INFRARED

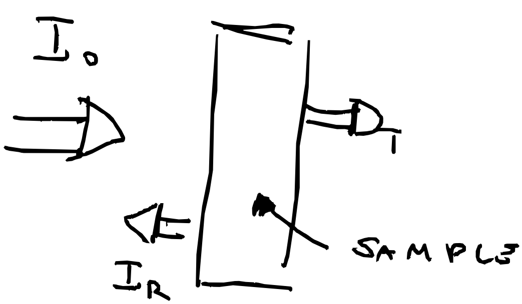
INCIDEND LIGHT I_0

REFLECTED I_R

TRANSMITTED I_T

ABSORBED LIGHT I_A

$$I_0 = I_R + I_T + I_A$$



$R = \dfrac{I_R}{I_0}$ REFLECTIVITY

$T = \dfrac{I_T}{I_0}$ TRANSMISSION

$A = \dfrac{I_A}{I_0}$ ABSORPTION

$$1 = R + T + A$$

- OPAQUE MATERIAL $T = 0$ $A = 1 - R$
- BLACK BODY $A = 1$
- HIGH-REFLECTING MATERIAL $R \sim 1$ $A = T \simeq 0$

WE WANTO TO CONNECT THESE MICROSCOPIC PROPERTIES TO THE INTRINSIC MICROSCOPIC MATERIAL PROPERTIES

- $\varepsilon(\omega) = \varepsilon_1(\omega) + i\,\varepsilon_2(\omega)$ DIELECTRIC CONSTANT

$$\boxed{D = \varepsilon E}$$

- COMPLEX REFRACTIVE INDEX

$$n(\omega) = n_1(\omega) + i\,n_2(\omega)$$

EXINTION COEFF

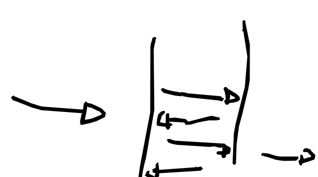
RELATED TO THE DIELECTRIC CONST

$$\underbrace{\varepsilon_2 = 2 n_1 n_2 \qquad \varepsilon_1 = n_1^2 - n_2^2}$$

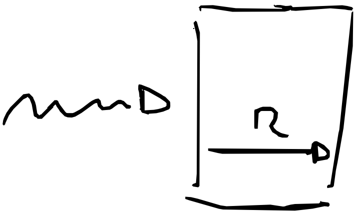
- FOR NORMAL INCIDENT LIGHT TO A MATERIAL OF INFINITE THICKNESS

$$R = \frac{(n_1 - 1)^2 + n_2^2}{(n_1 + 1)^2 + n_2^2}$$

- FOR FINITE THICNESS



• CONNECTION WITH PROPAGATING WAVE



$$I(r) = \frac{1}{2}|E|^2$$

$$E = E_0 e^{-i(\omega t - kr)}$$

$$k = k_1 + i k_2$$

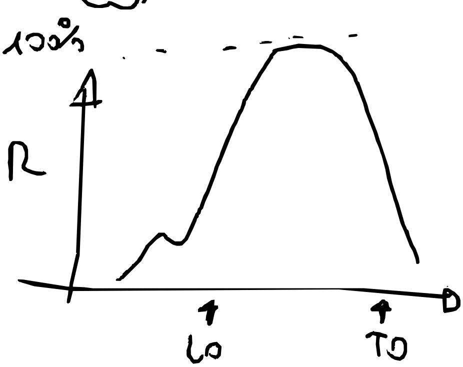
$$I(r) = \frac{1}{2} E_0^2 e^{-Kr}$$

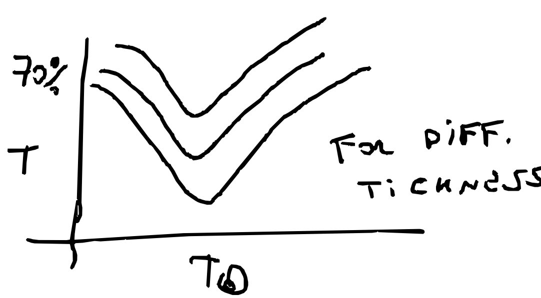
$K = 2k_2 = 2\frac{\omega}{c} n_2$!! EXINTION COEFFICIENT

