Photonics | Nanophotonics

Photonics 2nd Homework
Solution and
Nanophotonics 1st
Homework Solution

#1

Real time-expressions for circularly pol. light are:

RHCP $\Rightarrow$ $\bar{e}_R(t,z) = \hat{x} A \cos(\omega t - kz) + \hat{y} A \sin(\omega t - kz)$

LHCP $\Rightarrow$ $\bar{e}_L(t,z) = \hat{x} A \cos(\omega t - kz) - \hat{y} A \sin(\omega t - kz)$

$$\bar{e}_{tot} = \bar{e}_R + \bar{e}_L = \hat{x}\, 2A \cos(\omega t - kz)$$

With Jones Vector representation we have:

$$\bar{E} = \begin{bmatrix} a_x \\ a_y e^{i\phi} \end{bmatrix} \qquad \phi = \mp \frac{\pi}{2}$$

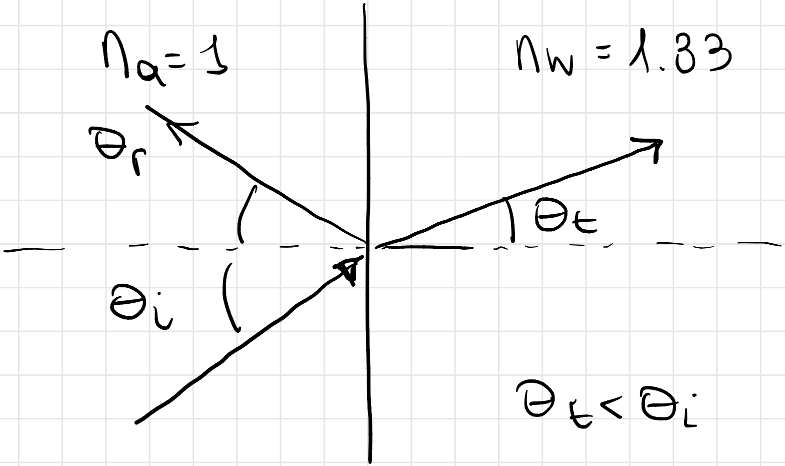
$$a_x = a_y = A$$

$$\text{RHCP} \Rightarrow A \begin{bmatrix} 1 \\ -j \end{bmatrix}$$

$$\text{LHCP} \Rightarrow A \begin{bmatrix} 1 \\ j \end{bmatrix}$$

$$A \begin{bmatrix} 1 \\ -j \end{bmatrix} + A \begin{bmatrix} 1 \\ j \end{bmatrix} = 2A \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

#2



TE pol

$$n_i \sin\theta_i = n_t \sin\theta_t$$

$$\theta_t = \arcsin\left(\frac{n_i}{n_t}\sin\theta_i\right)$$

$$\simeq 40.6^\circ$$

$$\theta_r = \theta_i = 60^\circ$$

$$R = |r|^2$$

$$r_{TE} = \frac{n_i \cos(\theta_i) - n_t \cos(\theta_t)}{n_i \cos(\theta_i) + n_t \cos(\theta_t)} = -0.3375$$

$$R = 0.1139 \Rightarrow R = 11.39\%$$

$$T = \frac{n_t \cos(\theta_t)}{n_i \cos(\theta_i)} |t|^2 = 0.8861 \qquad T = 88.61\%$$

$$t_{TE} = 2 \frac{n_i \cos(\theta_i)}{n_i \cos(\theta_i) + n_t \cos(\theta_t)} = 0.6625$$

