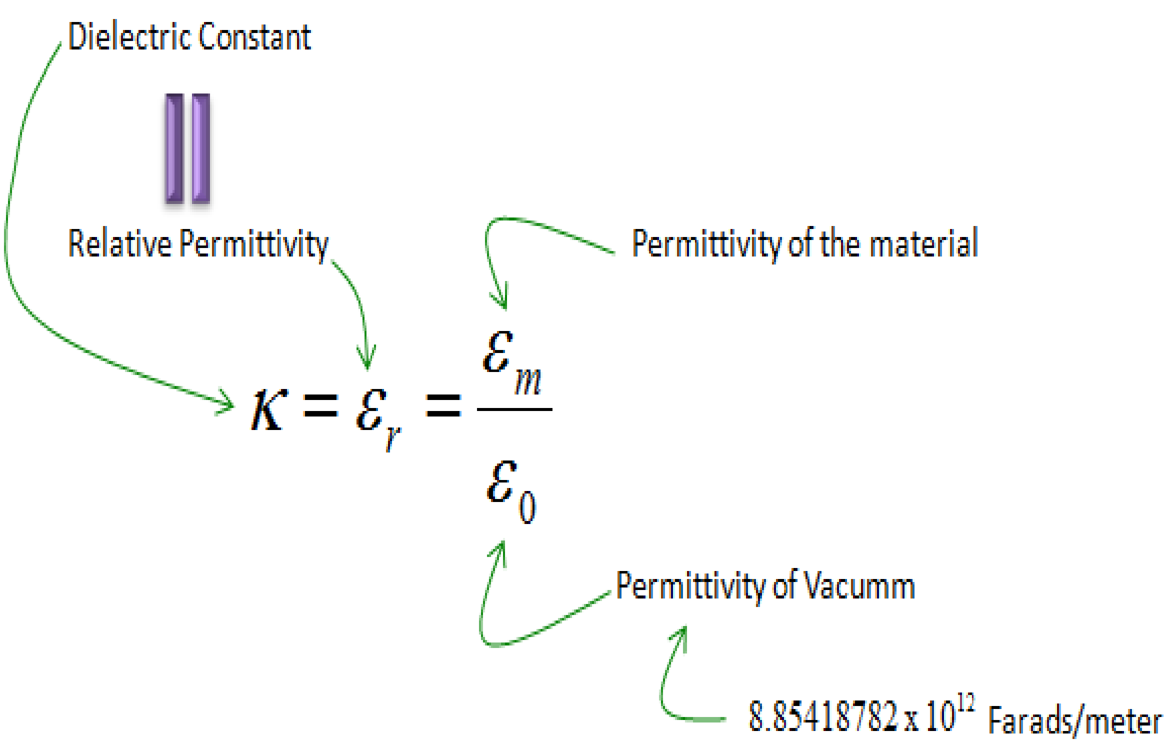
# Dielectric constant

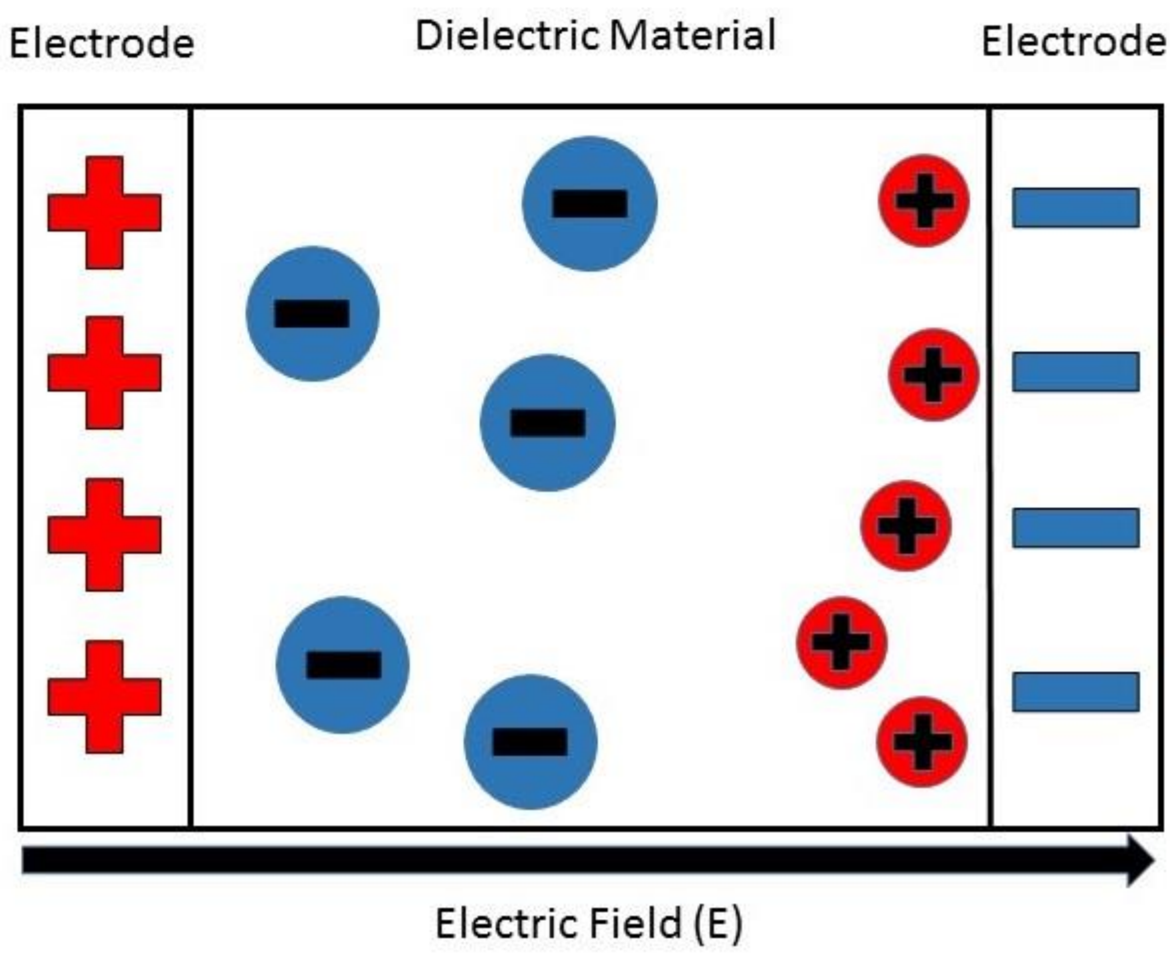
A typical capacitor comprises two conductive plates and a non-conductive dielectric material. The dielectric material separates the two conductive metal electrode plates. Applying voltage to the electrode plates of a capacitor causes an electric field in the non-conductive dielectric material. This electric field stores energy. The dielectric constant, also commonly known as relative permittivity, is the measure of the ability of a material to store electrical energy, and is one of the key properties of a dielectric material.

The capacitance of a parallel plate capacitor is a function of distance between plates, plate area, and dielectric material constant. An increase in plate area and dielectric constant results in an increase in capacitance while an increase in the separation distance between the plates results in a decrease in capacitance. Different dielectric materials have different dielectric constants.

