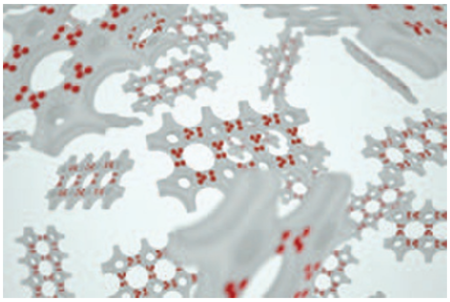
OPTICAL STORAGE

DNA multiplexing

Adv. Mater. **25,** 3593–3598 (2013)



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The density of optical data storage is usually constrained by the diffraction limit of light. Now, Mohammad Mottaghi and Chris Dwyer from Duke University in the USA have demonstrated a technique that can exponentially increase the density of bits stored, enabling a 1,000-fold increase in density beyond that permitted by the diffraction limit. Their technique, called polychromatic address multiplexing (PAM), exploits nanoscale fluorescence and Förster resonance energy transfer (FRET). A PAM disk consists of several physical storage layers, each containing storage cells with photo-erasable PAM elements (PEPEs). Each PEPE is composed of an ultraviolet-disruptable FRET pair placed on a grid-like DNA nanostructure in which donor (E) and acceptor (R) molecules act as excitation and read ports, respectively. Each cell stores several logical words — a collection of bits associated with a single address. A word address is a unique combination of incident excitation wavelengths used to activate a subset of the PEPEs in the cell. The binary value of an addressed word is translated by exploiting acceptor saturation in ER-PEPEs to induce a fluorescence enhancement. This enhancement is exclusively caused by the addressed structures; other structures remain inactive. The team says this approach can be applied to other data multiplexing applications. *RW*

METAMATERIALS

Gap plasmon stacks

Nature **497,** 470–474 (2013)

Metamaterials offering negative refraction often consist of resonator arrays. In recent demonstrations at visible wavelengths, resonators with small features required to achieve the magnetic response needed for a negative index have approached the fabrication limits of lithography. Fortunately, gap plasmon waveguide modes formed in thin dielectric gaps in metals can also provide negative refraction and be easily made in much smaller sizes, thus allowing operation at shorter wavelengths. Using this approach, Ting Xu and colleagues from the USA and Canada have made a metamaterial that gives a left-handed response to ultraviolet light. They achieved a negative index over a broad range of incident angles of transverse magnetic light in a layered structure of stacked metal–dielectric layers. Their structure was only several layers thick, but their results indicate that its characteristics approached that of a bulk metamaterial. In principle, it is relatively easy to make thicker samples. Similar to other design approaches for achieving negative refraction, optical loss in the structures needs to be considered when determining the maximum size of practical samples. *DP*

NANOPHOTONICS

Electrical excitation

Nano Lett. **13,** 2846–2850 (2013)

Plasmons are conventionally excited by illuminating metal–dielectric interfaces with light. However, electronic excitation is also possible, albeit with some caveats. For example, the tunnel current between the tip of a scanning tunnelling microscope and a surface can drive plasma and surface plasmon oscillations. Now, Theresa Lutz and colleagues from Germany, France and Switzerland have used a scanning tunnelling microscope to study tris-(phenylpyridine)-iridium complexes on a C_{60} monolayer and found that such systems can control excitation of plasmons on a silver substrate. They discovered that single molecules in a tunnel junction act as gates for the electrical excitation of optical plasmons under a ~1–2 V bias. They explain that the intensity and spectral distribution (that is, the colour) of the generated plasmons are directly related to the spatial shape and energy of the orbital closest to the Fermi energy. The team hopes that the idea may ultimately allow molecular tunnel junctions to act as electrically controlled plasmon sources. *DP*

DISTRIBUTED FEEDBACK LASERS

Biological lasers

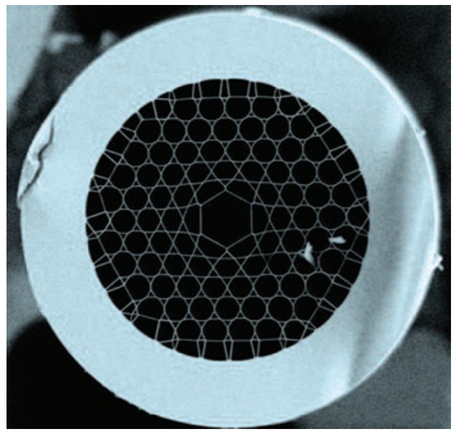
Lab Chip **13,** 2675–2678 (2013)

An all-biological laser whose active medium, resonator, pump and substrate are fabricated entirely from biological materials would be a very useful tool. Such a laser would in principle be biocompatible and biodegradable, so that it could be used in applications such as toxicity sensors for food or used *in vivo* to overcome the limited penetration of light through biological tissue. Now, Christoph Vannahme and colleagues from Denmark and Germany have demonstrated a single-mode distributed feedback laser made from gelatine doped with riboflavin (vitamin B2); both materials are nontoxic and digestible. The laser resonator was formed from a corrugated single-mode, second-order distributed feedback laser slab on a nanoimprinted low-index polymer. The researchers obtained lasing at wavelengths of 543 nm and 562 nm, which agreed well with modelling results. Although these lasers used biologically active materials, they had non-biological substrates; it is hoped that in the future, biological substrates can be used to realize the goal of an all-biological laser. *SP*

QUANTUM MEMORY

Hollow-core fibre

New J. Phys. **15,** 055013 (2013)



AMIR ABDOLVAND

Quantum memories with integrated architectures that are capable of storing broadband pulses are in high demand for applications such as quantum computing and metrology. Integrated designs such as on-chip waveguides and evanescent ridge waveguides have been investigated, but they tend to suffer from weak light–matter interaction and issues with broadening of the transit time of atoms crossing the optical mode. Now, Michael Sprague and co-workers from the UK, Germany and France have demonstrated that these two limitations can be overcome by using caesium atoms in kagome-structured hollow-core fibres. The international team used kagome fibres with 26-μm-diameter cores that could support large optical modes, and they employed light-induced atomic desorption to enhance the optical depth for resonance absorption. As a result, they achieved an extremely high optical depth of 3×10^4 at room temperature. Furthermore, they used saturation absorption spectroscopy to measure the linewidth of the atoms confined within the core and obtained a homogeneous linewidth of 6 ± 2 MHz.