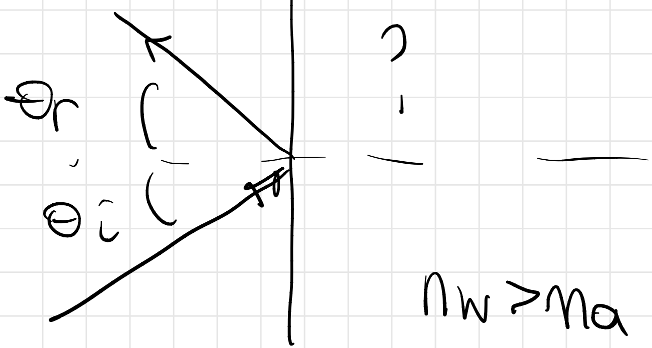
$$T = 1 - R = 88.61\%$$

(b) $I_t = 2\,MW/cm^2$

$$T = \frac{I_t A_t}{I_i A_i} = \frac{I_t \cos\theta_t}{I_i \cos\theta_i}$$

$$I_t = I_i \frac{\cos\theta_i}{\cos(\theta_t)} T = 1.167\ \frac{MW}{cm^2}$$

$n_w = 1,33$ $\qquad$ $n_a = 1$



$n_w > n_a$

$$\theta_r = \theta_i = 60^\circ$$

$$\theta_t = \arcsin\left(\frac{n_i}{n_t}\sin\theta_i\right) > 1$$

$$\theta_c = \arcsin\left(\frac{n_t}{n_i}\right) = \underline{\underline{48.75^\circ}}$$

$$\theta_i > \theta_c \Rightarrow \text{TIR} \Rightarrow R = 1$$

$$T = 0$$

3 Concept of scattering

4 (Photonics group only)

$n_1 = 1.5$

$n_2 = 3$

$a = 300$ nm

$\lambda_c = ?$

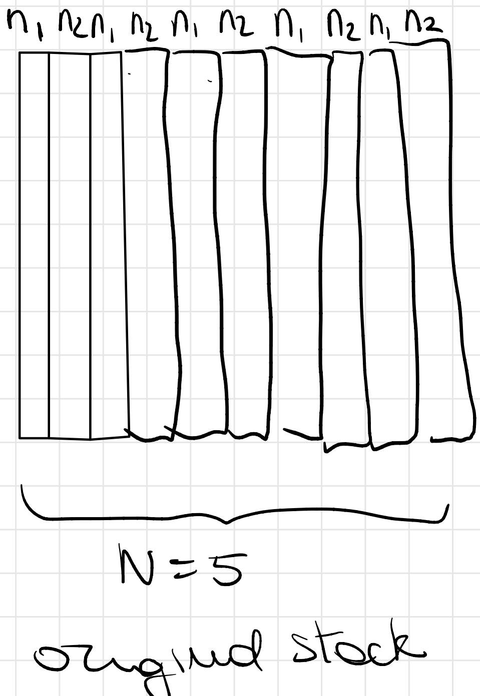
$N = 5$

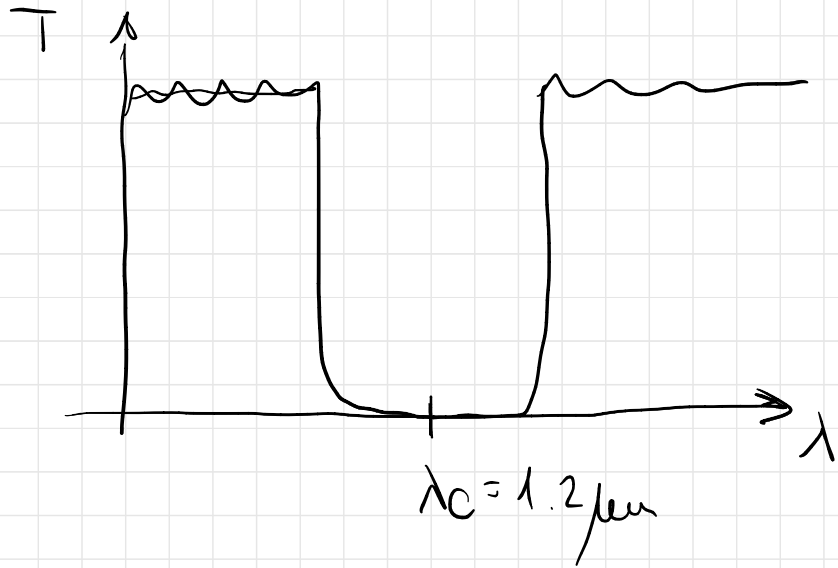
$$\omega_c = \frac{\sqrt{\varepsilon_1} + \sqrt{\varepsilon_2}}{4\sqrt{\varepsilon_1 \varepsilon_2}} \cdot \frac{2\pi c}{a} =$$

