Photonics/Nanophotonics

Homework 3 Photonics

and

Homework 2

Nanophotonics

PHOTONICS HOMEWORK PROBLEM 1 / NANOPHOTONICS HOMEWORK PROBLEM 2

$\lambda = 1064\ nm$

$\varepsilon_g = -43.8 - j4.2$

$\varepsilon_a = 1$

$\delta_a = ?$

$\delta_g = ?$

$\Lambda\ (m=1) = ?$

$\theta_i = 0°$

The penetration depth of the surface plasmon can be calculated as:

$$\delta_g = \frac{1}{q_m} = \frac{\lambda}{2\pi}\left(-\frac{\varepsilon_g' + \varepsilon_a}{\varepsilon_g'^2}\right)^{\frac{1}{2}} = 25.29\ nm$$

$$\delta_a = \frac{1}{q_a} = \frac{\lambda}{2\pi}\left(\frac{\varepsilon_g' + \varepsilon_a}{\varepsilon_a^2}\right)^{\frac{1}{2}} = 1.1\ \mu m$$

If we want to excite the surface plasmon with a shallow perturbation we need to satisfy the following equation:

$$k_0 n_{sp} = k_0 n_d \sin(\theta_i) \pm \frac{2\pi m}{\Lambda}$$

Which reduces to:

$$k_0 n_{sp} = \pm \frac{2\pi m}{\Lambda}$$ for normal incidence ($\theta_i = 0°$)

if $m = 1$

$$k_0 n_{sp} = \pm \frac{2\pi}{\Lambda} \Rightarrow \Lambda = \frac{2\pi}{k_0 n_{sp}} = \frac{2\pi\lambda}{2\pi n_{sp}} = \frac{\lambda}{n_{sp}}$$

Since $\varepsilon_g'' \ll \varepsilon_g'$

$$n_{sp} = \sqrt{\frac{\varepsilon_g' \varepsilon_a}{\varepsilon_g' + \varepsilon_a}} = 1.011$$

So the required periodicity is:

$$\Lambda = \frac{1064 \cdot 10^{-9}}{1.011} = 1.052\,\mu m$$

PHOTONICS HOMEWORK PROBLEM 3

$n_{oje} = 1.55$

$n_{cr} = 1.3$

$\lambda_0 = 500nm$

$d_{AR} = ?$

The optimal length for an antireflection coating is

$$d_{AR} = \frac{\lambda_{eff}}{4} = \frac{\lambda_0}{4\, n_{CR}} = 96.15 \ nm$$

NANOPHOTONICS HOMEWORK PROBLEM 1

$n_1 = 1.5$

$n_2 = 2$

$\lambda_{BRAGG} = 1200\,nm$

$L_1 = ?$

$L_2 = ?$

In a photonic crystal the normal incidence band-gap is maximized when

$$n_1 L_1 = n_2 L_2 = \frac{\lambda_{BRAGG}}{4}$$

It follows that the thickness of the layers in the

Photonic crystal must be

$$L_1 = \frac{\lambda_{BRAGG}}{4 n_1} = \frac{1200 \cdot 10^{-9}}{4 \cdot 1.5} = 200 \text{ nm}$$

$$L_2 = \frac{\lambda_{BRAGG}}{4 n_2} = \frac{1200 \cdot 10^{-9}}{4 \cdot 2} = 150 \text{ nm}$$

The resulting period of the structure is $\Lambda = L_1 + L_2 = 350\text{nm}$

Problem 2 in Photonics Homework and Problem 3 in Nanophotonics homework have been evaluated based on the content and the level of detaie of the answer.