

Dielectrics

In study of electromagnetism, materials are classified into two groups ~~two~~ depending on their response to an external electric field.

(i). Conductors; (ii) Insulators

Conductors: Metals. - Have large numbers of free electrons. These electrons are free to move inside the materials and any external field ~~effects~~ can affect these electrons instantaneously. These electrons ^{are} responsible for conducting electricity.

Insulators: Electrons are not free to move inside the material. They are tightly bound to atomic nuclei. On applying external electric field, these electrons can be slightly displaced to their normal positions (since nuclei are ~~not~~ heavier to move) but these electrons still bound to the nuclei. These materials cannot conduct electricity.

Dielectrics are insulating materials (insulators) that can be polarized in presence of external electric field.

Ideal dielectric materials have zero conductivity but in reality they may have small conductivity. Except from conductors and insulators there are also semiconductors, semimetals and electrolytes which have intermediate properties as far as we focus on conductivity only but these materials have ^{many} other useful and interesting properties that make them useful for application purpose.

One should note that vacuum cannot be treated as a dielectric since it cannot be polarized though it is insulator.

In presence of external electric field, positively charged nuclei and negatively charged electrons get displaced a little bit from their position and atom forms a point dipole. In similar manner all the atomic dipoles in the material ~~get~~ get aligned and form a macroscopic dipole moment. For small electric field, the induced dipole moment is approximately proportional to the electric field.

$$\boxed{\vec{p} = \alpha \vec{E}} \quad \text{---} \quad \textcircled{1}$$

We have assumed the simplest form of the above equation, i.e., \vec{p} and \vec{E} have linear relation for an isotropic material and α is a constant.