

ChE 891/2

Experimental Methods in Nanotechnology

Homework 5

Due 20 February 2008

1. Derive the relation we determined in the notes that

$$I_r^2/I_0 = \alpha^2 \omega^4/c^4 \sin(\psi)$$

where the symbols have been defined in the lectures. Show all steps then continue with your derivation and find the final Rayleigh relation for unpolarized light

$$I_r^2/I_0 = 9\pi^2/[2\lambda_0^4] V_{\text{scat}}^2 \{[n^2 - n_0^2]/[n^2 + 2 n_0^2]\}^2 \times [1 + \sin(\theta)^2]$$

The paper by Kerker (Ind Eng Chem **60** (1968) 31) or Yguerabide and Yguerabide (Anal Biochem **262** (1998) 137) may help in your derivation (there are of course other books and papers on the subject).

2. The scattering power of an object is related to its polarizability, α , which is given by (approximately)

$$\alpha = V_{\text{scat}} [3/4\pi] [n^2 - n_0^2]/[n^2 + 2 n_0^2]$$

Comment on this equation and its validity. Also, go to the literature and determine values for the polarizability and calculate it with the above equation, is it accurate?

3. Find, in the literature, the refractive index increment, dn/dc , and report values. Can you determine a way to estimate its value? Is it accurate? How sensitive is the scattering intensity to errors in dn/dc ?

4. Go to the literature and find manuscripts reporting the Rayleigh ratio (R_θ). What units do they use? What is its magnitude? Are there various definitions of it?

Please give the references to any archival journal or book in your homework solution.