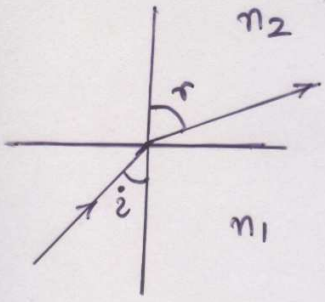
Reflection at dielectric - dielectric interface

$n_2 < n_1$



$$_1n_2 = \frac{\sin i}{\sin r} = \frac{n_2}{n_1} < 1 \Rightarrow \sin i < \sin r \Rightarrow i < r$$

$\Rightarrow$ Ray bends away from normal

Critical angle $r = 90$

$\hookrightarrow i = C$

$$\Rightarrow \frac{\sin i}{\sin r} = \sin C = \frac{n_2}{n_1} \Rightarrow C = \sin^{-1}\left(\frac{n_2}{n_1}\right)$$

If $i > C$, $\frac{\sin r}{\sin i} = \frac{n_1}{n_2} \Rightarrow \sin r = \left(\frac{n_1}{n_2}\right)\sin i = \frac{1}{\sin C}\cdot \sin i$

> 1

$\Rightarrow \sin\theta > 1$ ✗

$\Rightarrow$ No refracted wave $\Rightarrow$ Total Internal Reflection

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Fresnel amplitude relation $\Rightarrow$

$$\sin r = \frac{\sin i}{\sin C} = q > 1 \quad \text{for } i > c$$

$$\cos r = \sqrt{1-q^2} = \sqrt{-1}\cdot\sqrt{q^2-1} = jp$$

$$\frac{E''_{01}}{E_{01}} = \frac{n_1\cos i - n_2\cos r}{n_1\cos i + n_2\cos r}$$

$$= \frac{\cos i - \left(\frac{n_2}{n_1}\right)\cos r}{\cos i + \left(\frac{n_2}{n_1}\right)\cos r} = \frac{\cos i - j\left(\frac{n_2}{n_1}\right)p}{\cos i + j\left(\frac{n_2}{n_1}\right)p}$$

$$\Rightarrow |E''_{01}| = |E_{01}|$$

Similarly, $\frac{E''_{011}}{E_{011}} = \frac{\frac{n_2}{n_1}\cos i - jp}{\frac{n_2}{n_1}\cos i + jp}$

$$\Rightarrow |E''_{011}| = |E_{011}|$$

$\Rightarrow$ Reflected and incident amplitudes are same and hence we have Total Internal Reflection.

Reflection at dielectric conductor interface

For normal incidence $\frac{E''_{01}}{E_{01}} = \frac{n_2 - n_1}{n_2 + n_1}$ (forgetting $-$ sign)

Snell's law, $\frac{n_2}{n_1} = \frac{\gamma'}{\gamma}$ γ', γ are propagation constt.

For metallic medium γ' is complex, $\gamma' = \alpha + j\beta$

where $\alpha = \beta = \sqrt{\frac{\omega\mu\sigma}{2}} = \frac{1}{\delta}$ δ - skin depth.

$$\gamma' = \frac{1+j}{\delta}$$

$$\frac{E''_{011}}{E_{011}} = \frac{n_2 - n_1}{n_2 + n_1} = \frac{\gamma' - \gamma}{\gamma' + \gamma} = \frac{\left(\frac{1+j}{\delta}\right) - \gamma}{\left(\frac{1+j}{\delta}\right) + \gamma} = \frac{(1-\gamma\delta) + j}{(1+\gamma\delta) + j}$$

Coeff. of reflection

$$R = \frac{|E''_0|^2}{|E_0|^2} = \frac{(1-\delta\gamma)^2 + 1}{(1+\delta\gamma)^2 + 1}$$

$$= \frac{2 - 2\delta\gamma + \delta^2\gamma^2}{2 + 2\delta\gamma + \delta^2\gamma^2}$$

$$= \frac{1 - \delta\gamma}{1 + \delta\gamma}$$

$$= (1-\delta\gamma)(1+\delta\gamma)^{-1}$$

$$= (1 - 2\delta\gamma)$$