KEMS448 Physical Chemistry Advanced Laboratory Work

Quantum Yield of a Fluorescing Dye Molecule

Quantum yield of fluorescence is the ratio of the photons absorbed and emitted by a molecule. Therefore, it gives the probability of fluorescence which is the decay of a molecule's excited state by emitting light energy. Quantum yield is always positive and below 1, as any ratio is. (If it is 0, there is no fluorescence, and with it being 1, every photon goes through the fluorescence process.)

A common way of determining the quantum yield of a fluorescing dye molecule is to compare its intensity with known standardized samples. Another way is to determine the portion of light hitting the dye decaying non-radiatively, turning the excess energy into heat instead. The rest of the photons are then deduced to be the ones fluorescing. A way of examining heat formation is *thermal blooming* (or *thermal lens method*), which is based on the solution's refractive ability and its dependence on temperature. Thus, a point-sized heat source in a solution (eg. optically focused laser radiation) forms a spherical "lens" around itself, affecting all light passing through.

With molecules with no measured fluorescence, all energy is turned into heat and therefore the "lens" formed into the sample cell is the strongest. By comparing a non-radiating and a fluorescing molecule's "lens strengths", the portions of energy turned into heat, and light energy emitted as fluorescence can be determined in the dye's case.

In this laboratory work, in a group of 2-3 people, a measurement array is assembled for examining thermal blooming. The quantum yield of fluorescence is evaluated for two different dyes. Also, the absorption and emission spectra of the dyes are collected with a spectrometer.

Times for measurements can be arranged through the laboratory assistants.

Further reading:

*(1) James H. Brannon, and Douglas Magde: J. Phys. Chem., **82**, 705*