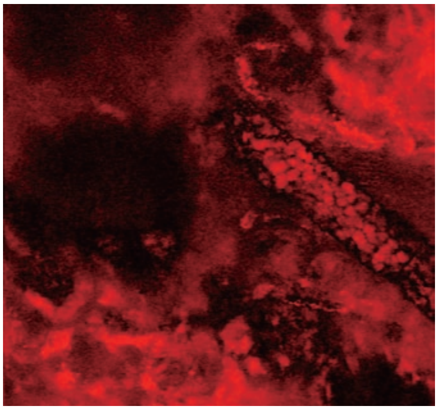
The authors perform simple pulse–echo experiments with their transducer and image a 25-μm-diameter wire. They measure a signal to noise ratio of more than 10 dB in the far field of the transducer, where the centre frequency is 40 MHz, with a bandwidth of 57 MHz at –6 dB. Their device is a useful addition to the field of high-frequency ultrasound.

TWO-PHOTON PROCESSES

Blood shots



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Opt. Lett. **32,** 2641–2643 (2007)

The ability to image blood vessels is important for a number of clinical tests. However, present imaging techniques lack sufficient resolution to resolve capillaries and are unable to measure the oxygenation level of blood. Now Warren Warren and colleagues from Duke University and Princeton, USA, have demonstrated that two-photon-absorption processes in haemoglobin can be used for imaging and can overcome some of the shortcomings of present techniques.

They used two collinear synchronized laser pulses centred at wavelengths of 775 nm and 650 nm — a pump (modulated at 10 MHz) and a probe (unmodulated). Any absorption processes at the focus of the two pulses caused the modulation of the pump pulse to be transferred to the probe.

Using this technique, the team was able to resolve individual blood cells in a dead mouse. They also used the technique to image a live mouse, and, although the movement of blood in the live mouse made it impossible to resolve individual blood cells, the structure of the vessels could easily be seen. In addition, by analysing the multiexponential decay from red blood cells it was possible to distinguish between oxygenated and deoxygenated blood. Using longer wavelengths that scatter less, a larger numerical-aperture objective and a higher input power could further improve the imaging capability of the technique.

QUANTUM OPTICS

Solitary interference

Science **317,** 929–932 (2007)

Researchers from the University of Michigan, the Naval Research Laboratory in Washington and the University of California in San Diego have shown that interference phenomena can be seen in single semiconductor quantum dots. The trick used by Xiaodong Xu and co-workers was to drive a neutral InAs self-assembled quantum dot embedded in a Schottky diode structure with two (pump and probe) frequency-locked but independently tunable continuous-wave lasers. It is known that under strong continuous-wave resonant optical excitation, the energy-level diagram of the absorption of a single neutral quantum dot can be represented by three levels. By controlling the probe absorption with the strong optical pump field, the researchers demonstrated that the single quantum dot coupled with the strong pump can work as a modulator of the probe absorption leading to two resonances, known as Autler–Townes splitting. When the Rabi frequency of the strong pump field is high enough, the team found that gain can be obtained even without population inversion. The scientists say that their findings highlight the importance of quantum dots for many applications, such as quantum-dot lasers and quantum logic devices.

MICROSCOPY

On track

GETTY

Opt. Lett. **32,** 2729–2731 (2007)

Confocal scanning microscopy combines high sensitivity and three-dimensional capabilities. However, until now it has been inefficient at imaging moving objects because scans cover so much unwanted background — like shots in a film where the main actor is out of view. Now Haw Yang and colleagues from the University of California at Berkeley have devised a clever feedback system that can enable a confocal microscope to 'track' fluorescent particles.

In the tracking set-up, light from the fluorescent particle is collected by an objective lens. Part of that light falls on a pinhole, and by monitoring the intensity of the light through the pinhole the movement along the axis between the particle and lens can be determined. To monitor movement perpendicular to that axis, Haw Yang and colleagues placed two prism mirrors in the path of the light, which deflect the light laterally. If the particle is centred opposite the apex of the prism mirror, equal amounts of light are deflected to either side, but lateral movement away from the centre will cause more light to be deflected to one side. These position measurements can be used in a feedback system to track the particle.

The researchers tested their system on 24-nm fluorescent nanospheres in 70% solution of glycerol and deduced that the system was capable of imaging with 10-nm spatial resolution and 1-ms time resolution.

QUANTUM DOTS

Immerse yourself

Nano Lett. doi: 10.1021/nl0717255 (2007)

For researchers to be able to manipulate light efficiently within nanophotonic devices, they need to be able to couple electromagnetic radiation in and out of a given system as effectively as possible. Anthony Vamivakas and colleagues have demonstrated improved coupling of light to quantum dots using lens immersion techniques.

Coupling light into an optical system is difficult, especially if the system is buried in the boundary between air and a high-refractive-index material, as is typical in most solid-state systems. In previous work with InAs quantum dots embedded in a GaAs host matrix, researchers found that the optical coupling to quantum dots was limited by the dielectric boundary formed between the matrix and the surrounding medium.

Vamivakas and co-workers use a lens system to overcome this problem. Their quantum dots, which are buried in a high-index GaAs host matrix, are coupled to an index-matched-numerical-aperture microlens on the bottom of the substrate to improve light collection. A solid immersion microlens on top of the system then reduces the focal spot area. Together, the lenses provide a record 12% extinction of light from the quantum dots. With this contrast level, the authors can, for the first time, perform resonant laser transmission spectroscopy on a single InAs/GaAs quantum dot, without the need for phase-sensitive lock-in detection.