Thursday, May 12, 2022

PHOTONICS spectra®

WHITE PAPERS & APPLICATION NOTES


Evaluation Warning : The version can be used only for evaluation purpose...

APPLICATION NOTE

Relative Quantum Yield of 2-Aminopyridine

AN_F78, Laura Nather, Daniella Gakamsky, Georgios Arvanitakis

EDINBURGH INSTRUMENTS

Introduction

Quantum yield is a fundamental photophysical parameter that describes a sample's fluorescence efficiency and is defined as the ratio of the number of photons emitted to the number of photons absorbed by a sample. Accurate and reliable quantum yield measurements are important for a broad range of applications including displays, solar cells, bioimaging and drug development.

There are two optical methods for measuring the quantum yield: the absolute method and the relative method. In the absolute method, the quantum yield is measured directly using an integrating sphere, while in the relative method the fluorescence intensity of the unknown sample is compared with the fluorescence intensity of a standard sample to calculate the quantum yield of the unknown.

In this application note, an Edinburgh Instruments FS5 Spectrofluorometer (Figure 1) is used to measure the quantum yield of 2-Aminopyridine (2AMP) via the relative method. 2AMP in sulfuric acid (H_2SO_4) has been previously used as a quantum yield reference standard in the UV-visible range. The quantum yield of 2AMP was measured to be 60% in 1968[1] and 64% in 1988.[2] These literature quantum yield references values are now decades old, and here we present a reinvestigation and revaluation of the quantum yield of 2AMP in 1M H_2SO_4 using quinine bisulphate (QBS) in 1M H_2SO_4 as the reference standard with a modern spectrofluorometer.

Figure 1: Edinburgh Instruments FS5 Spectrofluorometer

Methodology

The relative quantum yield of 2AMP can be calculated through the following form eq.1[3]

$$\Phi_x = \Phi_s \left(\frac{G_x}{G_s}\right)\left(\frac{1-10^{-A_s}}{1-10^{-A_x}}\right)\left(\frac{n_x}{n_s}\right)^2 \quad \text{(Eq.1)}$$

where the subscripts S and R denote sample of interest (2AMP) and reference standard (QBS), respectively. Φ is the quantum yield, I is the integrated fluorescence intensity, and A is the absorbance at the excitation wavelength. n is the refractive index of the solvents used for sample and reference solutions at the mean emission wavelength. In this application note, the same solvent (1M H_2SO_4) was used for both 2AMP and QBS and this term cancels.

To increase the accuracy and precision of the calculated quantum yield value, it is best practice to prepare and measure several solutions of the sample and reference with different concentrations. By plotting I versus 1-10^{-A} for 2AMP and QBS, the gradients (Grad$_x$ and Grad$_s$) can be used to calculate the quantum yield (Eq.2). This approach prevents potential systematic errors, such as dye aggregation, which would appear as a deviation from the straight line at higher concentrations.

$$\Phi_x = \Phi_s \left(\frac{\lambda_s}{\lambda_x}\right)\left(\frac{1-10^{-A_s}}{1-10^{-A_x}}\right)\left(\frac{n_x}{n_s}\right)^2 \quad \text{(Eq.2)}$$

$$\Phi_x = \Phi_s \frac{Grad_x}{Grad_s}$$

Five solutions of 2AMP in 1M H_2SO_4 and five solutions of QBS in 1M H_2SO_4 at different concentrations were prepared. Absorption and fluorescence spectra were measured using an FS5 Spectrofluorometer equipped with a 150 W Xenon lamp, a PMT-980 detector and a SC-05 cuvette holder.

Absorption & Emission Spectra of 2AMP & QBS

Firstly, the absorbance values of the five 2AMP and QBS solutions were determined by measuring the absorption spectra using the FS5's built-in transmission detector. The absorbance values of the solutions were kept below 0.1 at the excitation wavelength (310 nm) to minimise the probability of inner filter effects and ranged between 0.008 and 0.093. The normalised absorption spectra of 2AMP and QBS are shown in Figure 2a.

Next, the fluorescence spectra of five 2AMP and QBS solutions were acquired. The intensity of the fluorescence detected by a spectrofluorometer is dependent on the excitation wavelength, excitation and emission bandwidths, and integration time. By keeping these parameters identical the integrated fluorescence intensities, I_x and I_s, of 2AMP and QBS can be meaningfully compared. The experimental parameters were λ_{ex}=310 nm with excitation and emission bandwidths set at 3 nm and 0.5 nm, respectively, 1 nm step size, and 0.5 s integration time. Figure 2b shows the normalised fluorescence spectra of 2AMP and QBS.

Relative Quantum Yield of 2-Aminopyridine

Quantum yield is a photophysical parameter describing a sample's fluorescence efficiency. It can be measured optically via the absolute method and relative method. 2-Aminopyridine in sulfuric acid has been previously used as a QY reference standard in the UV-vis range but the 2 AMP QY values are now decades old. Edinburgh Instruments presents a reinvestigation and revaluation of the quantum yield of 2 AMP in 1 M H2SO4, using quinine bisulphate in 1 M H2SO4 as the reference standard with a Spectrofluorometer.

DOWNLOAD WHITE PAPER

EDINBURGH INSTRUMENTS

More White Papers from This Sponsor

- Spectrofluorometer Add-on for Widefield Fluorescence Microscopy
- Comparing Hole Extraction Efficiencies in Perovskite Solar Cells using PLQY
- X-ray Excited Luminescence Lifetime of Scintillators

Visit **Photonics Media** to download other white papers and learn more about the latest developments in lasers, imaging, optics, biophotonics, machine vision, spectroscopy, microscopy, photovoltaics and more.

www.photonics.com/WhitePapers.aspx