have time to interact when a single spin is optical rotated, whereas the two-qubit gate requires pulses that are longer than the interaction time between the two QDs. The fast interaction rate signifies the viability of optically controlled QD spins for use in multiqubit systems.

TERAHERTZ SPECTROSCOPY

Alternative detection

Appl. Phys. Lett. **97,** 251103 (2010)

Terahertz time-domain spectroscopy involves the conversion of a sub-100-fs near-infrared pulse to a single-cycle pulse of terahertz radiation. Gated detection of the terahertz pulse is usually achieved by time-delaying a fraction of the original near-infrared pulse, where the electric field of the terahertz pulse induces a birefringence in a crystal through the linear electro-optic (Pockels) effect. It has recently been shown that it is possible to detect terahertz and mid-infrared radiation that is not synchronized with the probe beam using a balanced photodiode detection scheme. Now, James Lloyd-Hughes and his co-workers in the UK and Switzerland have demonstrated the thermo-optic detection of terahertz radiation from a 3.2 THz quantum cascade laser. They used a balanced photodiode detection scheme with a ZnTe crystal and a pulsed laser beam at 780 nm and compared it with the gated detection of terahertz pulses from a photoconductive emitter. The unsynchronized signal was found to be dependent on the angle of the crystal and the modulation frequency of the quantum cascade laser, indicating a slow thermo-optic effect rather than an ultrafast electro-optic effect. The researchers present a simple model that accounts for the frequency dependence of the unsynchronized differential photodiode signal, and say that further investigation may lead to enhanced detection efficiencies for materials with high thermo-optic coefficients or those with suitable reflective coatings.

OPTICAL ISOLATORS

Small-gain saturation

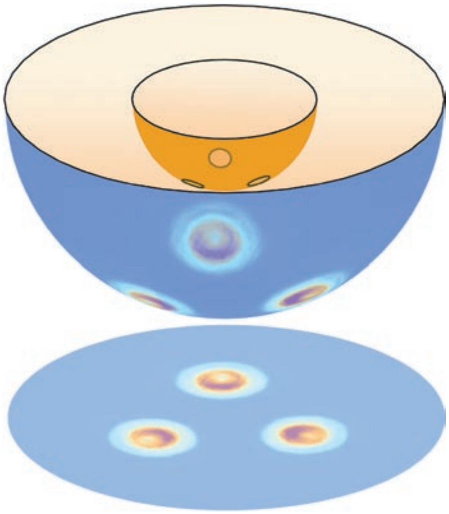
Jpn. J. Appl. Phys. **49,** 122201 (2010)

Integrated semiconductor active optical isolators are attractive for use in photonic integrated circuits. So far, however, the gain saturation effect — a critical factor in determining the propagation loss of such a device — has not been studied. Such optical isolators can only fully compensate for loss if the 3 dB saturation output power P_{3dB} is larger than the practical output power. Hiromasa Shimizu and Syunsuke Goto from the Tokyo University of Agriculture and Technology in Japan have now developed an evanescent semiconductor optical isolator (ESOI) that overcomes the problem of gain saturation. Their ESOI is a 1-mm-long ridge waveguide composed mainly of InGaAsP, with the cross-section of the p-InGaAsP guiding layer measuring 0.8 μm × 2 μm. The researchers covered the lateral side walls of the waveguide with AlO_x/Fe/AlO_x and placed the laser active layer, composed of InGaAsP quantum wells, at the base of the waveguide. Theoretical results predicted that this design would increase P_{3dB} by 6 dB. The researchers measured the propagation characteristics of their ESOI in both the forwards and backwards directions using a tunable laser diode. The ESOI was injected with 1,540 nm light up to 70 mA at a temperature of 10 °C and a permanent magnetic field of 0.33 T. The team obtained an optical isolation of 7.4 dB mm^{-1} and improved gain saturation characteristics over traditional optical isolators.

FAR-FIELD IMAGING

New dimension for hyperlens

Nature Commun. **1,** 143 (2010)

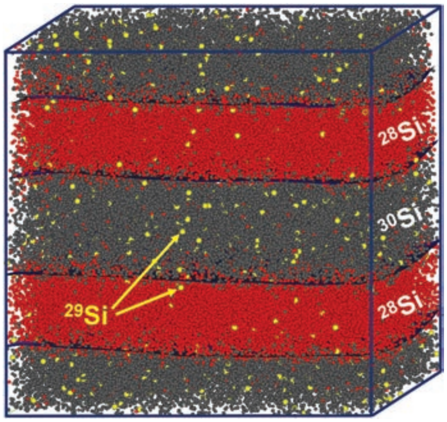


Hyperlenses — focusing devices capable of surpassing the fundamental resolution limit of conventional lenses — have previously been used in only one dimension and at ultraviolet wavelengths. Junsuk Rho and colleagues in the USA have now developed a hyperlens that can resolve 160 nm features in two lateral dimensions at the visible wavelength of 410 nm. The dome-shaped lens consists of alternating layers of titanium oxide, with a dielectric constant of 5.83, and silver, with a permittivity of −4.99 + 0.22i. The lens layers, which are thin compared with the wavelength of light used, form an effective medium that has very different radial and tangential permittivities of −64 − 19.83i and 0.42 − 0.11i, respectively. This difference causes a relative dispersion relation within the hyperlens material, allowing electromagnetic waves that carry high-spatial-resolution details to propagate into the far field instead of evanescently decaying. Such hyperlenses may enable the rapid imaging of nanoscale features in the far field, much like conventional optical microscopy.

TOMOGRAPHY

UV-assisted probe

Appl. Phys. Lett. **98,** 013111 (2011)



© 2011 AIP

The physical properties of a semiconductor can be drastically changed by the addition of stable isotopes. The key effect is the change in atomic mass, which influences both the lattice dynamics and the bandgap energy. A topographic technique is therefore required to isotopically probe nanoscale structures. Oussama Moutanabbir and co-workers from Germany, the USA and Japan have now achieved 3D isotopic imaging with high spatial resolution using a picosecond UV laser-assisted local-electrode atom probe (UV-LEAP). The wavelength, pulse energy and beam waist of the laser were 355 nm, 40 pJ and <5 μm, respectively. Isotopically modulated ^{28}Si and ^{30}Si ultrathin layers of thickness 5–30 nm were grown by solid-source molecular beam epitaxy. Needle-like specimens with tip radii of 20 nm were fabricated using the focused-ion beam-based lift-out method, after which they were placed in an ultrahigh-vacuum chamber and cooled to 60 K. Concentration depth profiles of the three Si isotopes — ^{28}Si, ^{29}Si and ^{30}Si — were calculated from UV-LEAP tomographic maps. The interfacial width was around 1.7 nm, demonstrating a significant improvement over isotope mapping techniques. The high resolution was attributed to the sharp focusing ability and short penetration depth of the UV laser.