INNOVATIVE ASSET MANAGEMENT

PHOTONIC TECHNOLOGIES IN SMART STRUCTURES

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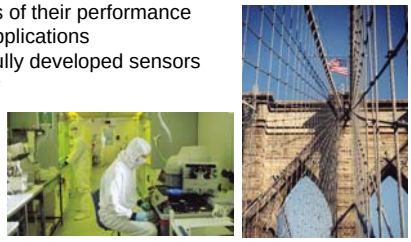
THIS PRESENTATION WILL FOCUS ON:

- Basic photonic sensor configurations
- The new active element (the FBG)
- Characteristics of their performance
- Overview of applications
- New, not yet fully developed sensors
- An opportunity



Large, expensive, complex structures can be monitored with new distributed, networked, sensor arrays to provide early indication of:

- Design shortfalls
- Maintenance issues
- Corrosion effects
- Loading consequences
- Dynamic constraints.

In the US alone there are more than 4 million Bridges, many approaching or have exceeded their design life.

Optical Fibre sensors have been around for approximately 30 years but early claims did not eventuate.

A new generation of these sensors has overcome these limitations and promise to deliver:

- High volume, low cost manufacture
- Physically small and robust
- Immune to electromagnetic influences
- No generated electrical noise
- High spatial resolution – distributed measurement
- Easily networked through an optical fibre system
- Scalable to a very large numbers of sensors

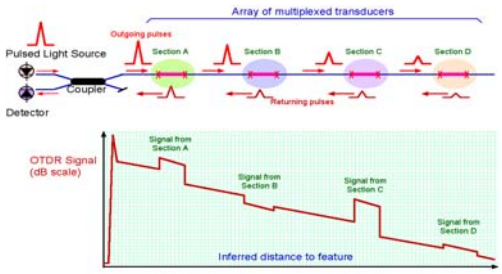
Advanced Distributed Sensors

- Time resolved intensity measurement
- Low coherence interferometry
- Fluorescence Detectors
- Point Sensors using Fibre Bragg Gratings
- Distributed Fibre Sensors

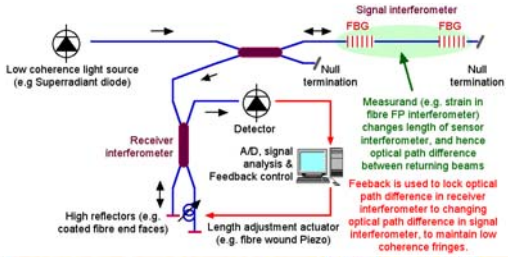
AN ENABLING COMPONENT TECHNOLOGY

Time resolved Intensity-

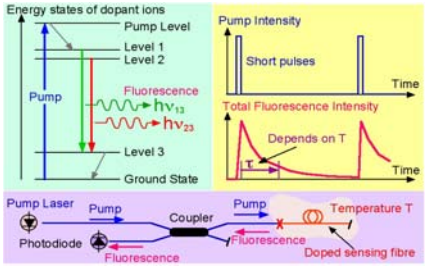
- Relies on time-of-flight (similar to radar)
- Long complex structures, eg roads, pipelines



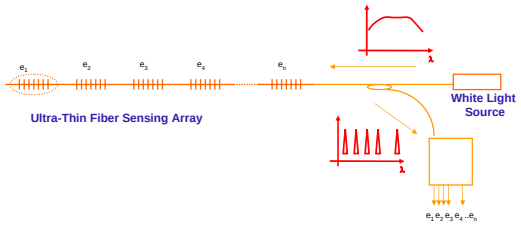
Low coherence interferometry
- High accuracy
- Multiple parameter (acoustic – seismic, strain)



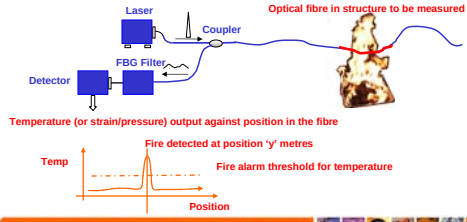
Fluoresence detectors
- Doped optical fibre (rare earth materials)
- Measure change in lifetime decay
- Measures temperature at a point or spatially averaged



