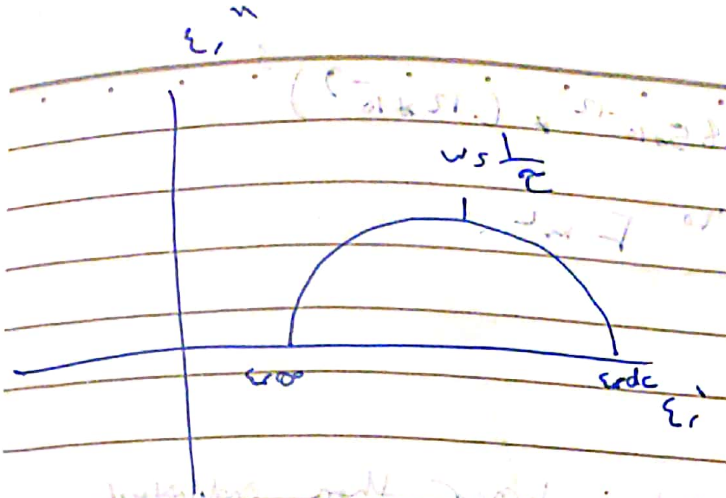


1 a) $\frac{\alpha_e N}{3\varepsilon_0} = \frac{\varepsilon_r - 1}{\varepsilon_r + 2}$

$\therefore \alpha_e = \frac{3\varepsilon_0}{N} \frac{\varepsilon_r - 1}{\varepsilon_r + 1} = \frac{3(8.85\times10^{-12})}{5\times10^{28}} = \frac{11.9-1}{11.9+2} = 4.17\times10^{-40}$ F m^2

b) $E_{loc} = E + \frac{1}{3\varepsilon_0} P$

$P = \chi_e \varepsilon_0 E = (\varepsilon_r - 1)\varepsilon_0 E$

$E_{loc} = E + \frac{1}{3}((\varepsilon_r - 1)) E$

$\frac{E_{loc}}{E} = \frac{1}{3}(\varepsilon_r + 2) = 4.63$

2 $N = \frac{\text{Density} \times N_{Avog}}{M_{at}} = \frac{4.3\times10^3\ kg/m^3 \times (6.022\times10^{23})\ mol^{-1}}{78.96\times10^{-3}\ kg/mol}$

Concentration

$= 3.279\times10^{28}\ m^{-3}$

$\frac{\varepsilon_r - 1}{\varepsilon_r + 2} = \frac{N}{3\varepsilon_0}\alpha_e$

$\therefore \alpha_e = \frac{3\varepsilon_0(\varepsilon_r - 1)}{N(\varepsilon_r + 2)} = \frac{3(8.854\times10^{-12})(6.7-1)}{N(6.7+2)}$

$= 5.31\times10^{-40}$ F m^2 → electronic

B) $\alpha_e' = 4\pi\varepsilon_0 r_0^3 = 4\pi\, 8.85\times10^{-12} \times (.12\times10^{-9})^3$

$= 1.92\times10^{-40}\ F\,m^2$

$\therefore \dfrac{\alpha_e}{\alpha_e'} = 2.76$

$\therefore$ α_e in in solid is larger than individual atom.

---

3) $N = \dfrac{n}{a^3} = \dfrac{1}{(.430\times10^{-9})^3} = 1.258\times10^{28}\ m^{-3}$

$\dfrac{\varepsilon_r - 1}{\varepsilon_r + 1} = \dfrac{1}{3\varepsilon_0}\left(N_i\alpha_i + N\alpha_{eCs} + N_{Br}\alpha_{eBr}\right)$

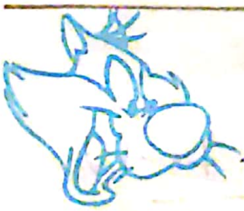
$\varepsilon_r = \dfrac{N}{3\varepsilon_0}\left(\alpha_i + \alpha_{eCs} + \alpha_{eBr}\right)\left(\varepsilon_{r(low)} + 2\right) + 1$

$\therefore \varepsilon_r = \dfrac{2N(\alpha_i + \alpha_{eCs} + \alpha_{eBr}) + 3\varepsilon_0}{3\varepsilon_0 - N(\alpha_i + \alpha_{eCs} + \alpha_{eBr})}$

$= 6.48$

at high f. $\longrightarrow$ $\varepsilon_r = \dfrac{2N(\alpha_{eCs} + \alpha_{eCl}) + 3\varepsilon_0}{3\varepsilon_0 - N(\alpha_{eCs} + \alpha_{eCBr})}$

$= 2.77.$



Date: ________ no: ________

$\boxed{4}$ $\omega_0 = \frac{1}{\tau} = \frac{1}{2\pi 6000} = 26.5\ \mu s$.

$\varepsilon_r = \varepsilon_{r\infty} + \frac{\varepsilon_{rdc} - \varepsilon_{r\infty}}{1+(\omega\tau)^2}$ @ 29000

$= 2.58 + \frac{3.6 - 2.58}{1+(2\pi\ 29000 \times 26.5\times10^{-6})^2} = 2.62$

$\varepsilon_r'' = \frac{(\varepsilon_{rdc} - \varepsilon_{r\infty})(\omega\tau)}{1+(\omega\tau)^2} = .202$

$\tan\delta = \frac{\varepsilon_r''}{\varepsilon_r'} = \frac{.202}{2.62} = .077$

Power loss $= W_{vol} = \frac{\text{Power loss}}{\text{Volume}} = \frac{V^2}{R_p\ \text{Ad}A} = \frac{V^2}{d^2}\omega\varepsilon_0\varepsilon_r''$

$C_{vol} = \frac{\varepsilon_0\varepsilon_r}{d_2}$

a) $V = \frac{C}{C_0} = \frac{C}{\varepsilon_0\varepsilon_r}d^2$

$\rightarrow \frac{100\times10^{-9}}{8.85\times10^{-12} \times 3.2}(10^{-6})^2 = 3.53\times10^{-9}\ m^3$

$\longrightarrow$ PET has smallest Volume

$\longrightarrow$ since $V \propto d^2$

b) $\frac{1}{2}E_{br} = \frac{V_{max}}{d}$

$d = \frac{2V_{max}}{E_b}$

$V = \frac{C}{\varepsilon_0\varepsilon_r}d^2 = \frac{C}{\varepsilon_0\varepsilon_r}\left(\frac{2V_{max}}{E_{max}}\right)^2 \xrightarrow{\text{using}} d = 2\ \mu m$

$= 1.57\times10^{-5}\ m^3$

$\therefore$ PET has smallest Volume.