sr_{0.50})TiO_3$ + polybenzoxazine

Table C10 Capacitance and dielectric constant of 1% $(Ba_{0.50}Sr_{0.50})TiO_3$ + polybenzoxazine

Frequency (kHz)	Cp (pF)	K
1	7.41	9.01464
10	7.23	10.06513
100	7.18	8.016328
100	7.125	7.042963

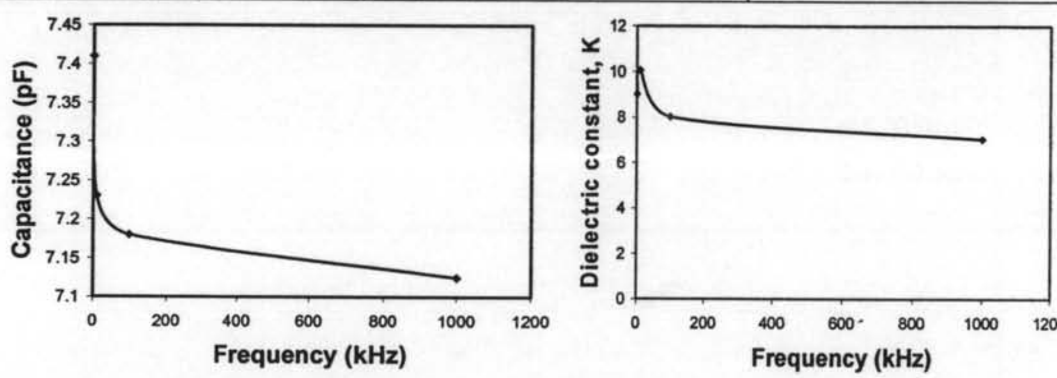


Figure C10 Capacitance and dielectric constant of 1% $(Ba_{0.50}Sr_{0.50})TiO_3$ + polybenzoxazine.

4. 5% $(Ba_{0.50}Sr_{0.50})TiO_3$ + polybenzoxazine

Table C11 Capacitance and dielectric constant of 5% $(Ba_{0.50}Sr_{0.50})TiO_3$ + polybenzoxazine

Frequency (kHz)	Cp (pF)	K
1	12.464	14.22273
10	12.328	9.790319
100	12.231	10.36825
100	12.155	9.094928

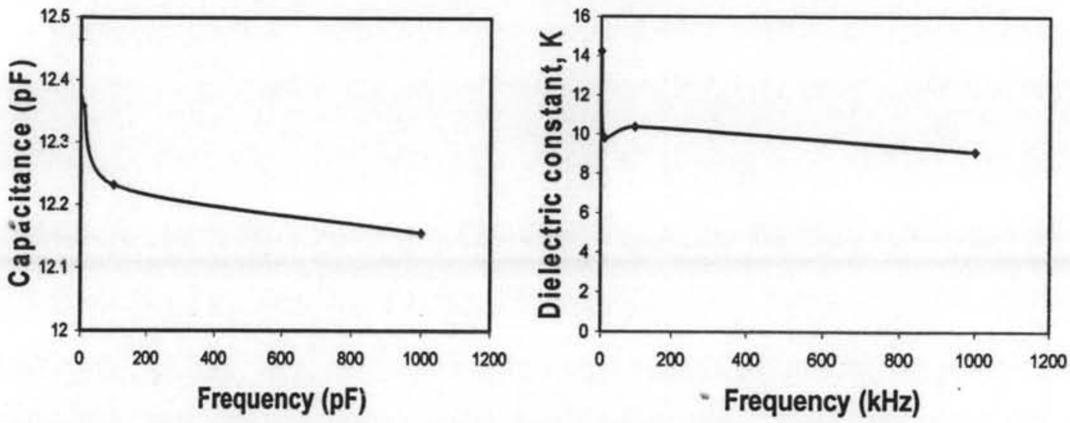


Figure C11 Capacitance and dielectric constant of 5% $(Ba_{0.50}Sr_{0.50})TiO_3$ + Polybenzoxazine.