Point sensors using Fibre Bragg Gratings (FBGs)
- Multiple axis
- Strain and temperature
- Multiple points sensors in a single fibre



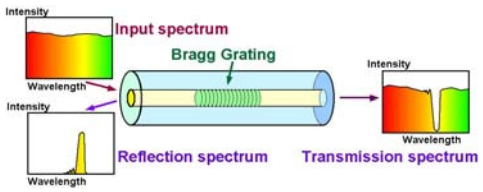
Distributed sensing
- Temperature (using Raman scattering)
- Strain (using Brillouin scattering)
- The fibre itself is the sensor
- Sensor array may be kilometers long
- Ideal for mines, tunnels, etc



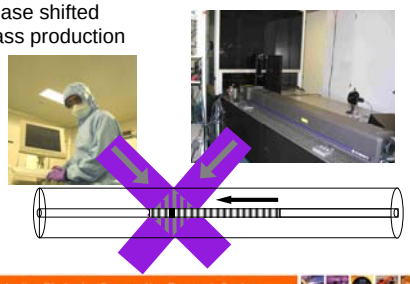
An extremely versatile fibre sensing element
- ***The Fibre Bragg Grating***

Refractive index variation written into the core of the fibre at a specific wavelength.

The FBG reflects a narrow wavelength of light and becomes A fundamental signal processing element

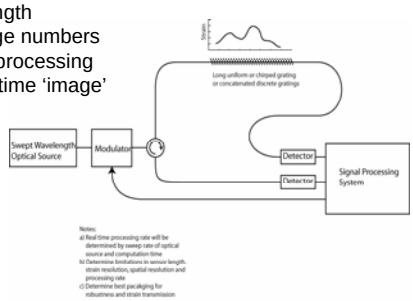


The FBG 'printing' process
- Using Ultra-violet light as a specific form of hologram
- Arbitrary wavelength
- Chirped pitch
- Phase shifted
- Mass production

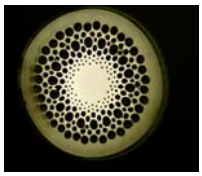


Fundamentally new sensors enabled by high fidelity FBGs

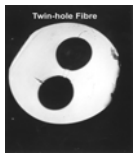
- One grating with variable pitch (chirp)
- 10 cm overall length
- Networked – large numbers
- Realtime signal processing
- Potential for realtime 'image'



New types of optical fibre

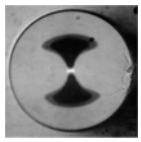


Holey



Multiple core

Novel shaped



- Holey structure
- One material
- Silica and polymer
- Accommodates FBGs
- Possibility of direct spectroscopic measurement of gases and liquids

APPLICATIONS

High and low frequency strain in:

Structures
- Bridges
- Towers
- Dams
- Buildings
- Pipelines

Platforms
- Aircraft
- Ships
- Rail infrastructure

In the form of:
- Single point – high precision
- Long linear multiple point
- Short (10cm) distributed, mm resolution
- Metre scale full area 'image'
- 1, 2 and 3 dimensional

The Australian Photonics Cooperative Research Centre

- An unincorporated joint venture
- 5 Universities and 21 Industry Partners
- 13 Start-up Companies
- Raised $240 million VC investment into Start-ups
- Start-up companies have paid more in Federal Taxes than total investment by the Australian Government in this CRC.

Structural Health Monitoring is the subject of a supplementary bid proposal currently being considered by DEST for funding.

Consortium

Australian Photonics Pty.Ltd together with its start-up company Redfern Optical Components Pty.Ltd. and other Commercial partners is developing a consortium to drive the application of photonic technologies in the area of Structural Health Monitoring.

Potential partners (users) are encouraged to contact Australian Photonics.

AUSTRALIAN PHOTONICS

REDFERN OPTICAL COMPONENTS

Conclusions

- Novel Photonic components for structural health monitoring are now available for assessment and incorporation into new designs.
- High spatial resolution, distributed sensing.
- Networked, with standard telecommunications backbone.
- Remotely accessed over standard telecomm's infrastructure.
- These sensor networks will form the basis of future '**Smart Structures'**