LOW-TEMPERATURE PHYSICS

Excitons condense

Nano Lett. **12,** 2605–2609 (2012)

At low temperature, a collection of bosons can condense into a state described by a single, collective wavefunction. Such condensates have been created using atoms, photons and magnons, allowing unique quantum phenomena to be observed. Now Arthur Gossard and colleagues at the University of California at Santa Barbara and the University of California at San Diego have demonstrated condensation of electron–hole pairs, which are called excitons, inside an electrostatic trap.

Because electrons and holes have a tendency to recombine quickly, Gossard and co-workers trapped one of each in separate semiconductor quantum wells. The resulting indirect excitons were spatially confined by an electric field created by a diamond-shaped electrode. Emission from spatially separated excitons then created interference patterns, whose dependence on temperature and exciton density confirmed the existence of an exciton condensate over the entire area of the trap. The coherence of the condensate was also shown to be spontaneous, and not induced by the laser light used to excite the excitons.

Condensation occurred at a lattice temperature of around 2 K, which is high relative to the temperatures typically required for atomic condensates. Furthermore, excitons are very different from bosons that have been condensed before and, therefore, exciton condensates are expected to exhibit a variety of unique behaviours. *MS*

NANOFABRICATION

A cracking pattern

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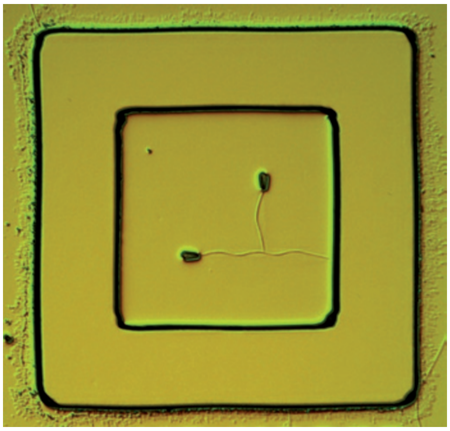

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The difference in chemical composition between a substrate and a deposited thin film creates intrinsic stress, which stores a certain amount of potential energy at the interface. In many cases this could be a source of unwanted cracking and material failure. However, Koo Hyun Nam, Il Park and Seung Hwan Ko have now harnessed this energy to produce controlled patterns in a silicon nitride thin film deposited on a silicon wafer.

The researchers — who are based at Ewha Womans University and KAIST — etched a micrometre-scale notch on the silicon substrate that concentrates local stress at its tip and initiates a crack as the thin film is deposited on top. The crack, which is typically deep enough to encompass both materials, propagates in a direction that depends on the crystal orientation of the substrate and can travel to the end of the silicon wafer. As a result, the Korean team also devised a stopping structure that absorbs the excess energy and allows the position that the crack stops at to be controlled. The cracks, which can either be wavy or straight depending on operating conditions, are about 10 to 100 nm wide.

Because crack propagation is a self-sustained process, the approach could perhaps provide an alternative to existing lithographic techniques for large-area patterning. *AM*

EXPERT OPINION

Public perception of applications

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As with other emerging technologies, the social and psychological factors that influence how the public respond to nanotechnology are important because these factors can influence how the field is developed and commercialized, and whether a new nanotechnology succeeds or fails. However, studies have shown that the general public has limited knowledge or awareness of the field, and are rarely involved in debates surrounding its development. Therefore, at this stage, the views of experts on societal attitudes towards specific products that emerge from nanotechnology are likely to influence the commercial and regulatory trajectory of the technology.

Nidhi Gupta and colleagues at Wageningen University and Newcastle University used the repertory grid and generalized Procrustes analysis methods to obtain opinions from 17 nanotechnology experts in North West Europe on which factors might influence societal response to various nanotechnology applications. The experts were from academia, industry, government, consumer representative groups and the media. A list of 15 key applications was drawn up and the experts were interviewed face-to-face.

They rated applications such as targeted drug-delivery, neuroimplantable devices, water filtration, soil–water remediation, chemical sensors and fuel cells as beneficial, necessary and useful, and therefore more acceptable to society. Less beneficial and unnecessary applications included smart pesticides, smart dust, radio-frequency identification tags, nanofabrics, cosmetics and sports goods. No consensus was found on whether the application of nanotechnology in food will be acceptable to society. *ALC*

NANOPHOTONICS

Rewriting selection rules

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Optical fields can be used to drive transitions between different states in quantum systems, but some transitions are much more likely than others. When visible light interacts with an atom, for example, electric dipole transitions are much more common than other transitions, such as electric quadrupole and magnetic dipole transitions. This happens because an atom is much smaller than the wavelength of visible light so, to a good approximation, it is exposed to a spatially uniform electric field, and such an electric field can only drive electric dipole transitions. However, Prashant Jain and co-workers have shown that these selection rules need to be rewritten when nanostructures are used to manipulate electromagnetic fields on the nanoscale.

Jain and co-workers — who are based at Berkeley, the Hebrew University of Jerusalem and Tel Aviv University — used a combination of theory and numerical modelling to study what happens when a semiconductor nanorod near a metal nanosphere is exposed to a spatially uniform electric field. They find that the strength of transitions allowed by the electric dipole selection rule increase, and that the strength of transitions forbidden by this selection rule increase by an even larger factor. They also predict changes in the wavelength of many transitions. The results have implications for spectroscopy and applications such as light harvesting and optical imaging. *PR*

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