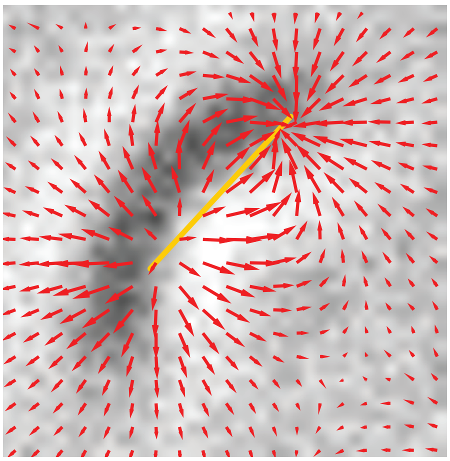
like', with a valence electron in a large orbit far from the ion core — have a few peculiar characteristics, particularly with respect to their electromagnetic response. Using laser pulses with intensities of the order of 10^{15} W cm^{-2}, the researchers observed lower-than-expected rates of ionization for helium atoms, which may allow atoms to be probed at much higher intensities than would otherwise be possible. A Rydberg wavepacket was produced using a linearly polarized laser pulse and (after a time delay) an elliptically polarized laser field accelerated any Rydberg atoms through field gradient effects. This acceleration (deflection) of the atoms confirms the interaction of the Rydberg atoms with the strong field. One of the most interesting outcomes of this experiment, apart from the lower-than-expected rate of ionization, is that each atom became 'tagged' with the laser intensity with which it was probed. This intensity can be read-out by detecting the momentum transfer of the laser field to the surviving atom. The researchers hope that their work will allow coherent manipulation using short-pulse lasers and the development of an efficient cascaded acceleration scheme. *DP*

IMAGING

Magnetic mapping

Nature **496,** 486–491 (2013)



The magnetic field created by individual living biological cells — magnetotactic bacteria — has now been successfully mapped using optically detected magnetic resonance imaging. Researchers from Harvard University, MIT and the University of Berkeley in the USA placed a saline solution containing the bacteria on the surface of a diamond chip featuring a 10-nm-deep layer of nitrogen–vacancy centres. The bacteria created internal magnetic nanoparticles that altered the spin states of the nitrogen–vacancy centres, which were then read-out using spin-state-dependent fluorescence in the red part of the spectrum. By making four independent measurements, the researchers were able to determine the vector components of the bacteria's magnetic field with a spatial resolution of 400 nm. They estimate that the magnetic moment of each magnetotactic bacterium is of the order of 10^{-16} A m^{-2}. By using visible LED illumination and a CMOS camera, the researchers captured high-resolution optical images of the bacteria, allowing the cell positions to be correlated with the magnetic field maps. *OG*

ARTIFICIAL PHOTOSYNTHESIS

Polymer power

Adv. Mater. **25,** 2932–2936 (2013)

An efficient and convenient means of converting solar energy into chemical energy (known as artificial photosynthesis) is required for a 'hydrogen economy' to become a realistic prospect. A promising way of achieving this is using polymer solar cells to generate the electricity required to split water into hydrogen and oxygen. To make the process as efficient as possible, both tandem and triple-junction cells are currently being investigated. Now, René Janssen and colleagues at the Eindhoven University of Technology in the Netherlands report a triple-junction polymer solar cell that simultaneously achieves a high optimized efficiency of 5.3% (a solar-to-hydrogen conversion efficiency of 3.1%) and, importantly, a maximum power point at around 1.70 V, which is sufficiently high to split water. Their triple junction consists of one wide-bandgap front cell and two identical narrow-bandgap middle and back cells (known as the '1 + 2 type configuration'). They demonstrate that this new design gives better performance than the corresponding tandem solar cell, and expect to reduce the water-splitting voltage in future work by using better hydrogen- and oxygen-evolving catalysts. *SP*

OPTICAL TRAPPING

Fibre–ion integration

New J. Phys. **15,** 053011 (2013)

Trapped ions are a potentially useful tool for applications in metrology and quantum information processing, but collecting their light emission in an efficient manner is a significant challenge. The use of high numerical-aperture optics is one possibility, but it limits the size and scalability of the system. The use of optical fibres to collect their light is hindered by the fact that the dielectric of the fibres can adversely affect the trapping potential applied to the ion. Hiroki Takahashi and co-workers from PRESTO in Japan and the University of Sussex in the UK have now managed to integrate a pair of optical fibres with a radiofrequency ion trap. To avoid disturbing the radiofrequency field around the ion, the researchers housed the fibres in two metallic concentric cylinders that not only shielded the fibres but also functioned as electrodes for an end-cap ion trap. This approach allowed the fibres to be located just 270 μm away from the ion, thus creating a compact and convenient means for capturing fluorescence. Such fibres not only allow the fluorescence to be easily analysed by photomultiplier tube detectors, but also allows the ion trap to serve as a fibre-coupled single-photon source. *OG*

OPTICAL METROLOGY

Measuring thin films

J. Nanophoton. **7,** 073094 (2013)

To reap the benefits of recent improvements in transistor technology, it will be important to increase the speed of interconnects by employing materials with lower dielectric constants (*k*). So far this has been achieved by increasing the free volume of the constituent materials, but this has the unfortunate side effect of reducing the device's thermal and mechanical properties. There is thus a need for non-contact, non-destructive metrologies capable of assessing the mechanical properties of low-*k* dielectric thin films. Nano-indentation measurements are the current industry standard, but their accuracy decreases markedly as film thicknesses drop below 100 nm. Now, Brian Daly and co-workers in the USA have shown that two non-contact optical techniques — Brillouin light scattering and picosecond laser ultrasonics — have the potential to replace nano-indention measurements. When measuring the Young's moduli of films thicker than 2 μm, they found excellent agreement between nano-indention measurements and the two optical techniques. They also showed that Brillouin light scattering can be used to measure films as thin as 100 nm. The combination of the two approaches has the potential to determine the elastic constants of low-*k* dielectrics at the desired thickness targets for future nanoelectronic interconnect technologies. *SP*

Written by Oliver Graydon, Noriaki Horiuchi, David Pile, Simon Pleasants and Rachel Won.