CL55_Q1. What are Ferro electric materials? How do polarizations change with temperature in a Ferro electric material?

Ans:

Ferroelectrics are a class of non-centro symmetric crystals which are also a subclass of the pyro electric / piezoelectric materials. These materials show a spontaneous polarization even in the absence of an electric field.

The spontaneous polarization observed in ferroelectric materials depends on the crystalline phase of the material. The dielectric susceptibility of the material is highly temperature dependent and is given by $\chi = \frac{C}{T-T_c}$, for all $T>T_c$ where C is a constant dependent on the material and T_c is the curie temperature. At temperature below T_c, the material shows spontaneous polarization and is classified as a ferroelectric material. At temperatures greater than T_c, the material is para electric with the susceptibility inversely proportional to temperature

CL55_Q2. Discuss the polarization mechanism in Pyroelectric materials.

Ans:

Pyroelectricity is the ability of certain materials to generate an electrical potential when they are heated or cooled. Non centro-symmetric crystals with a net spontaneous polarization can be sensitive to external temperatures.

The change in temperature modifies the positions of the atoms slightly within the crystal structure, such that the polarization of the material changes. This polarization change gives rise to a voltage across the crystal. If the temperature stays constant at its new value, the Pyroelectric voltage gradually disappears due to leakage current The Pyroelectric coefficient may be described as the change in the spontaneous polarization vector P_s with temperature T

$\boldsymbol{p_i} = \frac{\partial \boldsymbol{P_s}}{\partial \boldsymbol{T}}$ where p_i ($Cm^{-2}K^{-1}$) is the vector for the Pyroelectric coefficient.

CL55_Q3. Distinguish between inverse and direct piezoelectric effect?

Ans:

Piezoelectric Effect is appearance of an electrical potential across some faces of certain crystals when pressure is applied to the crystal and Inverse piezoelectric effect is the distortion observed in the crystal when an electrical field is applied.