(ES1-2) Dielectric Constant of a Medium

Aim of experiment

Measurement of the dielectric constant for separate and combined different materials using parallel plate capacitor.

Apparatus

Parallel Plate Capacitor, Glass Spacers, Plastic Spacers, Capacitance Meter (M).

Theory of experiment

The capacitance *C* of a parallel plate capacitor is given by

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

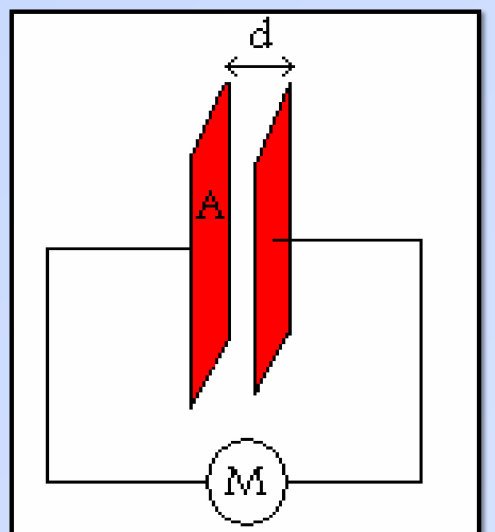


Fig (1)

where A is the overlap area of the two plates.
d is the distance between plates.
ε_m is the permittivity of insulator medium between plates, ε_o is the permittivity of air.
If one measures directly the capacitance C at different distances d, and constant A, one can calculate εm.
The dielectric constant, k, of the medium between the two plates is given by
$k = \varepsilon_m / \varepsilon_o$ (*k* = 1 for vacuum)

For a dielectric consists of two different materials (plastic and glass), one can obtain two capacitors in series connection so that, the total capacitance C_{pg} could be given from the relation

$$\frac{1}{C_{pg}} = \frac{1}{C_p} + \frac{1}{C_g}$$

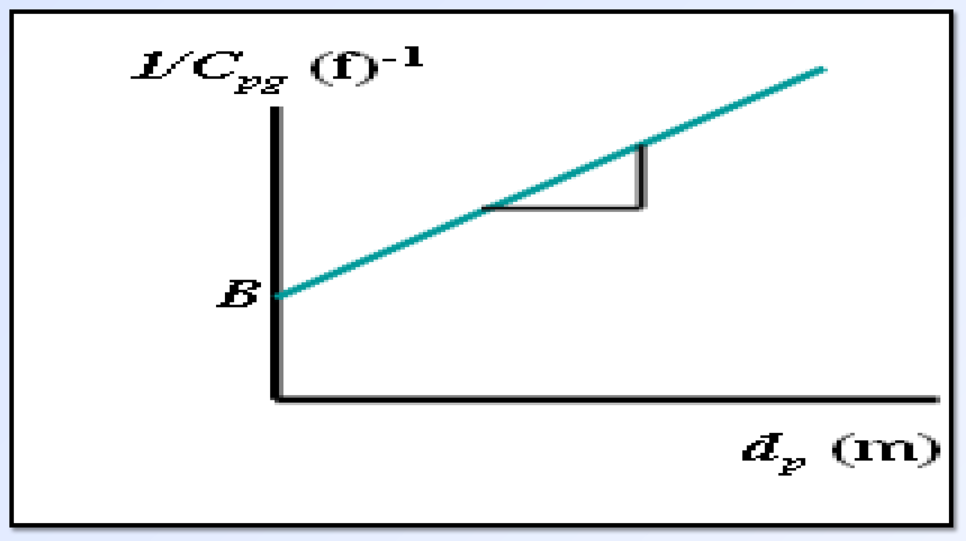
$$\frac{1}{C_{pg}} = \frac{d_p}{A.\varepsilon_p} + \frac{d_g}{A.\varepsilon_g}$$

Let d_g constant and d_p variable, then

$$\frac{1}{C_{pg}} = \frac{1}{A\varepsilon_p}.d_p + B$$

$$\frac{1}{C_{pg}} = \alpha.d_p + B$$

Where $\alpha = 1/A.\varepsilon_p$ and $B = dg/A.\varepsilon_g =$ Constant , from which ε_p and ε_g can be recalculated and compared to previously measured.



Procedures

1. Connect the circuit as show in figure.
2. Adjust the capacitance meter at zero then make a contact and complete overlap between the plates ε_p.
3. For air, increase the distance by 0.5 cm and measure the capacitance using the meter.
4. Tabulate your results as shown in table (1).
5. Plot the relation between 1/d and C.
6. From the slope which equals (C .d), calculate ε_o=C.d/A=slope/A.
7. For the given glass plates, determine the value of C at each thickness and tabulate your results in table (2) then draw a graph between *1/dg* and *C* to determine ε_g.
8. Calculate the dielectric constant from **$k = \varepsilon_g / \varepsilon_o$**.
9. For the given plastic plate, determine the value of C at each thickness and tabulate your results in table (3) and then draw a graph between $1/d_p$ and *C* to determine ε_p .
10. Calculate the dielectric constant from **$k = \varepsilon_p / \varepsilon_0$**.
11. Fix a glass thickness, dg, and vary the plastic thickness d_p, to determine the capacitance of the combination of glass and plastic.
12. Tabulate your results, in table (4), for different thicknesses of plastic plates d_p.
13. Draw the relation between d_p and *1/C* p_g then determine the slope = , so you can calculate $\varepsilon_p = 1/(A.slope)$. From the graph determine *B* and calculate ε $\varepsilon_g = 1/(A.B)$.
14. Compare the values of ε_g, ε_p with the previously obtained values of ε_g, ε_p.

