Supercontinuum success

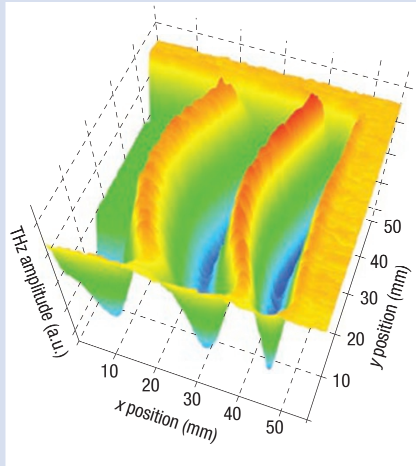
Opt. Express **16,** 10178–10188 (2008)
A UK–German collaboration claims to have used a supercontinuum source to perform broadband cavity-enhanced absorption spectroscopy of several trace gases simultaneously for the first time. Scientists from the University of Cambridge, UK, and the University of Erlangen-Nuremberg in Germany recorded spectra over bandwidths as broad as 100 nm, spanning multiple absorption lines of water vapour and oxygen. They also used their so-called SC-CEAS instrument to make quantitative measurements of the level of NO_2 and NO_3. In the case of NO_3, a detection sensitivity of three parts per trillion was achieved for a measurement acquisition time of 2 s. The SC-CEAS instrument consists of a commercial fibre-laser supercontinuum source, which emits light covering a spectrum from 400 nm to 2,000 nm, a series of spectral filters, and a 1.15-m-long cavity formed by two mirrors (with a reflectivity of 99.995% at a wavelength of 600 nm), which houses the gas sample to be analysed. A spectrometer and CCD camera are placed on the far side of the cavity to analyse the spectra of the light that leaves the cavity. Measurements were made in the spectral window from 420 nm to 740 nm. The team says that despite the initial demonstration being limited to visible wavelengths, there is no reason why the technique could not be extended into either the infrared or UV.

Twin-diode approach

Appl. Opt. **47,** 3023–3026 (2008)
Researchers in Germany have developed a low-cost terahertz spectrometer with coherent detection based on two simple and robust dipole antennas driven by two laser diodes. The spectrometer covers frequencies up to 1 THz, with a peak signal-to-noise ratio exceeding 40 dB for a lock-in integration time of 30 ms.

Conventional terahertz spectrometers are based on femtosecond lasers, which are still relatively expensive. The new system, developed by researchers at the Institute for High-Frequency Technology in Braunschweig together with researchers from Menlo Systems and the Research Centre Jülich, is based on two commercially available laser diodes.

The spectrometer is aimed at quality-control applications in the plastics industry. The group has shown it can accurately and remotely measure the thickness of a polyethylene wedge (see image).



Raman and optical coherence tomography

Opt. Lett. **33,** 1135–1137 (2008)
Researchers in the USA and the Netherlands have designed a dual-modal device capable of sequential acquisition for Raman spectroscopy (RS) and optical coherence tomography (OCT) along a common optical axis. The device uses OCT images to precisely guide the acquisition of RS data, bringing together the benefits of both approaches. The group, from Vanderbilt University, USA, and the Universities of Twente and Amsterdam in the Netherlands, used the system for studies of a localized malignancy in *ex vivo* breast tissue, and also to perform *in vivo* tissue analysis of a scab.

The researchers were able to sequentially acquire near-infrared RS and OCT data through common sampling optics, while keeping the source and detection arms separate. Optical coherence tomography imaging can be performed in real time and can be used to guide the measurement of a Raman spectrum from an area 600 μm deep and 75 μm wide along the central axis of the OCT image. Raman spectra can be acquired to specifically characterize the biochemical fingerprint of ambiguous structures within an OCT image.

Local oscillator for the mid-infrared

Appl. Opt. **47,** 2993–2997 (2008)
Heterodyne spectroscopy in the mid-infrared (MIR) wavelength regime is a powerful tool for atmospheric and astronomical studies because it enables measurements with extremely high spectral resolution compared with direct detection. Researchers at the University of Cologne, Germany, have used a fully reflective external-cavity quantum-cascade-laser system at MIR wavelengths as a local oscillator in a heterodyne receiver for the first time.

The demands on the lasers to qualify as a local oscillator for this application are quite challenging: the laser must cover large portions of the MIR region ranging from wavelengths of 3 μm to 30 μm; the laser must have a narrow linewidth of less than 1 MHz ; continuous-wave emission is required; it must be stable at high frequencies; and an optical output power of at least 5 mW must be possible. In the case of solid-state lasers, it is necessary to tune the laser continuously over a few gigahertz to enable absolute frequency calibration. Also for heterodyne systems the side-mode suppression of the laser is crucial for operation as a local oscillator.

Using a grating spectrometer, the researchers showed that the quantum-cascade-laser-based system is tunable over a range of about 30 cm^{-1} at around 1,130 cm^{-1}. A continuous tuning range of 0.28 cm^{-1} was verified by observing the spectra of an internally coupled confocal Fabry–Pérot interferometer and the absorption lines of gas-phase SO_2. In a second step the output from the system was used as a local oscillator signal for a heterodyne set-up. They showed that spectral stability and side-mode suppression are excellent and that a compact external-cavity quantum-cascade-laser system is well suited for use as a local oscillator in infrared heterodyne spectrometers.

The researchers claim that their local-oscillator system can also be used as a radiation source for laboratory spectroscopy, especially where high optical output power, high-frequency resolution and stability are needed. This work could be a precursor for laser sources in cavity ringdown spectroscopy, photoacoustic spectroscopy and two-photon experiments.