Chem 249 Problem Set 1

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Classical Description of Electromagnetic Radiation and Absorption Theory

A. Maxwell's Equations and Plane Electromagnetic Waves

1. Vector Fields and Notation
2. EM Fields and Superposition: E, B, D, H
3. Maxwell's Equations
4. EM Waves - Plane Waves
5. Polarization/Jones Vectors and Matrices
7. EM Waves in Dielectrics

B. Fresnel Calculations and Total Internal Reflection

1. Fresnel Calculations
2. Normal Incidence Reflectance
3. Brewster's Angle
4. Total Internal Reflection
5. Metal Surfaces

Problems:

Fresnel Calculations

1. The following file is data from a fluorescence decay measurement:

http://unicorn.ps.uci.edu/249/igor/fdata.txt

Please use the program Igor Pro to determine the lifetime of this decay curve.

2. Create an Igor Pro file to calculate the Reflectivity for p-polarized and s-polarized light (R_p and R_s) as a function of incident angle from normal incidence (0 degrees) to grazing incidence (90 degrees) in 0.1 degree increments for the following TWO phase system where the index of refraction n_1 is real, and the index of refraction n_2 can be complex:

i) BK7/Air @ 585 nm ($n_1 = 1.517, n_2 = 1.00 + 0i$)
ii) Air/Gold @ 632 nm ($n_1 = 1, n_2 = 0.1742 + 3.4116i$)

iii) Water/Si @ 632 nm ($n_1 = 1.33, n_2 = 3.882 + 0.019i$)

See the Hansen Paper for detailed equations. For Igor Pro, a text file of the refined History emailed to me is the most useful. Alternatively, you can use Mathematica or Matlab to create these Reflectivity curves, but I will be less able to help debug your calculation.

3. Using Igor Pro, please create graphs of E_x^2, E_y^2 and E_z^2 vs angle for three two-phase systems (see Hansen Paper for details):

i) BK7/Air @ 585 nm ($n_1 = 1.517, n_2 = 1.00 + 0i$)
ii) Air/Gold @ 632 nm ($n_1 = 1, n_2 = 0.1742 + 3.4116i$)
iii) Water/Si @ 632 nm ($n_1 = 1.33, n_2 = 3.882 + 0.019i$)

You should let people choose where to calculate the field: either above or below the interface.