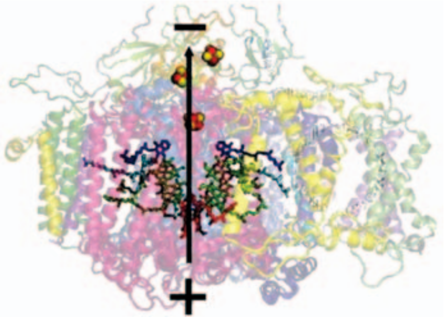
ORGANIC PHOTONICS

High-voltage surprise

Adv. Mater. **24,** 2988–2991 (2012)



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Recent research in Israel suggests that plant-derived compounds could be a promising route for the realization of high-voltage organic optoelectronic devices. Experiments have shown that dried crystals made from the light–energy converters that drive photosynthesis in plants can generate extremely large photovoltages and electric fields when illuminated with light. Hila Toporik and co-workers from Tel Aviv University studied micrometre-thick samples made from plant photosystem I using Kelvin probe force microscopy. When illuminated with laser light at an intensity of 1.1 W cm^{-2}, the samples generated voltages as large as 50 V and electric fields of the order of 100 kV cm^{-1}. This field strength is estimated to be twice as large as that in the ferroelectric crystal $LiNbO_3$:Fe and rivals the highest values reported for an inorganic material. The researchers say that the performance results from the superposition of aligned individual reaction centres, which induces a large net photoexcited dipole. They also say that these photosynthetic reaction centres have evolved over billions of years to become highly efficient light–energy converters that can operate with a quantum efficiency of almost 100%. *OG*

SPECTROSCOPY

Probing the mid-infrared

Opt. Express **20,** 10562–10571 (2012)

Femtosecond time-resolved mid-infrared probe spectroscopy is a powerful tool for investigating photoinduced molecular dynamics in fundamental chemical and biological processes. In particular, the spectral region of 1,000–3,000 cm^{-1} contains important vibrational information about many biological molecules, especially proteins. Jingyi Zhu and co-workers in The Netherlands have now used the nonlinear optical crystal $AgGaGeS_4$ to upconvert pump–probe ultraviolet/visible signals to the region of 1,000–1,800 cm^{-1}. Experiments with a sample of a 50-μm-thick GaAs crystal showed that the scheme is perfect for measuring transient changes in optical density (OD) as small as tens of milliOD, although signals measuring less than 1 milliOD suffered from baseline fluctuations. However, experiments with the blue-light-absorbing photoreceptor protein Slr1694 showed that signals below 1 milliOD were well-resolved after baseline correction. The researchers say that this method is an attractive alternative to the traditional mercury cadmium telluride arrays used in most mid-infrared pump–probe experiments. *JB*

COUPLED-MODE THEORY

Time-dependence

Opt. Eng. **51,** 054001 (2012)

Coupled-mode theory is a useful technique for determining the behaviour of electromagnetic fields in waveguides and other photonic structures, but is mainly used for developing analytical solutions to steady-state problems. In recent years, however, several groups have discussed time-dependent coupled-mode equations that can help to analyse Fano resonances in optical resonators and the temporal response of resonant grating effects. Vladislav Shteeman and Amos Hardy in Israel have now applied time-dependent coupled-mode theory to a 90° bend, a micro-interferometer with a based on a 5 × 5 array of waveguide cores, and a beamsplitter based on a 8 × 5 array of waveguide cores. They determined how optical pulses cause temporal variations in the refractive indices in the cores of each waveguide. The theory does not yet take into account backwards waves and is applicable only for small perturbations in the dielectric constants, which limits the effects that can be considered at this stage. The researchers claim that the solutions to their equations, although generally numerical, can be computed two orders of magnitude faster than traditional techniques such as finite-difference time-domain solutions to the Maxwell equations. *DP*

LASERS

Nanowire behaviour

Phys. Rev. Lett. **108,** 157402 (2012)

Lasing in ZnO nanowires at room temperature does not rely on excitons, as previously thought, but is instead likely due to an electron–hole plasma. That's the finding of Marijn Versteegh and co-workers from Utrecht University in The Netherlands, who have analysed the situation using a many-body quantum theory. Excitons — electron–hole pairs bound by the Coulomb force — are known to play an essential role in ZnO lasing at cryogenic temperatures, and it was widely thought that they would continue to be important at higher temperatures due to their large binding energy of 60 meV. However, it now seems that this is not the case. In previous work, the researchers developed a many-body quantum theory for describing the optical properties of a high-density interacting electron–hole gas in ZnO. When they applied this theory to the case of lasing, their theory accurately predicted the observed laser threshold, photon energy of the laser emission and peak spacing in the laser spectra. *OG*

NONLINEAR OPTICS

Silicon nitride success

Appl. Phys. Lett. **100,** 161902 (2012)

SiN is a popular material for use throughout the silicon-on-insulator platform. It is also a promising material for the fabrication of waveguide and resonators, owing to its low loss at visible and near-infrared wavelengths and compatibility with complementary metal–oxide–semiconductor processing. Generally, SiN is thought to be an amorphous, centrosymmetric material with no second-order harmonic bulk nonlinear response. However, Tingyin Ning and co-workers from the Tampere University of Technology in Finland have now observed strong second-harmonic generation from SiN films. They began by using plasma-enhanced chemically vapour deposition to produce an 800-nm-thick SiN film on a fused silica substrate. They then performed polarization-dependent measurements for various angles of incidence with light from a mode-locked YAG laser operating at the wavelength of 1,064 nm. Changing the polarization direction of the YAG laser light (and therefore that of the resulting second-harmonic wave) provided a measure of the second-harmonic generation intensity, which suggests that the SiN film exhibited in-plane isotropy. By using a simplified version of the Green's function formalism of nonlinear optics, the researchers obtained the non-vanishing tensor components of the second-order susceptibility from their experimental data. They then determined the absolute values of the tensor components by comparing the second-harmonic generation intensity to that through a Y-cut quartz crystal. The dominant component exhibited a magnitude of 2.5 pm V^{-1} — almost 60 times higher than that of Si_3N_4, and three times larger than that of potassium dihydrogen phosphate. *NH*