Appendix D Microstructures of Ceramics.

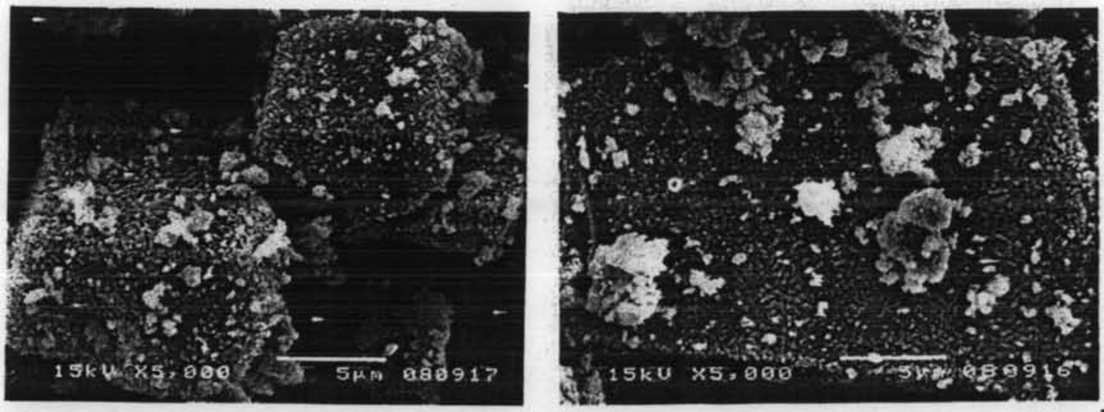


Figure D1 SEM images of $BaTiO_3$ after sol-gel process at 800°C.

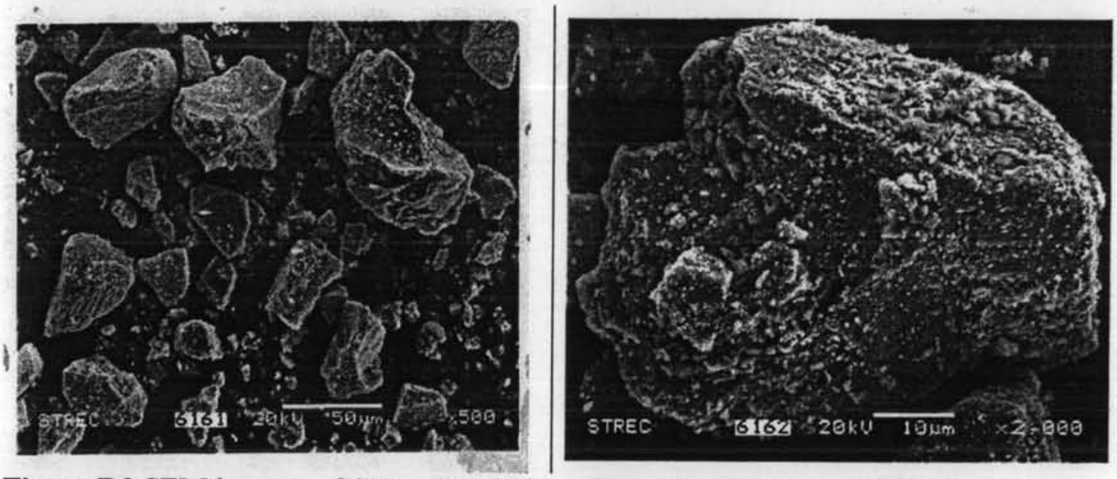


Figure D2 SEM images of $(Ba_{0.95}Sr_{0.05})TiO_3$ after sol-gel process at 800°C.

