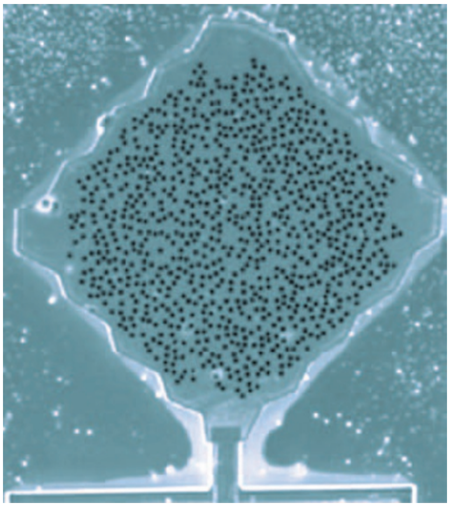
RANDOM LASERS

Mid-infrared regime

Adv. Mater. http://dx.doi.org/10.1002/adma.201303122 (2013)



Random lasers have the beneficial properties of a high temporal coherence and a low spatial coherence, making them ideal light sources for imaging with a high photon radiance without the nuisance of coherent artefacts. To date, electrically pumped random lasers have only been realized in ZnO heterostructures; extension to the mid-infrared regime has proved challenging because of the lack of a suitable scattering gain medium and the high optical losses in this regime. Now, Hou Kun Liang and colleagues from Singapore claim to have made the first electrically pumped mid-infrared random lasers. They operate at a wavelength of 10 μm. The researchers fabricated the lasers by etching circular, 10-μm-deep air holes in computer-generated random patterns onto quantum cascade laser heterostructures, which offer high gain in the mid-infrared regime and are amenable to electrical pumping. When such a laser with a sufficiently high density of air holes was electrically excited, the team observed the rise of random lasing peaks caused by multiple scattering and interference clustered closely around the gain peak of the material. The laser's operation threshold was found to decrease with increasing scattering strength and fill factor of the air holes, which is typical for random lasing. *RW*

PLASMONICS

No bend loss

Nano Lett. **13,** 4779–4784 (2013)

An important goal in nanophotonics is to realize more densely integrated optoelectronic circuits and devices by routing information between different locations using tightly confined light. Although much is known about dissipative losses, radiation leakage from the sharp bends in such applications requires further investigation. Now, David Solis Jr. and colleagues from Rice University in Texas, USA, have investigated light propagation along linear chains of spaced 54-nm-diameter silver particles. They were able to image propagation in the far field using a fluorescence technique that permanently records the near field of the plasmons by bleaching fluorophores coated onto the waveguide. Interestingly, when the team introduced a 90° bend into the linear chain of particles, the propagation distance of 633-nm light along the chain was 7.8 μm, which, within the uncertainty of the measurements, is the same as that in a straight waveguide. *DP*

OPTOMECHANICS

Squeezing light

Phys. Rev. X **3,** 031012 (2013)

An optomechanical method known as ponderomotive squeezing has been difficult to realize experimentally because it requires a large interaction between mechanical motion and quantum fluctuations of light. Now, Tom Purdy and a team from JILA, the National Institute of Standards and Technology, and the University of Colorado, Boulder, have observed ponderomotive squeezing at 1.7 dB below the shot-noise level and optical amplification of quantum fluctuations by over 25 dB. This was enabled by using light transmitted through a Fabry–Pérot optical cavity with an embedded, dielectric membrane that can flex. The cavity was 3.54 mm long and the membrane was a 500-μm^2 silicon nitride membrane that was 40 nm thick. Maximal squeezing occurred near the resonant frequency of the mechanical membrane. The results agree with a theoretical model with calibrated parameters that accounts for the thermal motion of the membrane with no other classical noise sources. Although stronger squeezing has been demonstrated before using various other approaches, the team notes that the ultimate limits of ponderomotively squeezed light have yet to be reached. *DP*

NANOPHOTONICS

Aperiodic advantage

Opt. Express **21,** A964–A969 (2013)

Nanowire arrays have attracted attention because of their strong optical absorption — a feature that is particularly beneficial for photovoltaic applications as it allows a thinner active layer to be used, hence reducing fabrication costs. However, to date, the origin of the absorption enhancement in aperiodic arrays has not been comprehensively explained. Now, Björn Sturmberg and colleagues from Australia have numerically studied the effect of localized clustering of nanowires in such arrays. Using a combination of simulation techniques, including the finite element method and the scattering matrix method, the team found that the reduced symmetry associated with cluster formation allows external coupling of plane waves into modes that are usually dark in periodic arrays, thus significantly increasing absorption. The same conclusion was obtained with clustering of two, three, four and five nanowires,

QUANTUM OPTICS

Mutual interaction

Nature **502,** 71–75 (2013)

In principle, photons do not interact with each other. However, if coherent interactions between individual photons became a reality, it would potentially open the door to applications such as all-optical switching and deterministic photonic quantum logic. Now, Ofer Firstenberg and co-workers from the USA have created a quantum nonlinear medium within which individual photons travel as massive particles with strong mutual attraction. This causes the propagation of photon pairs to be dominated by a two-photon bound state. The researchers realized mutual interaction between photons through dispersive coupling of light to strongly interacting rubidium atoms under the condition of electromagnetically induced transparency in systems with highly excited Rydberg states. When two Rydberg atoms were located within a distance of the Rydberg blockade radius (about 18 μm in this work), the doubly excited Rydberg state was largely detuned from the electromagnetically induced transparency resonance because of the repulsive van der Waals interaction. By tuning the frequency and narrowing the beam waist to 4.5 μm of the laser beam used to excite a cold rubidium gas, the researchers created a narrow region in which photon–photon interaction occurs. The experimentally measured concurrence of 0.09 at a delay time of zero indicates deterministic entanglement of previously independent photons during propagation through the quantum nonlinear medium. *NH*