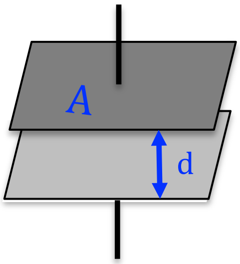
7.8.2 Anatomy of a capacitor and dielectrics

In section 7.8.1, we saw that a simple parallel plate capacitor consists of two parallel conducting plates separated with an air gap.

videos



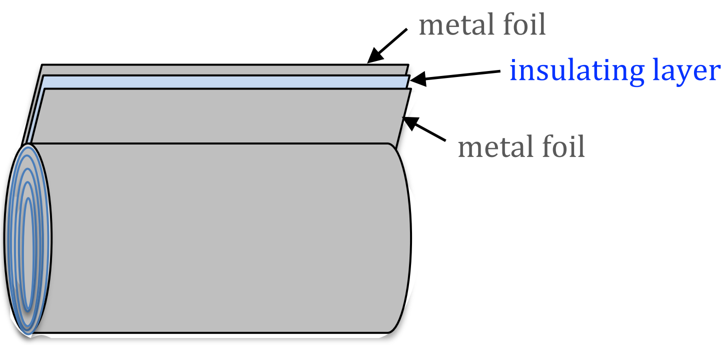
For such a capacitor, the capacitance is proportional to the area (A) of the plates and inversely proportional to the separation (d) of the two plates. The capacitance (C) is given by the relationship:

$$C = \frac{\varepsilon_0 A}{d}$$

$where\ \varepsilon_0 = permittivity\ of\ free\ space = 8.9 \times 10^{-12} Fm^{-1}$

(1)✐Calculate the capacitance of a parallel plate capacitor consisting of two metal plates with a surface area of $3.0 \times 10^{-3} m^2$*, separated by a distance* $1.0 \times 10^{-4} m$.

To produce a compact component with a high capacitance the two plates can be separated by an insulating material and rolled up. This allows a large surface to be enclosed in a small volume.

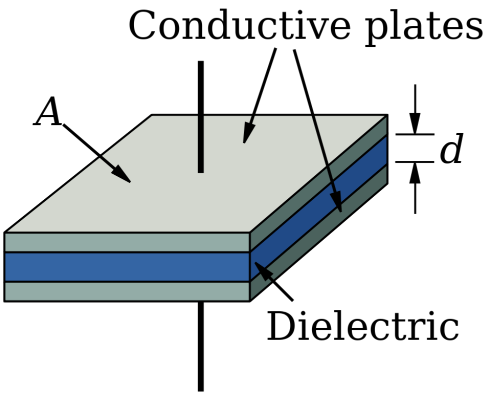


Introducing a material into the gap between the conducting layers changes the capacitance. There is no longer an air gap, so the permittivity changes. A modified formula is used to work out the capacitance:

$$C = \frac{\varepsilon_r \varepsilon_0 A}{d}$$

where $\varepsilon_r = relative\ permittivity\ (or\ dielectric\ constant)$

Insulators which become polarised in the electric field are called dielectrics. In this case ε_r is also known as the "dielectric constant".



The mineral mica can act as a dielectric. It has a dielectric constant of 7. This means that the capacitance of the capacitor is seven times that of an equivalent capacitor with just an air gap.

(2) Calculate the capacitance of capacitor consisting of two metal sheets with a surface area of $5.0 \times 10^{-3} m^2$*, separated by polythene with a thickness of 0.50mm. Polythene has a dielectric constant = 2.3.*

Some images of capacitors.