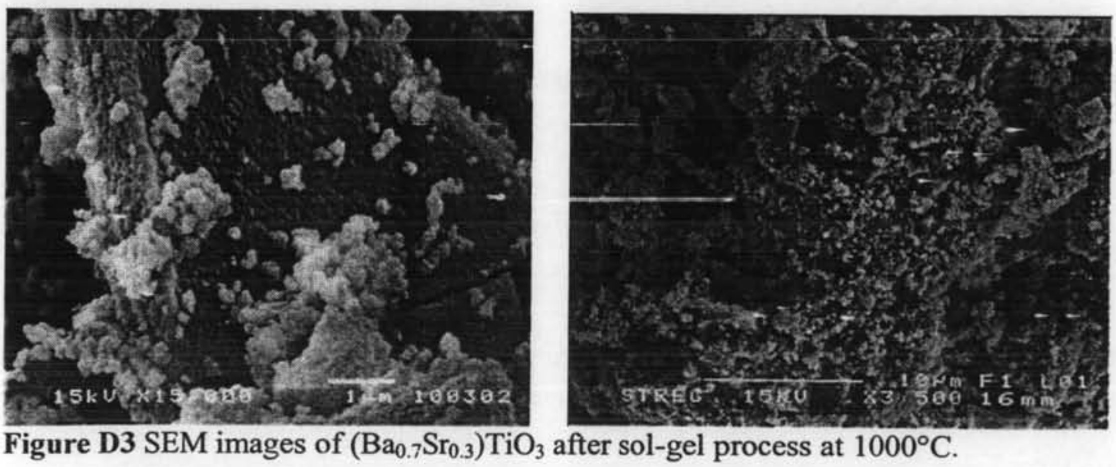


Figure D3 SEM images of $(Ba_{0.7}Sr_{0.3})TiO_3$ after sol-gel process at 1000°C.

