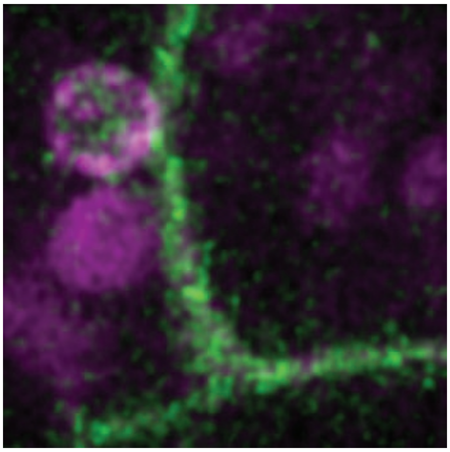
MICROSCOPY

STED for living cells

Biomed. Opt. Express **2,** 2364–2371 (2011)



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Stimulated emission depletion (STED) microscopy — an imaging technique that offers diffraction-unlimited resolution — is usually restricted to the one- or two-colour imaging of fixed cells, thus significantly restricting its application in the study of protein dynamics. Patrina Pellett and colleagues from the USA have now developed an elegant solution for live-cell two-colour imaging. They first connected tags to target epidermal growth factors and epidermal growth factor receptors in living cells, thus allowing them to be labelled by separate fluorescent dyes. The difference in Stokes shift between the dyes allowed the two proteins to be distinguished. By alternating the excitation laser in a line-by-line manner, the team were able to record fluorescence from the two dyes quasi-simultaneously and hence obtain two-colour STED images. They report resolutions of 78 nm and 82 nm for 22 sequential two-colour scans. The researchers anticipate that future developments will allow STED microscopy with more colours and three-dimensional imaging. *RW*

X-RAY OPTICS

Probing diamond

Nature Phys. **7,** 705–708 (2011)

Conventional imaging with electromagnetic radiation is subject to a diffraction limit that confines the achievable resolution to the scale of the wavelength. Now, Kenji Tamasaku and co-workers from the RIKEN Spring 8 Center, the Japan Science and Technology Agency and Nagoya University in Japan have proposed a method for visualizing the local optical response of a material to extreme-ultraviolet radiation at atomic resolution. The key technique in the study was X-ray parametric downconversion, which allowed the achievable resolution to be separated from the wavelength of the probe radiation. The researchers exploited the nonlinear response of diamond to X-rays to characterize the optical response of diamond at extreme-ultraviolet wavelengths of 103 Å (120 eV) and 206 Å (60 eV) and at a resolution of 0.54 Å. When illuminated with 11.1 keV X-rays, the diamond produced an idler signal through its second-order X-ray nonlinear susceptibility. Because this value also includes the material's linear optical susceptibility, which has a microscopic structure on the atomic scale, Fourier synthesis can be used to reconstruct the structure of the local optical response to the idler light. *NH*

X-RAY IMAGING

Synchrotron alternative

Opt. Lett. **36,** 2728–2730 (2011)

Three-dimensional high-resolution imaging of intact cells in a near-native state is important for a wide variety of biological studies. Soft-X-ray microscopes are advantageous for such imaging tasks because they do not require the use of chemical fixation, staining or sectioning. Although laboratory soft-X-ray microscopes based on laser-induced plasmas have been demonstrated, the imaging quality of these devices is still far from that of large, high-brightness synchrotron X-ray facilities. This may be about to change, thanks to the research of Michael Bertilson and co-workers at the KTH Royal Institute of Technology in Stockholm, Sweden. The researchers report that their laboratory soft-X-ray microscope has an imaging quality approaching that of a synchrotron. They produced their soft-X-ray source by focusing high-energy laser pulses (130 mJ per pulse, repetition rate of 100 Hz and pulse width of 3 ns) from a frequency-doubled (532 nm) Nd:YAG laser onto a nitrogen jet to create a plasma. The resulting X-ray emission was reflected by a multilayer mirror to provide a 2.48 nm source. The soft-X-ray microscope was used to perform tomographic imaging of a human kidney cell; by tilting the sample holder in 1.5° increments, the researchers took 58 cross-sectional images, each with an exposure time of 120 s. The reconstructed three-dimensional image showed nucleus, nucleoli and vacuoles. The smallest visible detail in these sections was ~100 nm. *NH*

PLASMONICS

Nanowire cavities

Nature Mater. **10,** 669–675 (2011)

Although the radiative rates of semiconductors and molecular systems can be modified by plasmonic structures, the associated enhancement factors have so far been limited to around 10–50. Chang-Hee Cho and co-workers from the University of Pennsylvania in the USA have now used plasmonic nanocavities based on CdS nanowires to achieve radiative rate enhancements of $>10^3$ at subpicosecond lifetimes. Each cavity consisted of a CdS nanowire (50–160 nm in diameter) surrounded by a 5-nm-thick SiO_2 interlayer and a 15-nm-thick Ag shell. The SiO_2 interlayer plays two important roles: electronic passivation and inhibiting the rapid quenching of CdS excitons. The researchers performed microphotoluminescence measurements at 77 K using a continuous-wave Ar^+ ion laser at a wavelength of 457.9 nm. The spectra showed hot-exciton emission lines below the laser excitation energy with a separation energy of 38 meV, which corresponds to the CdS longitudinal optical phonon. Time-resolved photoluminescence measurements revealed that the lifetime of the hot exciton was 7 ps, whereas that of excitons observed in a reference nanowire sample without an

LASERS

Gap plasmons

Opt. Express **19,** 15109–15118 (2011)

Most nanolasers demonstrated so far have exploited optical pumping at cryogenic temperatures, owing to problems with increased heating when using electrical pumping. Milan Marell and colleagues from Technische Universiteit Eindhoven in the Netherlands have now demonstrated electrically pumped room-temperature lasing at telecommunications wavelengths from gap-plasmon structures in semiconductor samples. The resulting device can be continuously driven at low temperatures of 80 K, producing a sharp spectral line. The device output has a strong transverse-magnetic polarization — as expected for a gap-plasmon mode — and a threshold current of around 500 μA. At room temperature, the researchers observed pulsed lasing for a pulsed voltage source with a repetition rate of 1 MHz and a pulse width of 50 ns. They formed gap–plasmon waveguides from a silver cladding covering an SiN insulator layer and an InGaAs gain region. They achieved distributed feedback by periodically varying the waveguide width to create a grating, and then changed the grating parameters to vary the lasing wavelength in the range of ~1,450–1,500 nm. *DP*