$$T = \frac{I(r)}{I(0)} = e^{-Kr}$$

<u>BEER'S LAW</u>

CONSIDER NaCl





FROM PREVIOUS LECTURE

$$\varepsilon(\omega) = \varepsilon_\infty \cdot \frac{\omega_{LO}^2 - \omega^2}{\omega_{TO}^2 - \omega^2}$$

NOTICE THAT IN REAL SYSTEM $\varepsilon(\omega)$ IS COMPLEX

$$\varepsilon(\omega) = \varepsilon_\infty \cdot \frac{\omega_{LO}^2 - \omega^2 - i\gamma\omega}{\omega_{TO}^2 - \omega^2 - i\gamma\omega}$$

DEPHASING FRICTION

$$\ddot{u} = -\omega_0^2 u + \frac{e^*}{M^*} E + \gamma \dot{u}$$ FRICTION !

LIGHT PROPAGATION

FROM PREVIOUS LECTURE

$$\omega^2 = \frac{c^2}{\varepsilon^2(\omega)} k^2$$ $\Rightarrow$ USING $\varepsilon(\omega)$ DEFINED ABOVE

$$k^2 = \frac{\omega^2}{c^2} \varepsilon_\infty \frac{\omega_{LO}^2 - \omega^2 - i\gamma\omega}{\omega_{TO}^2 - \omega^2 - i\gamma\omega}$$

WE FORGET FOR A MOMENT

THE DAMPING TERM $\gamma = 0$

$$k^2 = k_1^2 - k_2^2 + 2 i k_1 k_2$$

$$\begin{cases} k_1^2 - k_2^2 = \dfrac{\omega^2}{c^2} \varepsilon_\infty \dfrac{\omega_{LO}^2 - \omega^2}{\omega_{TO}^2 - \omega^2} \\ k_1 k_2 = 0 \end{cases}$$

•) FOR $\omega > \omega_{LO}$ OR $\omega < \omega_{TO}$

$$k_1 = \frac{\omega}{c} \sqrt{\varepsilon_\infty \frac{\omega_{LO}^2 - \omega^2}{\omega_{TO}^2 - \omega^2}}$$

•) FOR $\omega_{TO} < \omega < \omega_{LO}$

$$k_2 = \frac{\omega}{c} \sqrt{\varepsilon_\infty \frac{\omega_{LO}^2 - \omega^2}{\omega^2 - \omega_{TO}^2}}$$

REMEMBER

$K_1 = \frac{\omega n_1}{c}$ $\quad$ $K_2 = \frac{\omega n_2}{c}$

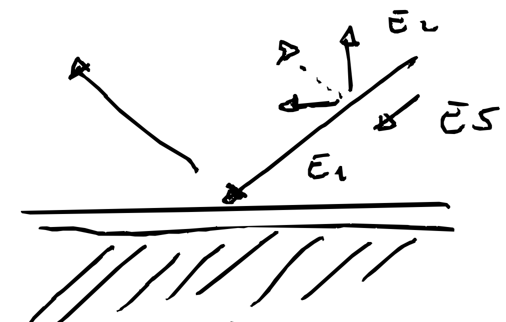
For $\omega_{TO} < \omega < \omega_{LO}$ $\quad$ $n_2 \neq 0$

$n_1 = 0$

BUT $R = \frac{(n_1 - 1)^2 + n_2^2}{(n_1 - 1)^2 + n_2} = 1$!

COMPLETE REFLECTION !!

MEASURE LO IN OPTICAL RESPONSE



METAL

E_1 p-like comp

E_2 s-like comp

E_2 CAN EXITE LO PHONONS

E_1 EXCITE TO PHON. BUT DUE TO THE METAL NO EFIELD $\perp$ CAN BE PRESENT

SIMILAR TO PLASMON