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New quantum dot process could lead to super-efficient light-producing technology

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Polarised light forms the basis of many technologies, such as computer monitors. However, current approaches for making polarised light are inefficient, as they produce more than is ultimately used or needed. Researchers may now have found a way to directly produce polarised light using tiny nanostructures, called quantum dots, opening the way for more energy-efficient technologies.

Most light sources, such as fluorescent light bulbs, produce light waves which scatter in all directions and orientations. However, this light can be 'polarised' using filters, which ensure that all light waves are of the same orientation. Like coins going through a slot, only light of the correct orientation can pass through a polarising filter, which blocks other orientations.

Polarisation forms the basis of many technologies, such as the LCD screens in computer monitors and hand held devices, including tablets and phones. It also has uses in more advanced applications, such as 'wiretapping-proof' quantum cryptography and medicine. However, because polarising filters block at least half of the light emitted, and therefore the energy used to produce it, many current technologies are far less energy-efficient than ideal.

One way to increase energy efficiency is to use materials that directly emit polarised light. 'Quantum dots' are one such material. Their shape and nano-size (around 10 000 could fit across the width of a single human hair) give them unique properties, allowing them to exploit quantum phenomena to produce light.

However, manufacturing quantum dots of only a single polarisation, rather than many different polarisations, is difficult. In an effort to overcome this challenge, the researchers found a way to force the light emitted from quantum dots to all take the same kind of polarisation.

They grew, layer by layer of atoms, tiny elongated six-sided nano-pyramids of the semiconductor material gallium nitride. This was done in a way that allowed the researchers to control the orientation of the pyramids, i.e. the pyramids were of the same basic structure, but rotated by different amounts.

Thin layers of gallium nitride containing the metal indium were placed on top of each elongated pyramid and formed an asymmetrical quantum dot. The level of polarisation emitted from the quantum dots was then measured and analysed.

The researchers found that controlling the orientation of the individual pyramids – and therefore the asymmetry of the quantum dots – aligned the polarisation of light emitted from the quantum dots. Light of a specified polarisation was therefore produced. On average, 84% of the light produced was polarised, much higher than has been achieved using different approaches.

The study's authors believe this is the first reported example of a controllable method for producing multiple aligned quantum dots. Importantly, the method is compatible with existing materials and processing techniques, meaning that the equipment to construct these quantum dots already exists in many laboratories and manufacturing plants.

The researchers believe that they could improve the overall level of polarisation, above the 84% achieved in this research, by altering the amount of indium. If so, such quantum dots could form the light source of new super-efficient LCD screens. Quantum dots can also be controlled in such a way that they emit a single photon of light at a time, making them ideal for use in quantum cryptography.