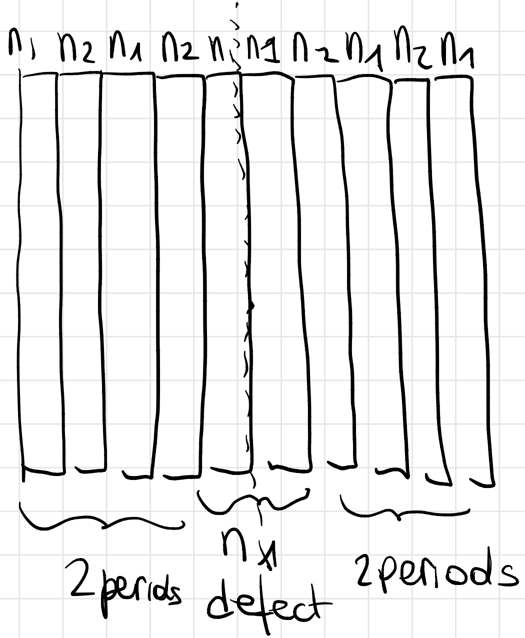
$$= \frac{n_1 + n_2}{4 n_1 n_2} \cdot \frac{2\pi c}{a} =$$

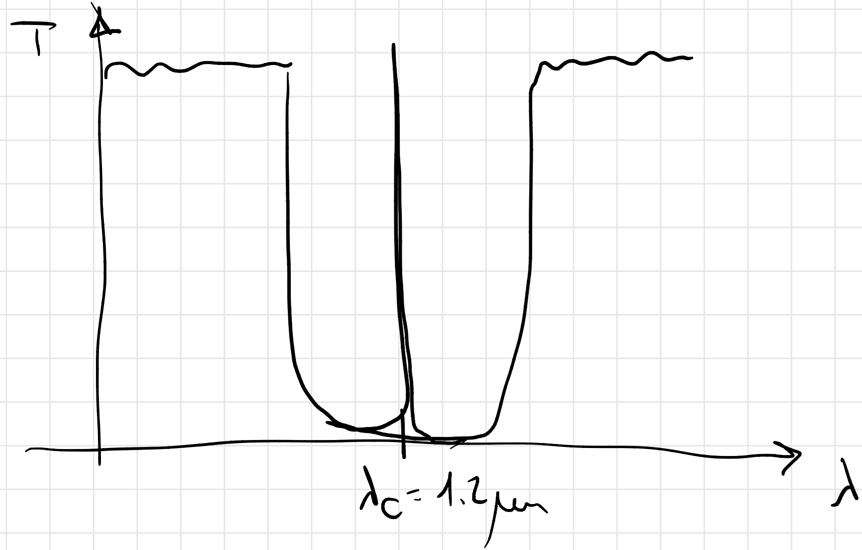
$$= \frac{4.5}{2 \cdot 1.5 \cdot 3} \cdot \frac{\cancel{2}\pi c}{\cancel{300}_{6} \cdot 10^{-9}}$$

$$\lambda_c = \frac{c}{f_c} = \frac{2\pi c}{\omega_c} = \frac{2\cancel{\pi}\cancel{c}}{\cancel{\pi c}} \cdot 600 \cdot 10^{-9} = \underline{1.2\ \mu m}$$









4.5 periods total