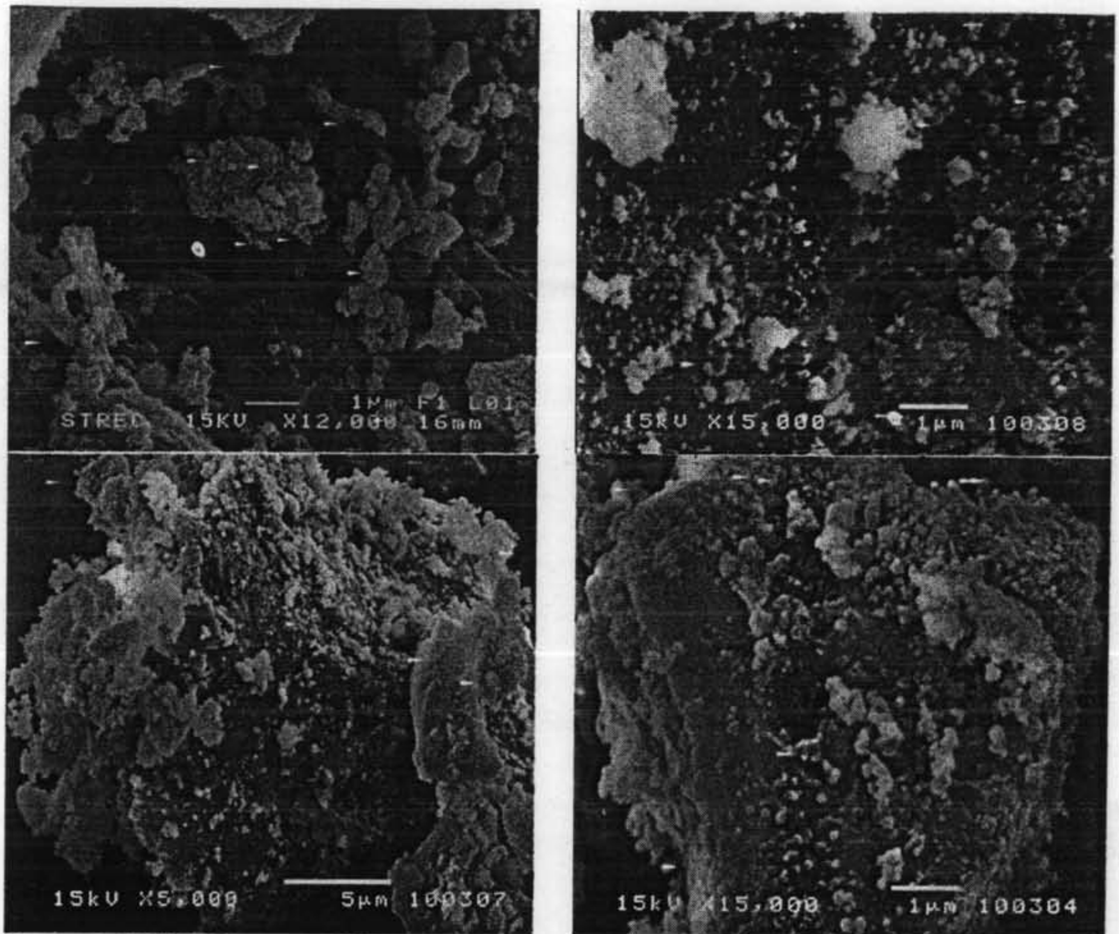


Figure D4 SEM images of $(Ba_{0.5}Sr_{0.5})TiO_3$ after sol-gel process at 1000°C.

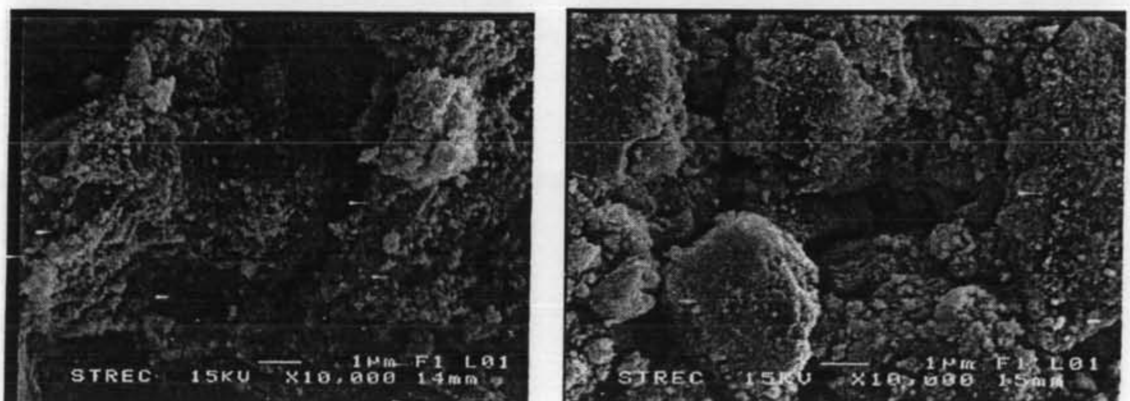


Figure D5 SEM images of $BaTiO_3$ after sintering process at 1200°C.

Figure D6 SEM images of $(Ba_{0.95}Sr_{0.05})TiO_3$ after sintering process at 1200°C.

