- **What is Dielectric?**

A dielectric is an insulating material in which all the electrons are tightly bound to the nuclei of the atom and there are no free electrons available for the conduction of current.

- **What is polarization?**

Polarization is defined as the process of creating or inducing dipoles in a dielectric material by a external electric field.

- **Types of Dielectric**

On the basis of the polarization concept, dielectrics are the materials that have either permanent dipoles or induced dipoles in the presence of an applied electric field. They are classified into two categories, namely, polar and non-polar dielectrics.

1. <u>Polar Dielectrics:-</u>

A dielectric material in which there is an existence of permanent dipole even in the absence of an external field is called polar dielectrics.

For polar dielectrics, the center of gravity of the positive charges is separated by finite distance from that of the negative charges of the molecules. So such molecules possess permanent electric dipole

Examples: H_2O, NaCl, HCl, CO.

2. Non-polar dielectrics:-

Non-polar Dielectrics

A dielectric material in which, there is no permanent dipole existence in the absence of an external field is called 'non-polar' dielectrics.

For non-polar dielectrics, the center of gravity of the positive and negative charges of the molecules coin- cide. So such molecules do not have any permanent dipole moment .
Examples: O_2, H_2, N_2, CO_2, H_2O_2.

TYPES OF POLARISATION

Dielectric polarisation is nothing but the displacement of charged particles under the action of the electric field they are subjected to. Some microscopic mechanisms occur in the presence of an external electric field in the dielectric material leading to its polarisation. These mechanisms can be grouped into four

sections as given below:

(i) Electronic polarisation
(ii) Ionic polarisation
(iii) Orientational polarisation
(iv) Space-charge polarisation

■ Electronic polarisation

Electronic polarisation is the result of the displacement of positive and negative charges of an atom in the presence of an external electric field.

Usually, in an atom, protons and neutrons are concentrated at its centre to form the nucleus, and the electrons revolve around the nucleus. Hence, the positive and negative charges of the atom are balanced by each. When the same atom is subjected to an external electric field, the nucleus and the electron experience Lorentz forces in op posite directions. Therefore, nucleus and electron clouds are pulled apart and a coulomb force develops between them, which tends to counter the displacement. Experimentally it observed that the order of the magnitude of displacement between nucleus and electron cloud is 10^(-17) corresponding to the electric field of 30 kV/m.

As the nucleus and the centre of electron cloud are separated by a certain distance, dipole moment is reated in each atom. The induced dipole moment (p) is proportional to externally applied electric field

$\vec{Pe} \propto \vec{E}$

If there are N atoms in the dielectric, then

$\vec{Pe} \propto N\vec{E}$

$\vec{Pe} = a_e N\vec{E}$

Where a_e is the Electronic polarisability. Electronic polarisability is independent of temperature.

■ Ionic polarisation

dielectric materials having ionic bonds, such as NaCl, show ionic polarisation. Polarisation in such ionic crystals arises on account of the ions displaced from their equilibrium positions by the force of the applied electric field.
It has been observed that the induced dipole moment due to ionic polarisation is proportional to applied electric field, i.e.

$\vec{P}i \propto E$

Or, $\vec{P}i = N a_i E$

where a_i is the ionic polarisability.
For most of the materials, the ionic polarisability is very less than the electronic polarisability It is generally observed that $a_i = 0.1 a_e$

■ Orientational Polarisation

Orientational polarisation occurs in polar substances. These substances exhibit dipole mon absence of external electric field. Due to the random orientation of dipoles or molecules the net dipolemomoment is zero. When such material are subjected to an external electric field, the permanent molecular dipoles rotate about their asie as are axis of symmetry to align with the applied field, which exerts a torque on them. This type of polarisation is as orientational polarisation.

■ Space-Charge Polarisation

Sometimes, due to the application of an electric field to the dielectric material, charges accumulated at the electrodes or at the interphases in the multiphase dielectric due to a sudden change in conductivity.

Under the influence of applied electric

field, the ions are diffused over appreciable distance, due to which redistribution of charges in the dielectric medium takes place. The tendeney of redistribution of charges in the dielectric medium in the presence of an external electric field is known as the space-charge polarisation.

The space-charge polarisation is not an important factor in most common dielectrics.

- ***APPLICATIONS OF DIELECTRIC MATERIALS***

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Dielectric materials have a large number of applications in the field of engineering, medicine, indusmne research. Some important applications are as follows:

1) Dielectric materials having low dielectric constant are widely used in engineering, microelectron. ics, industries, computers, and medical equipments, etc.
2) Dielectric materials having high value of dielectric constant are frequently used in semiconducting manufacturing processes in which silicon dioxide is not suitable.
3) Dielectric materials having high value of dielectric constant are commonly used in microchips. integrated circuits, transistors, microprocessors, computers, and so on.
4) The heating property of dielectric materials is widely used in dehydration of food, tobacco, etc.
5) They are also used in microwave ovens and other home appliances.
6) The use of dielectric materials as an insulator is one of its most popular and important .