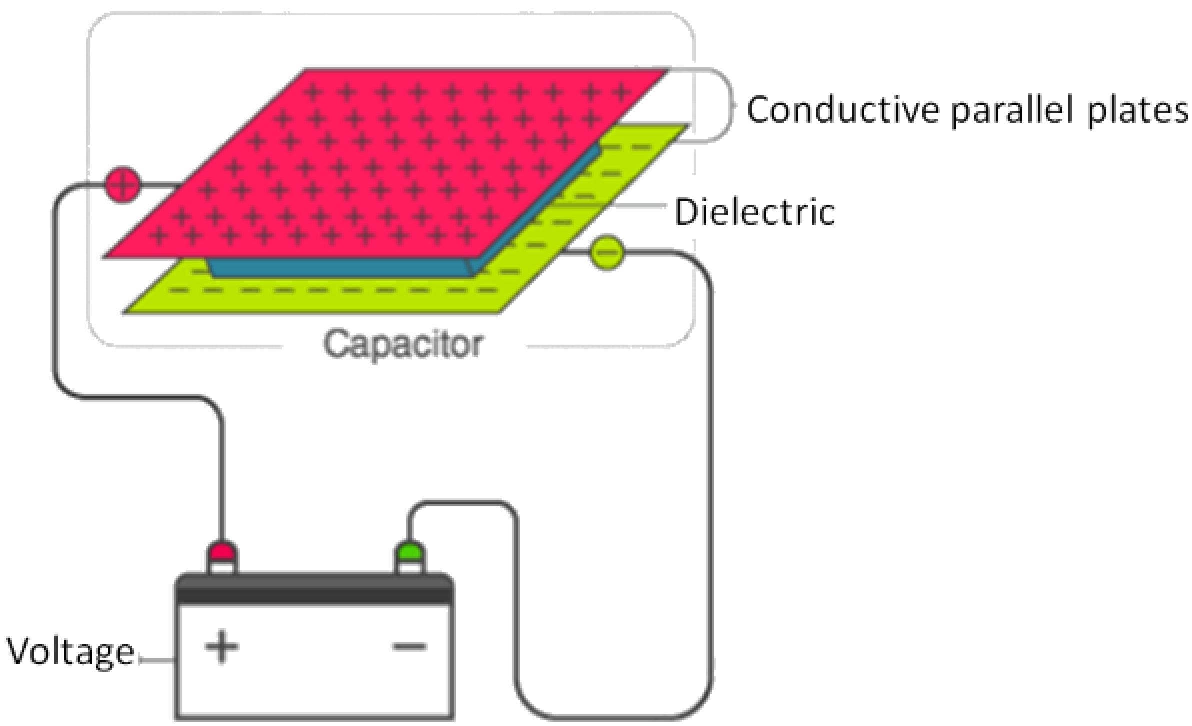


**Effects of dielectric constant on the characteristics of a capacitor**

The dielectric material of a capacitor polarizes when voltage is applied. This process reduces the electric field and causes negatively charged electrons to shift slightly towards the positive terminal. Although the electrons do not shift far enough to cause a flow of current, the process creates an effect that is critical to the operation of capacitors. Removing the source of voltage causes the dielectric material to lose polarization. However, if the material has weak molecular bonds, it can remain in polarized state even when the source of voltage is removed.



A capacitor stores energy in the electric field when a voltage is applied. The capacity to store electrical energy varies from one dielectric material to another. The amount of electrical energy that a capacitor can store is influenced by the amount of polarization that occurs when voltage is applied. Materials with high dielectric constants can store more energy compared to those with low dielectric constants. The electric susceptibility of a material is a measure of the ease with which it polarizes in response to an electric field. Good dielectric materials have high electric susceptibility.




The dielectric constant is one of the key parameters to consider when selecting a dielectric material for a capacitor. This constant is measured in farads per meter and determines the amount of capacitance that a capacitor can achieve. Dielectric materials with high dielectric constants are used when high capacitance values are required, although, as mentioned above, other parameters that determine the capacitance of a capacitor include the spacing between the electrodes and the effective plate area.

**Dielectric constants of common dielectric materials**

All materials are capable of storing electrical energy when they are exposed to an electric field. The storage capacity varies from one material to another. The permittivity of materials is usually given relative to the permittivity of free space, usually symbolized by $\epsilon_0$. The permittivity of vacuum is commonly known as absolute permittivity and refers to the amount of resistance required to form an electric field in a vacuum. The absolute permittivity of free space is approximately $8.85418782 \times 10^{-12}\ m^{-3}\ kg^{-1}\ s^{4}\ A^{2}$.

The permittivity of a dielectric material relative to that of free space is referred to as relative permittivity, usually symbolized by $\epsilon_r$, or dielectric constant. The following equation relates absolute permittivity ($\epsilon_0$), relative permittivity or dielectric constant ($\epsilon_r$), and permittivity of a material ($\epsilon$).

$$\epsilon_r = \epsilon / \epsilon_0$$

The table below shows the dielectric constants of commonly used dielectric materials.

| Material | Dielectric Constant (relative permittivity) |
|---|---|
| **Air** | **1.0006** |
| **Aluminum Oxide** | **8.5** |
| **Barium Strontium Titanate** | **500** |
| **Ceramic porcelain** | **4.5 – 6.7** |
| **Glass** | **3.7 – 10** |
| **Mica** | **5.6 – 8** |
| **Paper** | **3.85** |
| **Polyester PET** | **3.3** |
| **Polypropylene** | **2.25** |
| **Tantalum Oxide** | **27.7** |