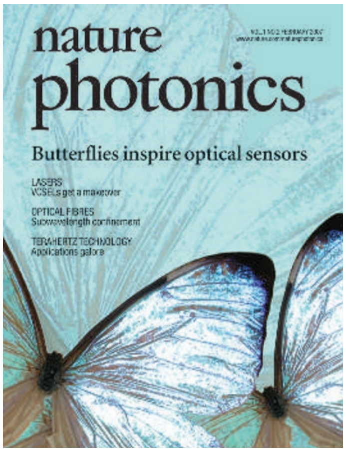


COVER STORY

Vol.1 No.2 February 2007

Is there no end to the startling optical properties of butterfly wings? Although it has been known for some time that the nanostructures found on certain tropical butterflies exhibit photonic-bandgap effects and exceedingly high reflectivities, researchers have now demonstrated that they can act as optical vapour sensors that can outperform man-made designs. Experiments performed by Radislav Potyrailo and his co-workers show that the reflectance spectra of the wing scales are not only highly sensitive to vapours, but also highly selective, giving a markedly different response for vapours from water, methanol, ethanol and three isomers of dichloroethylene. Artificially created replicas of these natural photonic structures could launch a new direction in the design of highly selective chemical sensors with straightforward colorimetric readout that could replace more complicated sensor arrays. **[Article p123; Interview p130]**

FIBRES BEAT DIFFRACTION LIMIT

A design of optical fibre that can confine light on the subwavelength scale and effectively 'squeeze' the optical field into a tiny central air hole running the fibre's length has been demonstrated by Gustavo Wiederhecker and his co-workers. The fibre is made by adding a tiny hollow bore into the solid core of a photonic-crystal fibre during its fabrication process. Fibres with central air holes with a diameter less than 200 nm — about 50 times smaller than the diameter of a conventional light-guiding core in a standard single-mode fibre — have been achieved. Direct measurements with a near-field optical microscope confirm the field confinement effects at wavelengths of 700 nm and 1,050 nm. As the optical energy within the central hole is squeezed into a much smaller area than diffraction would usually allow, this type of fibre could prove useful for observing optical nonlinear effects or analysing the interaction between light and matter.

In addition, preliminary measurements suggest that the fibre has an attenuation of the order of a few decibels per metre at visible wavelengths, which should allow long interaction lengths.

[Letter p115; News & Views p89]

BEST OF BOTH WORLDS

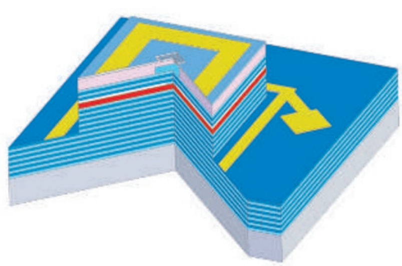
Often interesting science results when two very separate disciplines are brought together. This is certainly the case for 'optofluidics', which is a marriage of photonics and microfluidics — the study of the behaviour of liquids on the microscopic scale. In this issue, Christelle Monat and her colleagues provide an insight into recent successes in constructing integrated optical devices that exploit optofluidics. The achievements described include new types of light sources, sensors and reconfigurable devices that have applications ranging from medicine and biochemistry through to telecommunications and environmental monitoring. The ability of a liquid to tune or redefine optical functions is shown to greatly enhance the flexibility of optical devices, compared with their 'dry' counterparts. Moreover, the sophistication of such 'lab-on-a-chip'-style devices is set only to increase in the future as fabrication technology continues to evolve.

[Review p106]

MIRROR MAGIC

One of the most popular designs of high-performance mirror found in semiconductor lasers is the so-called distributed Bragg reflector (DBR) — a stack of thin layers of semiconductors of alternating high and low refractive index. This type of structure has served the laser industry well for many years, enabling the creation of high-performance laser diodes that are well suited to high-speed optical communications. However, despite all their benefits DBRs have several limitations. First, their fabrication is often challenging, requiring the deposition of tens of thin layers with a tightly controlled thickness and quality. Second, although their peak reflection can be very high (around 99%) it is very narrow and not available at all wavelengths. Now, thanks to some clever micro-engineering at the University of California at Berkeley, an attractive alternative is on offer. Mike Huang and his co-workers have made a mirror from a high-index-contrast grating and used it to replace a DBR in a vertical-cavity surface-emitting laser (VCSEL) for the first time. The result is a new type of semiconductor laser that is potentially easier to make, more tunable, highly efficient and offers polarization control.

[Letter p119; News & Views p87]



A high-index-contrast grating incorporated into a vertical-cavity surface-emitting laser.

p119

TERAHERTZ TECHNOLOGY

Located between the infrared and microwave parts of the electromagnetic spectrum lies the home of terahertz waves — a much-neglected waveband that is now proving to be very valuable for applications in imaging, spectroscopy and telecommunications. Much of the excitement stems from the unique behaviour of materials when illuminated with terahertz waves. For example, many chemicals such as drugs or explosives offer a very distinctive absorption fingerprint in this waveband, whereas other materials are either almost completely transparent (textiles, plastic and wood) or opaque (metals, water).

In addition, the inherent high frequency of terahertz waves makes them a prime candidate for enabling much faster wireless data transmission. Although difficulties in generating and detecting terahertz waves hindered the development of terahertz systems in the early days, devices are now much improved and providing scientists with a valuable tool for probing the world. In this issue, Masayoshi Tonouchi provides an update on the status of the technology and its diverse applications and future prospects, and Duncan Graham-Rowe takes a look at the efforts being made to bring commercial systems to the market.

[Review p97; Out of the Lab p75]