

# Institute for Photonics & Advanced Sensing (IPAS) Chemical & Radiation Sensing

## Theme Leaders



**Prof Nigel Spooner**

Using in-house and specialty optical fibre with unique surface coatings developed by our chemistry team, we have research programs developing novel optical fibre based chemical sensors. We are using these sensors for monitoring: water quality, corrosion, wine maturation, embryo development, soil nutrients and fuel degradation.

We are also researching new fibre based radiation dosimeters for medicine, industry and Defence.

The IPAS Environmental Luminescence facility is home to the most comprehensive suite of luminescence research equipment anywhere in the world. Using this capability we develop new forensic luminescence techniques and provide a wide range of training and dating services to industry.



## Chemical Sensing

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## Radiation Sensing

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## Optical Dating & Environmental Dosimetry

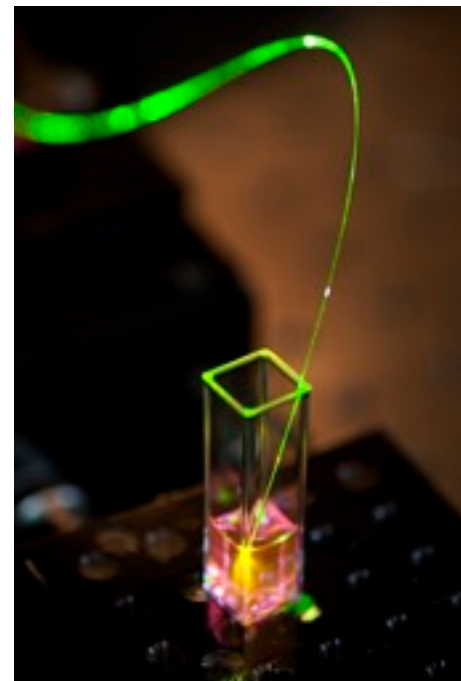
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## Environmental Luminescence Facility

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## Chemical Sensing

Chemical Sensing research at IPAS focuses on a range of applications, including corrosion sensing, wine monitoring, embryo monitoring and soil & water quality monitoring. We are developing new ways to target analytes such as aluminium ions ( $\text{Al}^{3+}$ ), free  $\text{SO}_2$  and hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) on a suite of platforms including dip sensors, distributed sensors and exposed core fibre sensors. Working closely with our Optical Materials & Surface Functionalisation researchers, we are developing new techniques with irrigation companies, Defence organisations, embryologists and oenologists.

Our new biophotonics facility at the University's Medical School, the STARR laboratory, allows us to perform novel biomedical research which we were unable to do within our existing photonics laboratories.

## Radiation Sensing

The Radiation Sensing work at IPAS focuses on the development of new radiation dosimetry techniques for both fundamental research and applications for health, Defence and industry. Protection from harmful radiation is a key area of our work, particularly towards the improvement of cancer treatment safety. This includes the development of a dosimeter that uses optically stimulated luminescence (OSL) to sense radiation. This novel approach involves an optical fibre capable of producing OSL intrinsically, meaning the optical fibre becomes the active sensing material.

## Optical Dating & Environmental Dosimetry

Our Optical Dating & Environmental Dosimetry researchers specialise in the physics of luminescence, particularly of minerals and artificial building materials. This has led to the advancement of luminescence techniques for forensic dosimetry, dose reconstruction following radiological incidents, and the application of thermoluminescence (TL) and optical dating to a diverse range of questions in archaeology, geomorphology and palaeohydrology. This includes the dating of ancient ceramics, megafaunal extinctions, and human migrations across Australia (publications in *Science and Nature*).

## Environmental Luminescence facility

The radiation sensing and optical dating work described above takes place in our Environmental Luminescence facility. The facility is unsurpassed globally in terms of luminescence research and dating capabilities and equipment.

The apparatus suite includes the world's most sensitive TL spectrometer, a photon-counting imaging system (PCIS) developed in collaboration with ANU, and state-of-the-art TL/OSL Risø readers. In addition, we have specialised TL apparatus for the measurement of luminescence kinetics, and a single-aliquot low-light level detection chamber for characterising signal stability. Luminescence techniques are highly versatile, being able to accurately measure ages of up to 500,000 years before present, down to doses as low as a fraction of one day's background radiation. We undertake fundamental research to advance these techniques and further extend the applicability of luminescence analysis. We also provide training and contract research and dating services to industry, Defence and academia.

## Case Study: Corrosion Sensing

In collaboration with DSTO, we have developed microstructured optical fibre sensors for the application of distributed corrosion sensing within aircraft monocoque.

This work included the first fabrication of glass exposed-core microstructured optical fibres, and IPAS are the only group with the capability to fabricate these fibres. This novel approach has enabled the first demonstration of spatially distributed chemical sensing within a microstructured optical fibre. In addition to this, we have also performed the first experimental demonstration of a surface functionalised microstructured optical fibre dip sensor for the detection of aluminium ions, a key analyte for corrosion sensing, in a 5nL sample.