

Fluorescence Spectra and the Rate of Electron Transfer by Quenching

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Practical:

Abstract

In this experiment you will study the fate of excited molecules in which fluorescence

competes with quenching. When quenching occurs, excess energy held by an excited state molecule is passed on to other molecules in solution. As a consequence, the excited molecule is no longer able to fluoresce, and the fluorescence intensity diminishes in the presence of the quencher.

The experiment is in two parts. In part A you will gain experience using a fluorimeter

by measuring the fluorescence excitation spectrum and fluorescence emission

spectrum of fluorescein; fluorescein's absorption spectrum is also recorded. These spectra are used to illustrate the well-known "mirror-image" relationship.

Part B of the experiment uses the short lifetime of the excited state of Ru(bipy)₃²⁺

as an internal clock. Under the conditions of the experiment, fluorescence competes

with electron transfer to Fe³⁺ or Cu²⁺, and the kinetics of the reactions are deduced

from the degree by which the fluorescence is quenched. From the rate constants for

quenching the activation energy for the electron transfer is calculated, and you will

also determine whether the electron transfer reaction is diffusion or activation

controlled.

Intended academic level

2nd/3rd year honours chemistry

Duration

3-5 hours, depending upon student preparation and skills

Outcomes

As a primary goal, the experiment is intended to encourage students to think about the principles of fluorimetry and the fluorescence process. The study of quenching allows consideration of the kinetics of liquid-phase reactions and the Stern-Volmer plot. It may be extended as required to include concepts such as inner- or outer-sphere reactions and Marcus Theory.

Materials

Fluorescein, tris(2,2'-bipyridine)ruthenium (II) chloride, sodium hydroxide solution, sulphuric acid, iron and copper ion solutions

Costs

A standard fluorimeter and a uv/visible spectrometer are required. Running costs for the experiment are low, since the volumes of solutions required are small and the chemicals needed are stable.

Further comments

Reading

Printed instructions as pdf file from the URL given above

Contact details

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