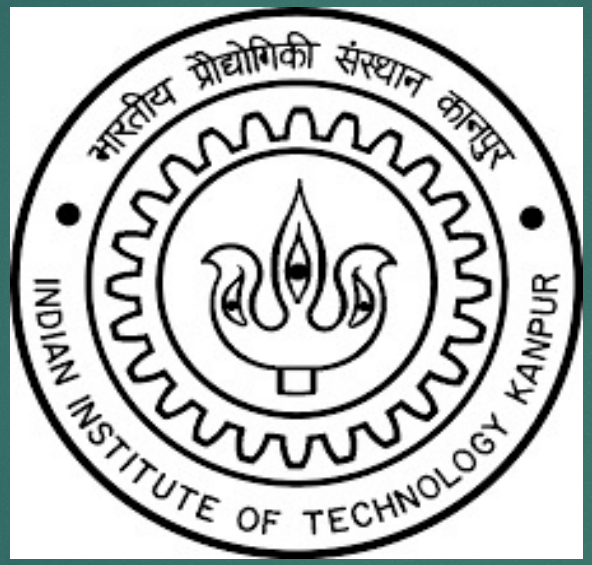
Experiment-4
Dielectric Behavior of Barium Titanate



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Objective

To study the dielectric behaviour of Barium Titanate upon its phase transformation with heating and cooling cycles and calculate its Curie temperature.

Experiment Design

The dielectric behaviour of $BaTiO_3$ changes upon phase transition from Cubic to Tetragonal or vice versa. To achieve this, vary the temperature and note down the values of capacitance and after a temperature the capacitance trend starts to change. This change in dielectric behaviour at a temperature is the Curie temperature.

