Formulas

$c = \frac{c_0}{n}$ $\quad k = n k_0$ $\quad k = \omega / c$ $\quad v_p = \frac{\omega}{k}$ $\quad n = \sqrt{\mu \varepsilon}$

$\lambda = \frac{\lambda_0}{n}$ $\quad \lambda = \frac{c}{f}$ $\quad v_g = \frac{\partial \omega}{\partial k}$

Mirror lens

$M = -\frac{z_2}{z_1}$

$$\frac{1}{z_1} + \frac{1}{z_2} = \frac{1}{f}$$

concave →  $R = \ominus$

convex →  $R = \oplus$

$$f = -\frac{R}{2}$$

Snell

$\theta_i = \theta_r$

$n_1 \sin\theta_i = n_2 \sin\theta_t$

$n_1 > n_2 \rightarrow \theta_i < \theta_t$

$n_1 < n_2 \rightarrow \theta_i > \theta_t$

Critic ang

$\theta_t = \frac{\pi}{2} \Rightarrow \theta_c = a\sin\left(\frac{n_2}{n_1}\right)$

Brewster

Only with TM

$\theta_B = a\tan\left(\frac{n_2}{n_1}\right)$

TE

$E \perp$ plane inci

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

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

TM

$H \perp$ plane inci

$$t_{TM} = \frac{2 n_i \cos\theta_i}{n_i \cos\theta_t + n_t \cos\theta_i}$$

$$r_{TM} = \frac{n_i \cos\theta_t - n_t \cos\theta_i}{n_i \cos\theta_t + n_t \cos\theta_i}$$

$$R = \frac{P_r}{P_i} = (r)^2$$

$$T = \frac{P_t}{P_i} = 1 - R$$

$$P_t = I_t A_t = I_t \cos\theta_t$$

$$\begin{pmatrix} y_2 \\ \theta_2 \end{pmatrix} = M \begin{pmatrix} y_1 \\ \theta_1 \end{pmatrix}$$

Fresnel app

$N_F = \frac{\theta_m^2}{\lambda} \ll 1$ $\quad N_F = \frac{a^2}{\lambda z}$ $\quad \theta_m = \frac{a}{z}$

$t(x,y) = h_0 \, e^{-j(n-1) k_0 d(x,y)}$

$h_0 = e^{-j k_0 d_0}$

Diff grat

$\theta_q = \theta_i + q \frac{\lambda}{\Lambda}$

Diffraction

$d(\sin\theta_m - \sin\theta_i) = m\lambda$

$\frac{\Delta(\lambda)}{\lambda} = \frac{1}{mN}$

Gaussian:

beam div: $2\theta_0 = \frac{4\lambda}{2\pi W_0}$

depth fo.: $2z_0 = \frac{2\pi W_0^2}{\lambda}$

diameter: $2W(z) = W_0 \sqrt{1 + \left(\frac{z}{z_0}\right)^2} \cdot 2$

rad. curv.: $R(z) = z\left[1 + \left(\frac{z_0}{z}\right)^2\right]$

$W_0 = \sqrt{\frac{\lambda z_0}{\pi}}$

op. intensity: $I(\rho, z) = \frac{2P}{\pi W^2(z)} e^{-2\rho^2 / W^2(z)}$

$$\bar{e}(t,z) = \hat{x} a_x \cos(\omega t - kz) + \hat{y} a_y \cos(\omega t - kz + \varphi)$$

linear pol: $\varphi = 0$, $\varphi = \pi$

LHCP: $a_x = a_y = a$, $\varphi = \pi/2$ ↻

RHCP: $a_x = a_y = a$, $\varphi = -\pi/2$ ↺

$\cos(\alpha \pm \beta) = \cos\alpha \cos\beta \mp \sin\alpha \sin\beta$

Jones

$$E = \begin{bmatrix} a_x \\ a_y e^{j\varphi} \end{bmatrix}$$

$\omega_{bragg} = \frac{n_1 + n_2}{4 n_1 n_2} \frac{2\pi c}{\Lambda}$ $\quad \lambda_{bragg} = \frac{2\pi c}{\omega_{bragg}}$

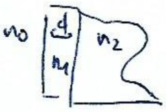
$L_1 + L_2 = \Lambda$

Plasmon

$|\varepsilon'| \gg |\varepsilon''|$

$$k_{sp} = k_0 n_{sp} = \frac{\omega}{c} \sqrt{\frac{\varepsilon_m' \varepsilon_d}{\varepsilon_m' + \varepsilon_d}}$$

$n_1 d = \lambda_{AR}/4$



$n_1 = \sqrt{n_0 n_2}$

to supress competely reflection

o) Main steps manofabrication

Top-down ⇒ wafer → processing → dicing → packaging

Bottom-up ⇒ molecular sup → selfassembly → dicing → device

Litography

o) Surface plasmon

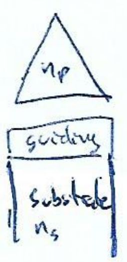
They are collective vibrations of an electron gas (or plasma) surrounding the atomic lattice sites of metal

→ e^- oscillations that exist at the interface between any two materials where the real part of dielectric function changes sign across interface

How to excite via prism coupling

We excite evanescence field

We introduce a prism in proximity of guiding film



$n_p > n_s$

If transverse momentum inside prism k_{zp} matches modes propagation β the plane wave from the prism is coupled.

o) Scattering

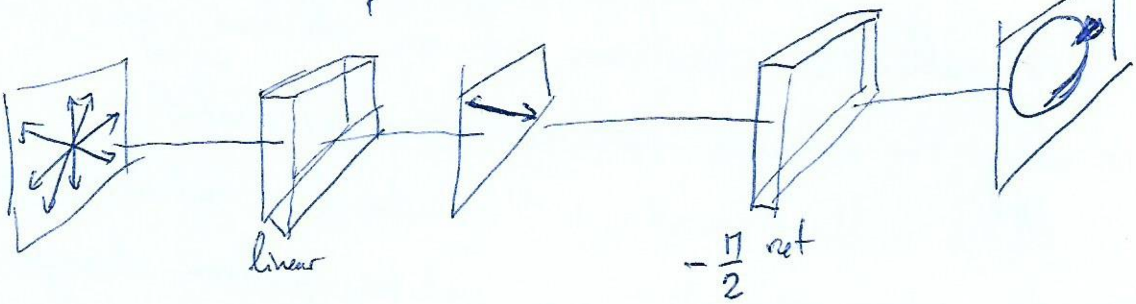
o) Theories

∘) How to obtain circulary polarized from unpolarized

We put a linear polarizer and then a wave retarder

The wave retarder delays one axis by a phase.
of

For instance, linear polarizer in x axis
and quarter wave retarder



∘) Scattering

→ Redirection of radiation out of the original direction due to interactoons with molecules and particles

→ Refraction, reflection, diffraction etc are all different forms of scattering

→ Types: elastic, inelastic, quasi-elastic, single, multiple