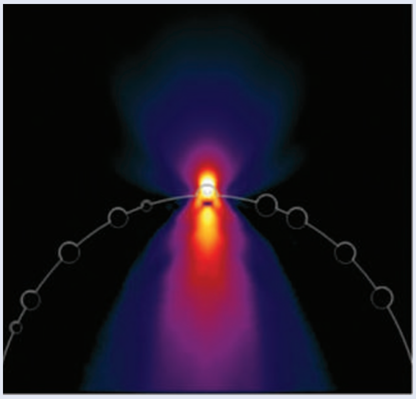
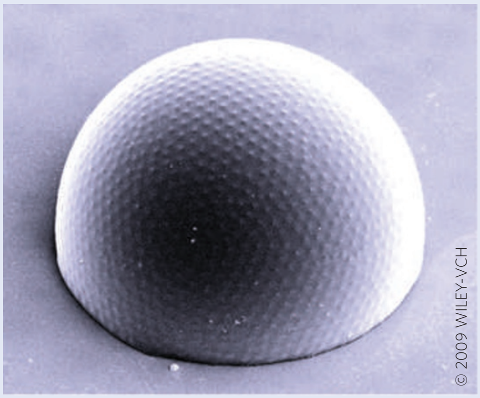
MICROPATTERNING

Photonic domes





Miniature resin domes that contain an intricate pattern of tiny polystyrene beads could have a useful role as near-field microlenses or biomolecule detectors, according to their Korean creators (*Adv. Mater.* doi:10.1002/adma.200901243; 2009). Measuring a few tens of micrometres across, the domes resemble microscale golf balls with their well-defined and distinctive embossed pattern. According to Seung-Man Yang and co-workers from KAIST, South Korea, the fabrication scheme is simple, fast and inexpensive, with no need for etching or complex processing.

"Our domes can be used as highly efficient near-field capturing lenses, with the polystyrene microbeads on the dome surface functioning as microlenses that transmit radiation from any point on the dome to the centre, owing to its spherical symmetry," Yang explained.

"Because the functional groups on the exposed area of the microbeads can be replaced with desired molecules, binding sites for specific target molecules on the particles can be made selectively and separately," said Yang. Hence, the photonic dome could in principle be used for sensing specific chemicals or biomolecules tagged with fluorescent dyes or quantum dots — the light from the dye or dot would simply be focused onto a detector at the base of the dome.

To make the domes, the team mix a photocurable resin called ETPTA with an aqueous solution of 1-μm-diameter polystyrene microbeads that have a carboxyl group attached. The resulting emulsion drops are then deposited on glass substrates pre-patterned with hydrophobic dots that have diameters in the range of 20–50 μm and are separated by 50–150-μm intervals to define the base-size and spacing of the resulting domes. The ETPTA droplets are subsequently solidified by UV irradiation. The shape of the domes is essentially determined by interfacial tension, and the two-dimensional arrangement of the polystyrene microbeads on the dome's surface is achieved by well-controlled surface chemistry.

According to Yang, in the current design the focusing performance is limited by the low refractive index of the polystyrene microbeads. It can, however, be improved if materials with a higher refractive index, for example titanium dioxide, are used instead. The team is also considering the idea of adding radial waveguide structures, which connect the exterior of the dome to a central position on its base.

"To achieve higher capturing efficiency, a waveguide structure in the dome connected to each colloidal lens can enhance the directionality of emission from the point source, transmitting the emission to the centre more effectively than a simple colloidal lens," said Yang.

RACHEL WON

SILICON PHOTONICS

Beating the electronics bottleneck

The use of cascaded nonlinear silicon waveguides that function as 'time lenses' is providing new opportunities for generating and measuring ultrafast optical waveforms.

David J. Richardson

The ability to encode information in a laser beam, either by modulating the amplitude or phase of the light, is a fundamental requirement of all optical communication systems and of many sensor systems. This is normally performed using a modulator, typically an electro–optic or electro–absorption modulator, driven (as the name implies) by an electronic signal. Although the use of electronically driven modulators allows for a great deal of control and ready interfacing with other electronics such as buffers, they have a significant drawback; it is difficult to move electrons around at high speeds, thereby limiting the modulation bandwidths that can be achieved. Moreover, they consume significant amounts of electrical power.

State-of-the-art electronic devices operate at frequencies of up to 100 GHz, but the inherent bandwidth of a fibre transmission-line is many terabits per second. This apparent mismatch between encoding and transmission capacity can be addressed through the use of multiple optical carriers within the fibre transmission