TFY 4240

Øving 9 2006

Problem 1

Problem 9.19 in Griffiths

Problem 2

a) The reflection coefficient of a thin film is given by

$$r = \frac{r_{01} + r_{12}e^{2i\delta}}{+ + r_{01}r_{12}e^{2i\delta}}$$

Express r_{01}, r_{12} *and* δ in terms of the appropriate dielectric constants and the film thickness. The index 0 stands for the incident medium (vacuum), 1 stands for the film and 2 for the substrate.

b) If the film is very thin, the expression above can be expanded in terms of d/λ or you can alternatively expand the sinus and cosinus terms in the transfer matrix. Show that to first order one obtains

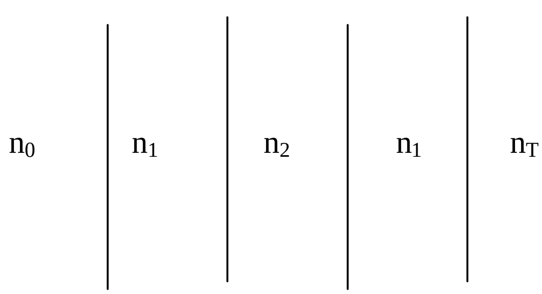
$$r = r_{02}(1 + 2ik_0 d\frac{\varepsilon_1 - \varepsilon_2}{1 - \varepsilon_2})$$
$$R = |r|^2 \quad ; \quad k = \frac{2\pi}{\lambda}$$

Use this expression to estimate the influence of a10 nm oxide film on the reflectivity of aluminium at $\lambda = 0.5$ μm.

ε_{Al}=-36+i9.2
N_{Al}=0.76 + i6.05
ε_{oxide}=3.0+i0.0

Problem 3

Calculate the transfer matrix for the structure shown in the figure below at the design wavelength λ_0. Each layer is a λ/4 layer.



Show that the anti reflection condition is given by

$$n_1^4 = n_0 n_T n_2^2$$

No materials are available to satisfy this condition exactly. Find the reflection coefficient if the available materials are Al_2O_3 with refractive index 1.69 and MgF_2 with refractive index 1.38. The substrate is quattz with refractive index 1.445. n_0=1.0. What should the refractive index of the high index material have been in order to give zero reflectivity?