CL54_Q1. Discuss the concept of centro-symmetry in crystals.

Ans:

The distribution of ionic charges of a crystal about their lattice sites decides centro-symmetry. If the distribution is symmetrical, such crystals exhibit no net polarization in response to external stimuli. The distribution of charge maintains symmetry even after displacement. Non-centro-symmetric crystals can respond to an external stimulus producing polarization (e.g: piezo and pyro electric crystals).

CL54_Q2. What structural changes are observed in $BaTiO_3$ with change in temperature and explain why it losses spontaneous polarization above Curie temperature.

Ans:

$BaTiO_3$ is a good example of a non centro-symmetric crystal. Between 5^0C and 120^0C the material is in the tetragonal phase exhibiting ferroelectric behaviour.

Below 5^0C and -90^0C the material has a orthogonal phase and below -90^0C the material is in the orthorhombic phase. In all these phases also the material exhibit ferroelectric behaviour.

The spontaneous polarization in $BaTiO_3$ is due to the movement of titanate in the octahedral structure of oxygen. Above Curie temperature the material becomes centro-symmetric where material losses its spontaneous polarization and behaves as a paraelectric.

CL54_Q3. In what way do ferroelectrics differ from ordinary dielectrics?

Ans:

Ferroelectric dielectrics differ from dielectric materials in their response to external applied electric field. Ferroelectrics display a nonlinear response of polarization to changing electric fields and display a hysteresis in the P versus E variations. The hysteresis loop is caused by the existence of permanent electric dipoles in classes of materials, which develop spontaneously below the Curie temperature.