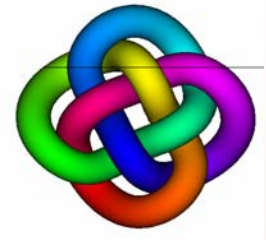


# Guided Wave Optics & Photonics Research



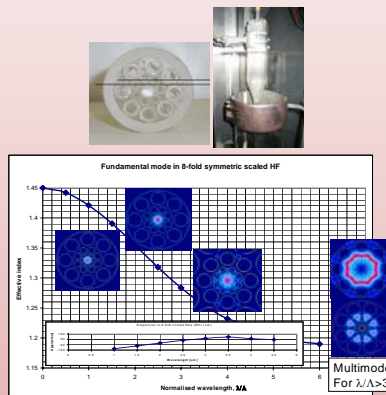
[www.elec.mq.edu.au/gwopr](http://www.elec.mq.edu.au/gwopr)

“Photonics” is the use of photons in ways historically associated with electrons - e.g. for transmission and processing of information. The sample of activities below are supported by the Australian Research Council, the Department of Education Science and Training, Macquarie University, the Defence Science & Technology Organisation, Australian industry, ANSTO, and collaborating European universities.

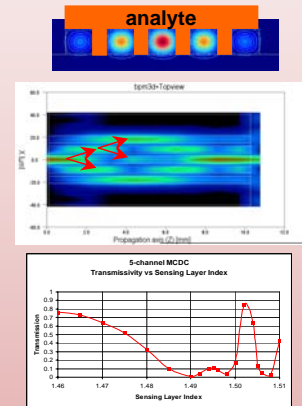
## Guided-wave Polymer Optics

**Aims:** To develop inexpensive and adaptive optical waveguides and devices (e.g. fibres, filters, integrated-optical switches) using novel polymer-based materials, clever design, and low cost fabrication methods.

**Applications:** Automotive and domestic optical communication networks, biomedical and environmental sensing.



**Example 1: Scaled holey polymer fibre;** typical preform (top L), manufacturing at Aston Uni. (top R), calculated modes and dispersion (bottom).

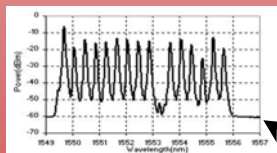


**Example 2: Multichannel directional coupler** refractive index sensor; end view (top), top view (middle), calculated sensing characteristic (bottom).

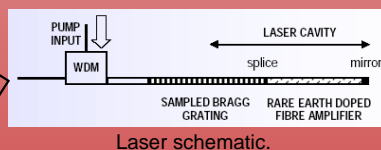
## Multi-wavelength Lasers

**Aims:** To develop and improve the performance of optical fibre lasers continuously generating several wavelengths.

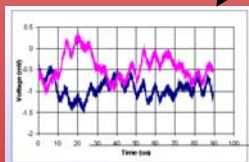
**Applications:** High-resolution and high dynamic-range sensing, microwave signal generation and transmission (e.g. wireless access networks).



Optical spectrum of the laser's output.



Laser schematic.



Temporal output of two wavelengths, showing in-phase and anti-phase intensity noise.



A prototype packaged by METS.

## Optical Continuum Generation

**Aims:** To optimise extremely broadband (e.g. > 1000nm) and high-brightness optical sources by combining low-cost pump lasers, highly nonlinear microstructured fibre, and an improved understanding of the interplay between nonlinear and dispersive propagation in optical waveguides.

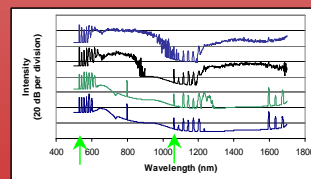
**Applications:** Optical spectroscopy and sensing, medical imaging, high-resolution metrology.



Schematic of experiment (above), and the nonlinear Schrödinger equation for propagation in optical fibres (right).

$$\frac{\partial A}{\partial z} = -\frac{\alpha}{2} A - j \frac{\beta_2}{2} \frac{\partial^2 A}{\partial T^2} + \frac{1}{6} \beta_3 \frac{\partial^3 A}{\partial T^3} + j \left[ \beta_1 |A|^2 A + \beta_2 \frac{\partial}{\partial T} (|A|^2 A) - \gamma_s A \frac{\partial |A|^2}{\partial T} \right]$$

LINEAR TERMS,  $L$       NONLINEAR TERMS,  $N$   
 loss    group velocity dispersion (GVD)    3rd order dispersion    self-phase modulation (SPM + XPM)    self-steepening    stimulated Raman scattering (SRS)  
 Nonlinearity coefficient:  $\gamma = \frac{n_2 \omega_p}{c A_{eff}}$      $L_{nl} = \frac{1}{\gamma P_0}$   
 (typ.  $\gamma \sim 20$  [W/km])    (typ.  $L_{nl} \sim 5$  km @  $P_p = 10$  kW)



Optical spectrum of continuum generated with dual-wavelength pump (532nm + 1064nm), for increasing pump powers.

The Guided-Wave Optics & Photonics research group is a member of the Macquarie University Centre for Lasers and Applications



Contact: A/Prof Graham Town  
gtown@ics.mq.edu.au, 9850 9063

Department of Electronics