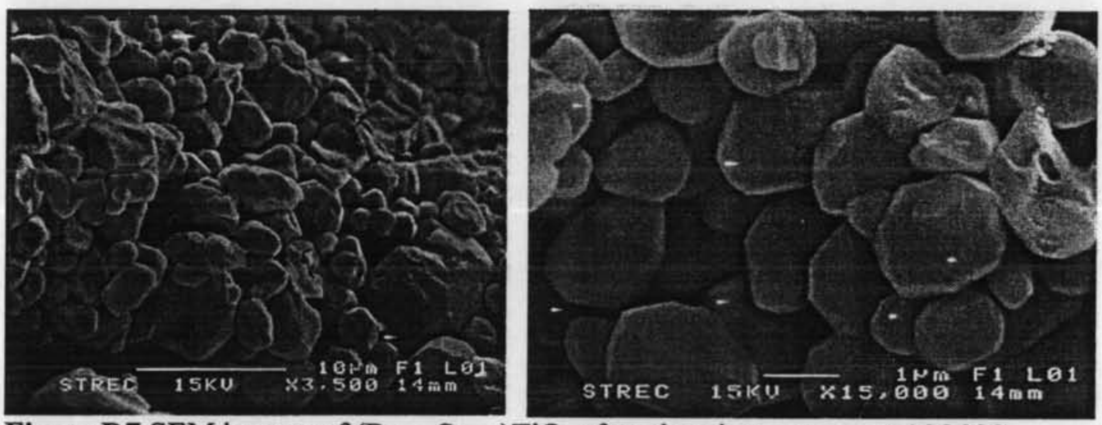


Figure D7 SEM images of $(Ba_{0.95}Sr_{0.05})TiO_3$ after sintering process at 1330°C.

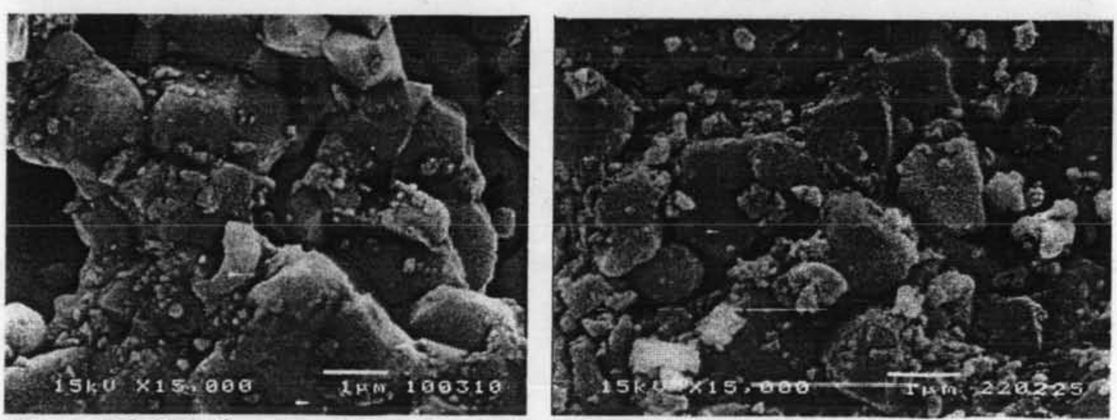


Figure D8 SEM images of $(Ba_{0.7}Sr_{0.3})TiO_3$ after sintering process at 1330°C.

