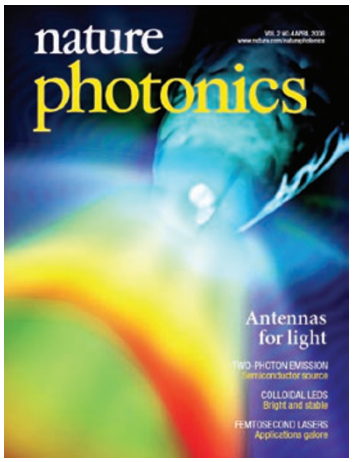


Cover story

Vol.2 No.4 April 2008

The ability to control the direction of emitted light from a single molecule is important for those involved in the development of single-photon sources, as well as optical microscopy and spectroscopy on the nanoscale. It now appears that carefully designed miniature optical antennas can accomplish this feat in the same way that radio masts perform directional broadcasting of television and radio signals. In this issue, Tim Taminiau and co-workers describe what happens when a tiny optical antenna about 105 nm high and 40 nm wide, fabricated by ion milling the tip of an optical-fibre probe, is brought into close proximity with a fluorescent single molecule. The results show that once the molecule and antenna are coupled, the antenna controls the direction of the fluorescence regardless of the molecule's orientation. **[Letter p234; News & Views p213]**

ULTRASHORT APPLICATIONS

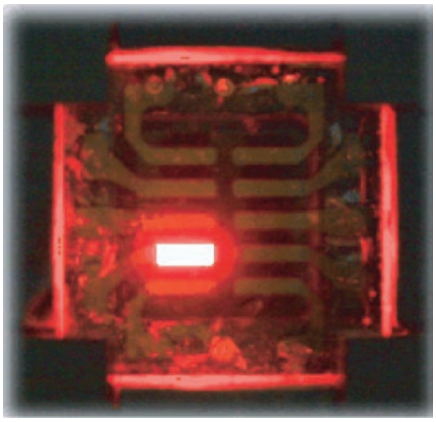
Although ultrashort light pulses are useful for exploring new areas of science they have also become an important tool for materials processing, enabling fast precise fabrication of many types of devices. In this issue, Rafael Gattass and Eric Mazur from Harvard University report on the progress that has been achieved so far in micromachining transparent materials with femtosecond lasers. Gattass and Mazur describe the physical mechanisms that are responsible for the structural changes in the processed materials and provide guidance on the optical parameters that are required. They then give a summary of important emerging applications for the technology, including fabrication of waveguides, resonators and filters, as well their uses in polymerization, rapid prototyping and nanosurgery.
[Review p219]

TWICE THE LIGHT

The generation of two simultaneous photons could have important uses for quantum information processing and spectroscopy, but it is very hard to find convenient and efficient sources. Now, Alex Hayat and his colleagues from Technion in Israel report the first observation of two-photon emission from a semiconductor. The phenomenon is demonstrated with optically pumped GaAs and electrically driven GaInP/AlGaInP quantum wells and validated by coincidence measurements, which confirm that both photons are indeed emitted simultaneously. A big advantage of the approach is its high efficiency, and the team report two-photon emission with powers of around 30 nW, which should be sufficient for many applications. The research is an important step towards the creation of a semiconductor source of entangled photon pairs, and the researchers are now planning to perform 'Bell's tests' to check for entanglement.
[Letter p238; News & Views p212; Interview p256]

BRIGHTER COLLOIDS

The idea of LEDs that can be printed or spin-coated onto substrates creating large-area light sources for displays or lighting applications is obviously an attractive one. The use of colloidal quantum dots is a promising approach to realizing this goal. Unfortunately, until now such colloidal quantum-dot LEDs have suffered from poor light-generation efficiency and limited drive currents or degradation when exposed to the environment. Now, by adapting the design and using metal oxide charge transport layers, Vladimir Bulović and co-workers from Massachusetts Institute of Technology in the USA have succeeded in fabricating red quantum-dot LEDs that overcome these limitations and offer a peak brightness exceeding 1,950 cd m^{-2}, an efficiency of nearly 0.1% and dramatically improved lifetime stability. The results also pave the way towards the creation of electrically pumped colloidal quantum-dot lasers.
[Letter p247; News & Views p209]



Quantum dots and metal oxides are used to make robust colloidal LEDs that compete in brightness with the best organic-based quantum-dot LEDs.

p247

OPTICAL NETWORKS ON A CHIP

As optical communications and computing move to higher and higher data rates, there is a need for miniature optical switches that can re-route data streams, but are small enough to fit on a silicon chip. With this motivation in mind, Yurii Vlasov and colleagues at IBM have developed a silicon nanophotonic switch that is capable of switching multiple 40-Gbit s^{-1} data channels with a switching time of less than 2 ns and a power penalty of less than 0.3 dB. Based on microring resonators, the 30×10 μm^2-sized device may prove useful for future on-chip optical interconnects that can replace electrical connections. The demonstrated device has the additional benefits of being temperature-insensitive (over a range of ±15 °C) and offering error-free transmission (bit-error rates of less than 10^{-12}).
[Letter p242]

ANTENNA-ENHANCED DETECTORS

By combining a tiny optical antenna with a germanium photodetector, Liang Tang and colleagues from Stanford University, have created a nanoscale photodetector for infrared light. The device, which operates at a wavelength of 1.3 μm is just $150 \times 60 \times 80$ nm^3 in size, allegedly the smallest photodetector demonstrated so far, and has an active volume of just 0.00072 μm^3, two orders of magnitude smaller than previously demonstrated detectors at such wavelengths. Using an antenna to enhance the collection of light gives the photodetector an increase in the generated photocurrent of a factor of two. The device could serve as a useful bridge for unifying the worlds of nanoscale electronics and microscale photonics.
[Letter p226]