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Results

1- Air				2- Glass		
d (10^{-2} m)	1/d (10^{2} m^{-1})	C (10^{-12} F)		d (10^{-2} m)	1/d (10^{2} m^{-1})	C (10^{-12} F)

Table (1) Table (2)

3- Plastic				4-plastic+glass		
d (10^{-2} m)	1/d (10^{2} m^{-1})	C (10^{-12} F)		d (10^{-2} m)	1/d (10^{2} m^{-1})	C (10^{-12} F)

Table (3) Table (4)

d_g=…………….m

A = ………….. m^2

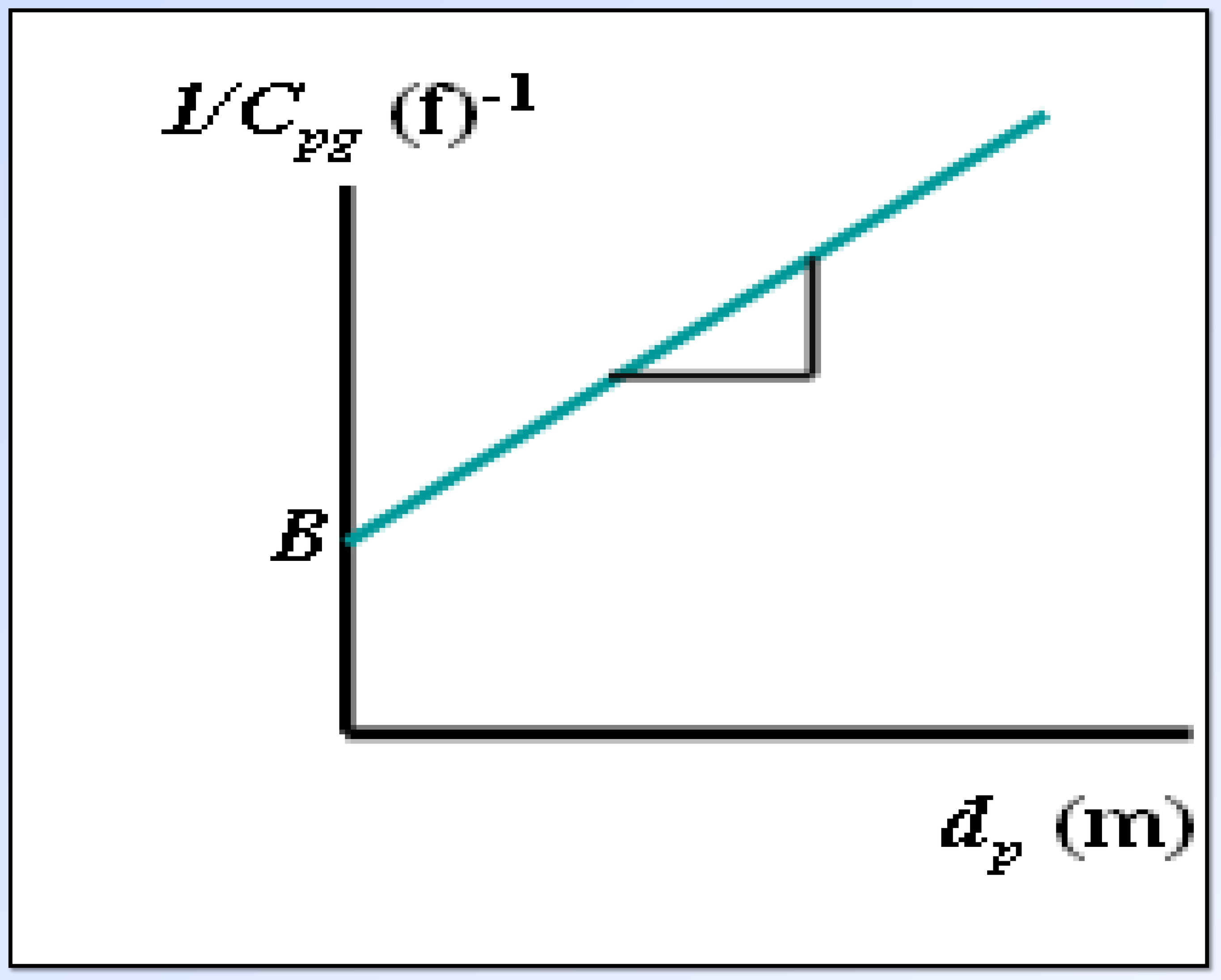
ε_o= Slope/A= ……..

ε_g= Slope/A= ……. k_g =………

ε_p= Slope/A= ……. k_p =………

B=……… k_g =………

α= ……… k_p =………



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