OPTICAL FIBRES

Low loss nanofibres

AIP Advances **4**, 067124 (2014)

Tapered glass nanofibres with ultrahigh transmission have been fabricated by a US–French collaboration. Jonathan Hoffman and co-workers, from the Joint Quantum Institute (a partnership between the University of Maryland and the US National Institute of Standards and Technology) and the Université de Paris-Sud, report that their ultrathin optical glass fibres can transmit 99.95% of light. Such nanofibres are potentially useful for a diverse set of applications including optical trapping and sensing or coupling light to miniature photonic devices such as resonators or photonic crystals. The nanofibres are made by heating and pulling conventional silica optical fibres under optimal conditions of cleanliness, temperature and motor speed. The result is a tapered fibre that shrinks to a diameter as small as 530 nm when it is stretched by 84 mm. When propagating within the nanofibre, the fundamental optical mode experiences a loss of just 2.6×10^{-6} dB per millimetre. Such nanofibres can also support surprisingly high optical powers without suffering damage and more than 400 mW of 760 nm light from a Ti:sapphire laser has been successfully transmitted under high vacuum conditions. *OG*

MOLECULAR SENSING

Fluorescent-free detection

Nature Commun. **5,** 4495 (2014)

The optical detection of single proteins is possible without requiring fluorescent labelling, report scientists in Germany. Marek Piliarik and Vahid Sandoghdar from the Max Planck Institute for the Science of Light in Erlangen have used their interferometric detection of scattering (iSCAT) system to sense cancer marker proteins in a buffer solution. It has previously been thought that the amount of light scattered by a single protein far from any optical resonance would be too small to detect. However, the use of iSCAT provides sufficient sensitivity and contrast to perform such a task. The researchers performed their measurements at a rate of 3,000 frames per second with 15 μW of incident 450 nm laser light and used a CMOS camera to detect both the scattered light from the sample and a reference beam. The optical intensity involved was well below the typical damage threshold of a biological sample. A variety of biologically relevant proteins — including fibrinogen, mouse immunoglobulin, bovine serum albumin and carcinoem-bryonic antigen — were successfully detected using the scheme. *OG*

DISPLAYS

Phase-changing pixels

Nature **511,** 206–211 (2014)

NPG

Phase-change materials such as germanium antimony tellurium (GST), which can be rapidly switched between amorphous and crystalline states, have attracted considerable attention as candidates for inexpensive high-speed data storage. It now seems that such materials may also prove useful for constructing displays. A team from the University of Oxford and the University of Exeter have demonstrated electrically-induced colour change in ultrathin films of GST and claim that the material could be suitable as a pixel for a new type of microdisplay. By sandwiching a layer of GST, just a few nanometres thick, between two transparent electrodes made of indium tin oxide (ITO), the researchers created miniature displays from arrays of 300 × 300 nm pixels. When the GST phase is switched, the transmission of the pixel changes due to the differences in the reflectivity of the amorphous and crystalline states. Furthermore, control over the colour of the image is achieved by changing the thickness of the bottom ITO electrode, which enhances the reflectivity of specific wavelengths while suppressing others. Because the pixels are ultrathin, they are compatible with flexible surfaces. They can be used with or without a mirrored substrate and are therefore well suited for either reflective or semi-transparent configurations. The researchers expect that displays based on this technology will exhibit very low energy consumption as they do not require power when displaying a static image. *MM*

QUANTUM OPTICS

Giant Casimir effect

Proc. Natl Acad. Sci. USA **111,** 10485–10490 (2014)

It is known that the Casimir effect — a manifestation of the quantum fluctuation of electromagnetic fields — typically results in a tiny force. These forces have been enhanced in particular structures, such as closely spaced metal films (mirrors), but they still remain almost immeasurably small. Now, Ephraim Shahmoon and a team from Israel, Austria and Russia, have theoretically proposed that 'giant' Casimir effects should exist in transmission line waveguides where two conductors guide 'one-dimensional' modes. The authors use two different theoretical approaches to calculate the interaction between two dipoles mediated by a TEM mode of the structure. The first approach uses quantum electrodynamics perturbation theory, starting from the interaction Hamiltonian. The second approach involves analysing the scattering of vacuum fluctuations by solving

QUANTUM OPTICS

Subnatural-linewidth biphotons

Phys. Rev. Lett. **112,** 243602 (2014)

To achieve efficient conversion of a quantum state between photons and atoms, the bandwidth of the photons involved must be narrower than the natural linewidth of the relevant atomic transitions. So far, this requirement has been difficult to satisfy. Now, Kaiyu Liao and colleagues from China have demonstrated an experimental scheme for producing subnatural-linewidth photon pairs with polarization entanglement. The polarization-entangled photons are generated from a laser-cooled ^{85}Rb atomic ensemble by the quantum interference of two spontaneous four-wave mixing (SFWM) processes driven by two counter-propagating pump-coupling beams in a Mach–Zehnder interferometer. The phase difference between the two SFWM paths is stabilized by locking the reference laser in the interferometer. The Chinese scientists find that the photon bandwidth can be reduced by lowering the coupling laser power. When the powers of the pump and coupling beams are 8 μW and 0.13 mW respectively, the photon bandwidth is about 0.8 MHz — much narrower than the natural linewidth of the Rb atomic transition (6 MHz). *NH*