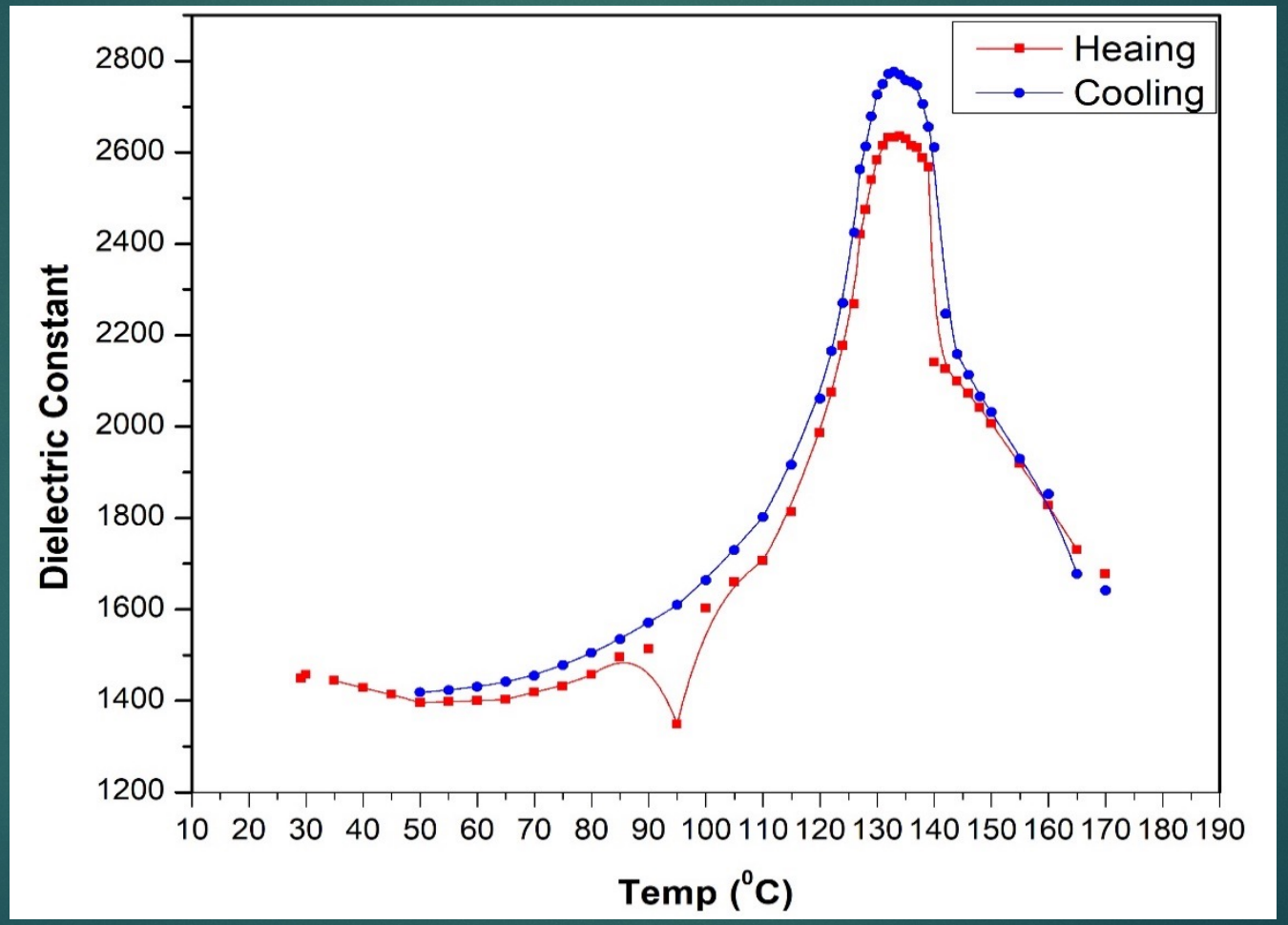
Dielectric Constant unit

PID Oven

Test Data obtained at Lab

Temperature (^{0}C)	Capacitance (pF)	Dielectric constant	Capacitance during cooling	Dielectric constant
29.1	638	1448.26		
30	642	1457.34		
35	636	1443.72		
40	629	1427.83		
45	623	1414.21		
50	615	1396.05	625	1418.75
55	616	1398.32	627	1423.29
60	617	1400.59	630	1430.1
65	618	1402.86	635	1441.45
70	625	1418.75	641	1455.07
75	631	1432.37	651	1477.77
80	642	1457.34	663	1505.01
85	659	1495.93	676	1534.52
90	667	1514.09	692	1570.84
95	594	1348.38	709	1609.43
100	706	1602.62	733	1663.91
105	731	1659.37	762	1729.74
110	752	1707.04	794	1802.38
115	799	1813.73	844	1915.88
120	875	1986.25	908	2061.16
122	914	2074.78	954	2165.58
124	959	2176.93	1000	2270
126	999	2267.73	1068	2424.36
127	1066	2419.82	1129	2562.83
128	1090	2474.3	1151	2612.77
129	1119	2540.13	1180	2678.6
130	1138	2583.26	1201	2726.27
131	1152	2615.04	1211	2748.97
132	1160	2633.2	1221	2771.67
133	1160	2633.2	1223	2776.21
134	1161	2635.47	1220	2769.4
135	1158	2628.66	1215	2758.05
136	1152	2615.04	1213	2753.51
137	1150	2610.5	1210	2746.7
138	1140	2587.8	1192	2705.84
139	1131	2567.37	1170	2655.9
140	943	2140.61	1150	2610.5
142	937	2126.99	990	2247.3
144	925	2099.75	951	2158.77
146	913	2072.51	931	2113.37
148	899	2040.73	910	2065.7
150	884	2006.68	895	2031.65
155	845	1918.15	850	1929.5
160	805	1827.35	816	1852.32
165	762	1729.74	739	1677.35

Dielectric constant VS Temperature



Result

The transition in the Capacitance is observed at 134^0C upon heating and 133^0C upon cooling. The curie temperature from this temperature is approximately

$\frac{134 + 133}{2} = 133.5^0 C.$

Therefore, $BaTiO_3$ has a phase transition temperature at around 133^0C

Discussions:

Theoretical Curie temperature of $BaTiO_3$ is 120^0C but the experimental is at 134^0C. This difference in the Curie temperature is may be due to

- Impurities present in the sample changes the curie temperature.
- Variations in the applied electric field
- Inherent errors in setting the temperature which leads to the non-equilibrium temperature between the metal contact and the $BaTiO_3$.

Thank you