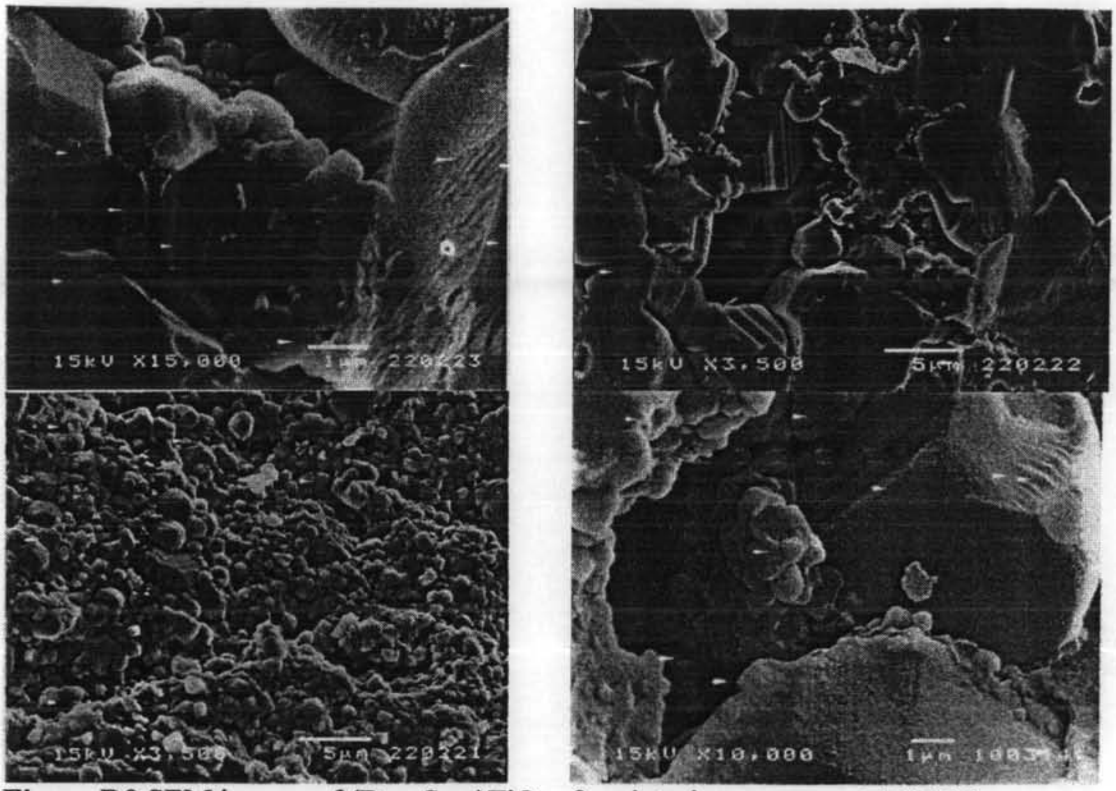


Figure D9 SEM images of $(Ba_{0.5}Sr_{0.5})TiO_3$ after sintering process at 1330°C.

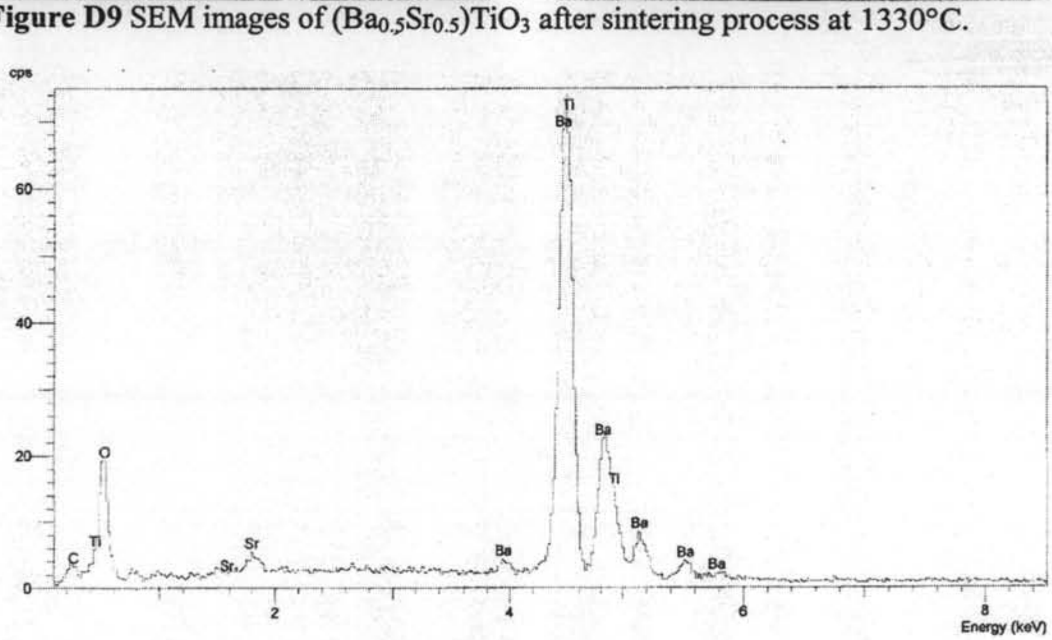


Figure D10 EDS spectrum of $(Ba_{0.95}Sr_{0.05})TiO_3$.

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