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A precision fibre optic CO_2 sensor

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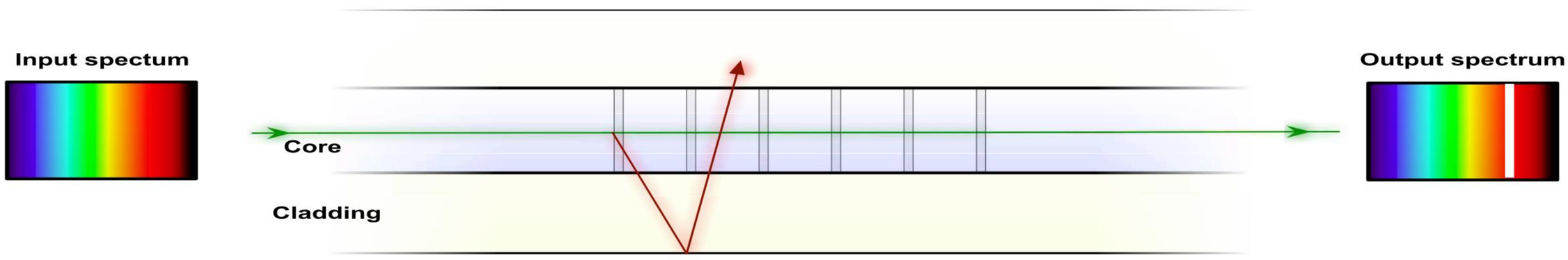
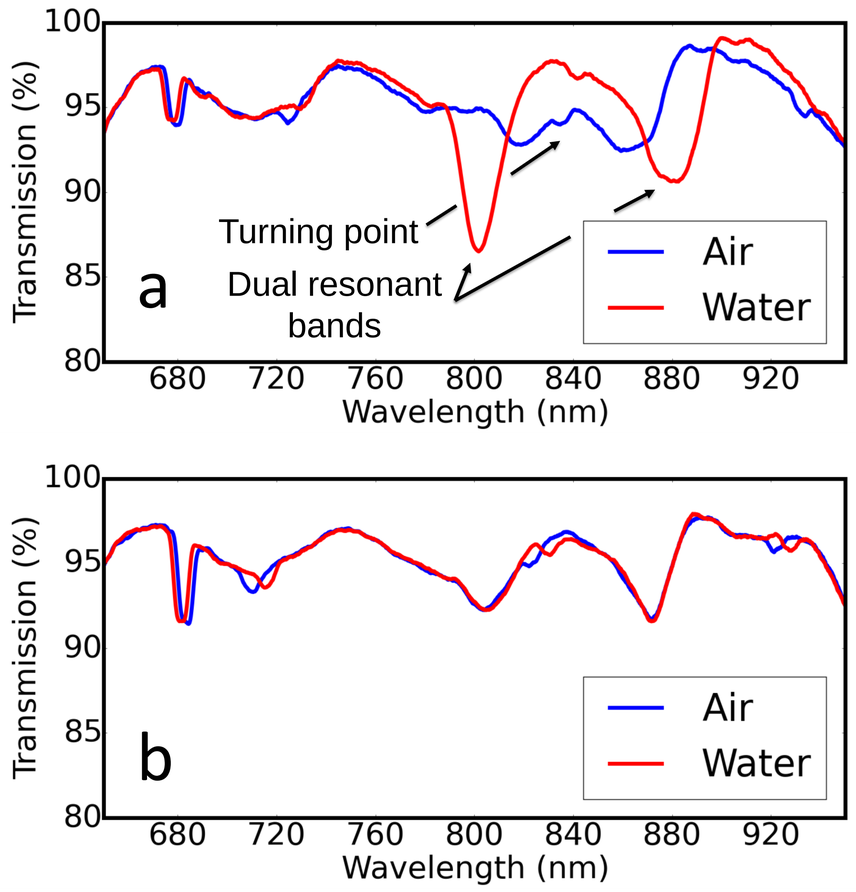
Fibre optic sensors
Optical fibre offers a flexible, compact (diameter of 125 µm) sensing platform which is immune to EM interference and possess the capacity to be multiplexed.

