

in-coupling efficiency of over 50% (incident wavelength, 811 nm) is impressive. An out-coupling efficiency of 75% was achieved. The researchers attribute this high efficiency to the structure's shape and the smooth gold surface obtained by using crystallographic etching and thermal SiO₂ growth processes. DP

GUIDED MODES

Silicon alternative

Appl. Phys. Lett. **104**, 091108 (2014)

Aluminium nitride (AlN) offers a broad electronic bandgap capable of servicing wavelength regions that lie beyond the reach of silicon-on-insulator technology. Matthias Stegmaier and co-workers at Karlsruhe Institute of Technology in Germany have now demonstrated waveguiding in AlN structures as narrow as 40 nm. The rib waveguides were made from 140-nm-thick polycrystalline AlN films sputtered on thermally oxidized silicon substrates with a 2.0- μ m-thick oxide layer, which reduces leakage into the silicon substrate. Light with a wavelength of 400 nm was guided along the waveguides. The width of the waveguides is smaller than the diffraction limit (~ 90 nm) for light in the core material with $n \approx 2.2$. However, it should be noted that this is diffraction-limited guiding, and the optical mode width actually increases with decreasing waveguide width (and effective index) in this regime. When the waveguide becomes too narrow (~ 30 nm in this case), the mode index decreases to that of SiO₂, allowing light to leak (that is, the core mode is cut-off). The researchers noted that waveguides 170 nm or wider are preferable. Even though multiple modes are supported, surface roughness and propagation loss can be significantly improved. DP

MULTISPECTRAL IMAGING

Exploiting the infrared

Opt. Express **22**, 4985–4994 (2014)

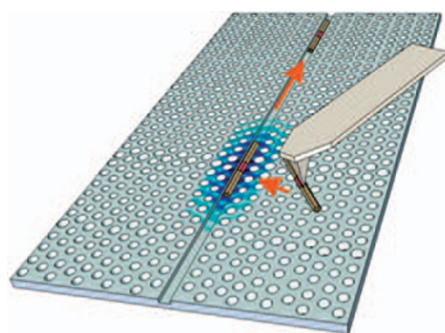
Various multispectral systems have been developed that provide detailed data in several wavelength bands, but for many applications the experimental instrumentation is too complex and the information too detailed to be practical and cost effective. Now, researchers based in the USA and China have developed a simple multispectral camera that can simultaneously acquire four spectral images. It employs a complementary metal–oxide–semiconductor (CMOS) sensor with a four-channel Bayer pattern. As both CCD (charge coupled device)

and CMOS photodetectors are sensitive to near-infrared (NIR) radiation, most visible-light systems employ a red, green and blue colour filter array to obtain colour information and an infrared filter to block NIR radiation. In contrast, instead of rejecting NIR light, the new system employs a four-colour filter array (red, green, blue and NIR) to obtain both visible and NIR information at the sensor. The researchers have also developed a colour separation algorithm to extract this information from a single image. They demonstrate three potential applications of this system, namely shadow removal, portrait enhancement (where NIR information is used to obtain a smoother skin appearance) and vein enhancement (useful for vein detection systems). In the future, the team intends to improve the colour correction algorithms by using a look-up table to obtain more accurate colour information. SP

PHOTONIC CRYSTALS

Mobile high-Q nanoresonators

Nature Mater. **13**, 279–285 (2014)



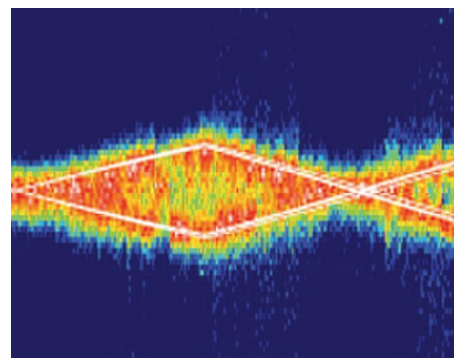
Subwavelength optical cavities that tightly confine light offer very useful functionality for integrated photonic circuits, but it is challenging to produce them in a manner that allows them to be easily relocated. Now, Muhammad Birowosuto and colleagues from NTT Corporation in Japan have come up with an elegant solution. They placed a single III–V semiconductor (InAsP/InP) nanowire with a diameter of less than 100 nm in a square-grooved waveguide in a two-dimensional silicon photonic crystal. Thanks to the perturbation of the photonic crystal, a high-Q cavity is created around the nanowire. This cavity can be repositioned by simply moving the nanowire along the grooved waveguide using an atomic force microscope. When the cavity was excited, fast (91 ps) spontaneous emission was observed from the nanowires as a result of

the Purcell effect, which is associated with the cavity. A sharp resonance associated with the cavity was observed to move in tandem with the displacement of the nanowire, confirming the effectiveness of the approach. The realization of a moveable cavity may be useful for realizing spatially tunable nanolasers and all-optical memories. RW

ATOM OPTICS

Veselago lensing by atoms

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When diverging electromagnetic rays enter a material with a negative refractive index (such as an optical metamaterial) from a medium with a positive index, the rays are focused so that they converge — a phenomenon known as Veselago lensing. An analogous phenomenon has been theoretically predicted to occur for matter waves, but it had not been experimentally verified until now. Researchers at Institut für Angewandte Physik der Universität Bonn in Germany have recently demonstrated Veselago lensing of matter waves using a sample of ultracold rubidium atoms in a bichromatic optical lattice. They realized a relativistic (that is, photon-like) dispersion relation for the atomic lattice — an essential condition for observing phenomena analogous to those found in optical materials with negative refractive indices — and applied a Raman π -pulse to transfer atomic de Broglie waves between the two branches of this dispersion relation. For a one-dimensional system, the scientists observed refocusing despite the presence of an inhomogeneous external potential; they also used ray-tracing simulations to investigate two-dimensional lensing. Possible uses of this technique include applications in metrology and novel probes of quantum many-body physics in optical lattices. SP

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