Metal Ions and Ligands in Sensing and Imaging : A Workshop on Principles, Examples, and Applications

J. A. Gareth Williams

Department of Chemistry, Durham University, Durham, DH1 3LE, U.K.
E-mail: j.a.g.williams@durham.ac.uk

Modern methods for the detection of light are exquisitely sensitive: light can be detected at extremely low levels using low-cost equipment. Fluorescence microscopy is a key technique in physiology and biomedical sciences, widely used to explore cell structures down to around 200 nm, with high temporal resolution. Meanwhile, the non-contact nature of photoluminescence also renders it suitable for the remote monitoring of, for instance, the temperature and pressure around objects as large as aircraft wings and turbine blades.

This presentation will offer an overview of some of the principles underpinning the use of luminescence for sensing and imaging, and a personal perspective of how a diverse range of systems that emerged in our laboratory over the past 25 years have been investigated and applied.

(1) Examples of Pt(II) and Ir(III) complexes, related to those of Lecture 1, will be presented, where the luminescence properties are modulated in response to the binding of analytes. The perturbation of excited state energies can lead to a desirable ratiometric response, and/or quenching processes (*e.g.,* photo-induced electron transfer, PET) can be suppressed or activated.[1]

(2) The attractions of using *phosphorescent* emitters – as opposed to conventional fluorophores – will be discussed. Long lifetimes allow time-resolved detection procedures to be employed: lifetime-based sensing is less prone to uncertainty arising from fluctuations in the efficiency of delivery and collection of light. Moreover, time-gating provides a way to eliminate background emission. Early examples of phosphorescence lifetime imaging microscopy will be presented, using Pt(II) and Ir(III) complexes.[2]

(3) Temperature sensing using molecular and solid-state ionic materials will be described. I will first review how the luminescence of lanthanide 3+ ions differs from that of, say Pt(II) and Ir(III) complexes, and then discuss examples of dual emission from oxides containing Cr^{3+} and lanthanides.[3] Unusual Mn^{5+} systems that emit brightly in the near-infrared have also been discovered.

(4) Finally, we will consider how fundamental principles of coordination chemistry can be used to aid the design of ligating groups that bind metal ions selectively over others. *Selectivity* – and not just *sensitivity* – is key to applications. Recent advances in tackling the challenge of how to target Mg^{2+} selectively over Ca^{2+} will be summarised, together with an intriguing new family of Zn^{2+}-binding ligands.[4]

Selected references:

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