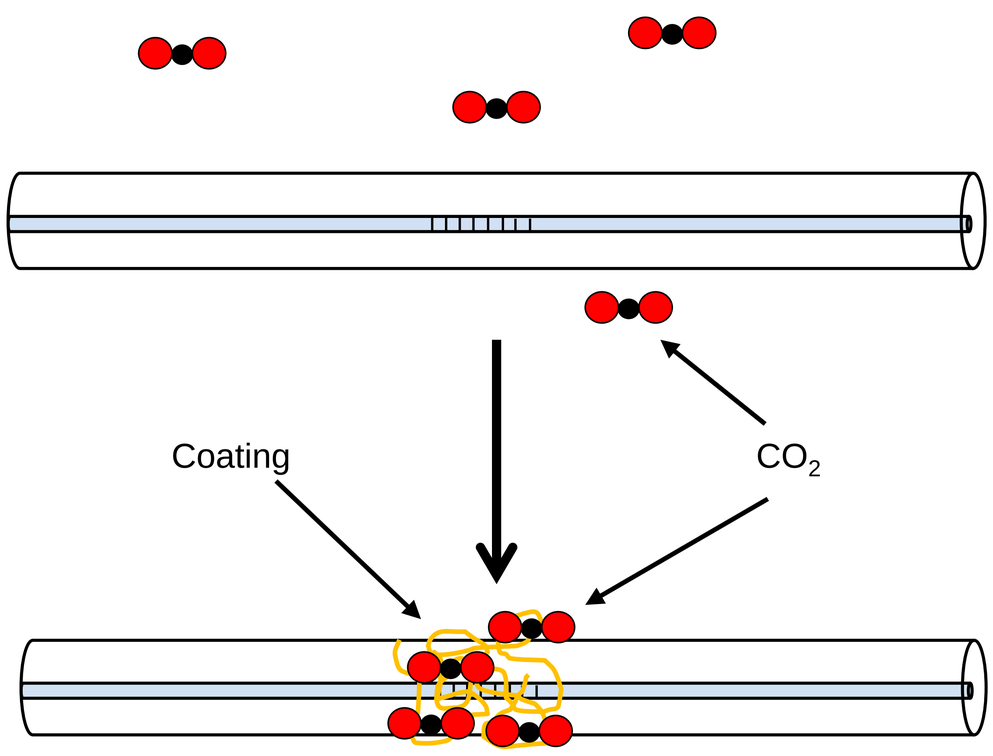
Long period gratings (LPGs)
LPGs, a class of optical fibre sensor, are a series of periodic modulations to the refractive index of the optical fibre's core, typically with a period between 100 – 1000 µm. The grating allows certain wavelengths of light, that satisfy the phase matching equation, to couple into the cladding and interact with the surrounding environment.



Phase matching turning point
Each mode that is coupled into the fibre's cladding displays a turning point. LPGs operating at a phase matching turning point display greater sensitivity to surrounding perturbations thus having the potential to be used to fabricate a highly sensitive device.



Changing the external refractive index of the LPG through immersion in water demonstrates the improved sensitivity of an LPG operating at the phase matching turning point (a), characterised by the movement of dual resonant bands in opposite directions, in comparison to a standard LPG (b)



Coating deposition
Deposition of an active nanostructured coating onto the LPG can enhance the selectivity of the device to a desired external stimulus. As such, identification of a functional coating which demonstrates reversible CO_2 selectivity is essential to manufacturing a precision CO_2 sensor.

Next steps
Fibre optic sensor technology offers an excellent platform for the precision CO_2 sensor through combining the enhanced sensitivity of LPGs operating at the phase matching turning point with a CO_2 selective nanostructured coating.

Future work will involve assessing prospective CO_2 sensitive coatings for their CO_2 mediated responses via interferometric techniques. Following this, the chosen period for the LPG will be evaluated using differing refractive index standards. Finally, the coated LPG will be examined for humidity and temperature related responses prior to long-term stability testing.

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