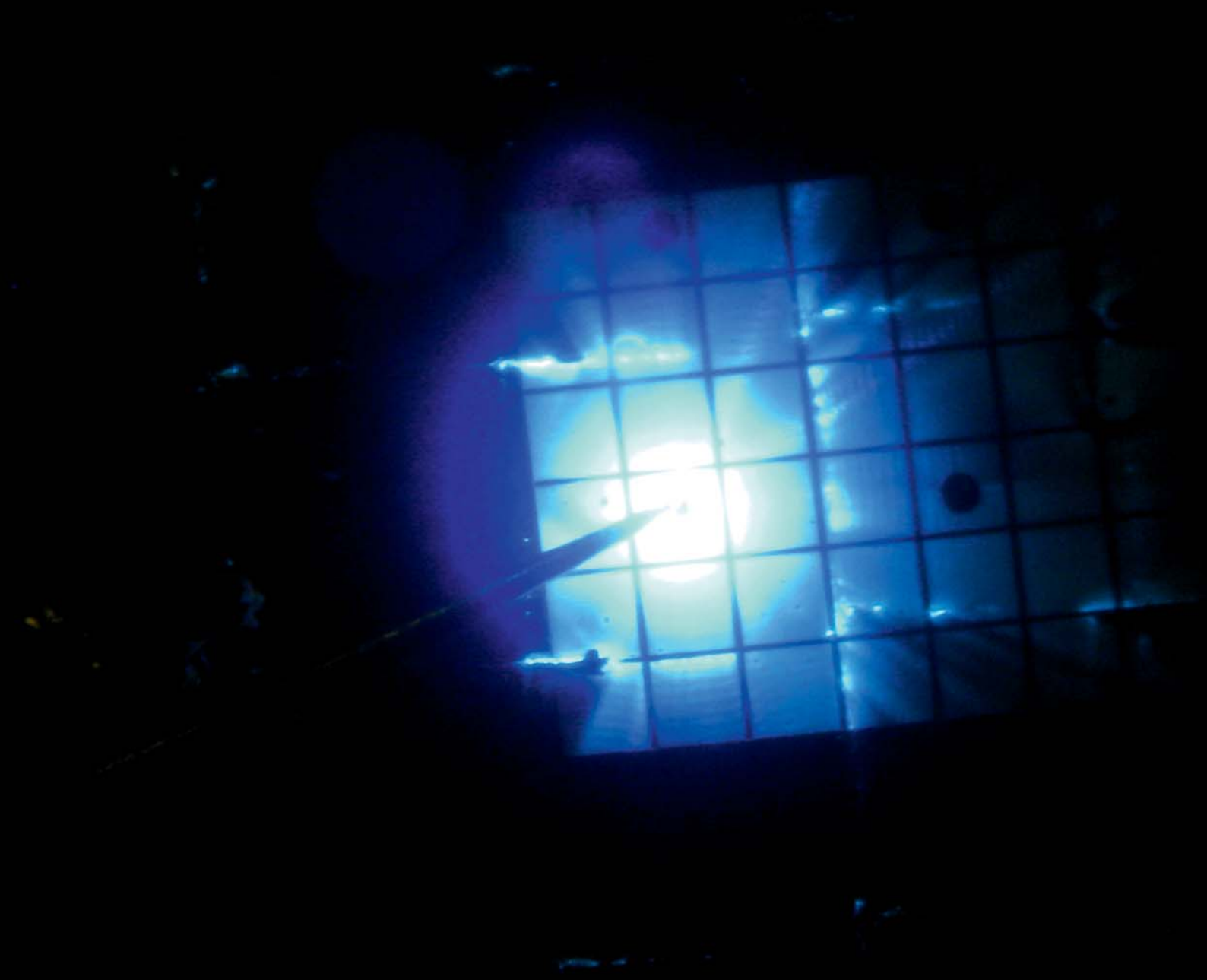
University of Glasgow

Photonic Crystals



Bright solution for slim televisions

Increasing demands from consumers to have ever thinner televisions have presented major development problems for manufacturers because, until recently, this has led to the picture quality suffering.

In state-of-the-art televisions, light-emitting diodes (LEDs) are used as backlights. These have to be kept at a certain distance away from the liquid crystal display (LCD) panel where the images appear. However, when the LEDs and display panels are brought closer together in thinner televisions, individual LEDs start to appear on the screen as little dots, meaning the picture quality suffers.

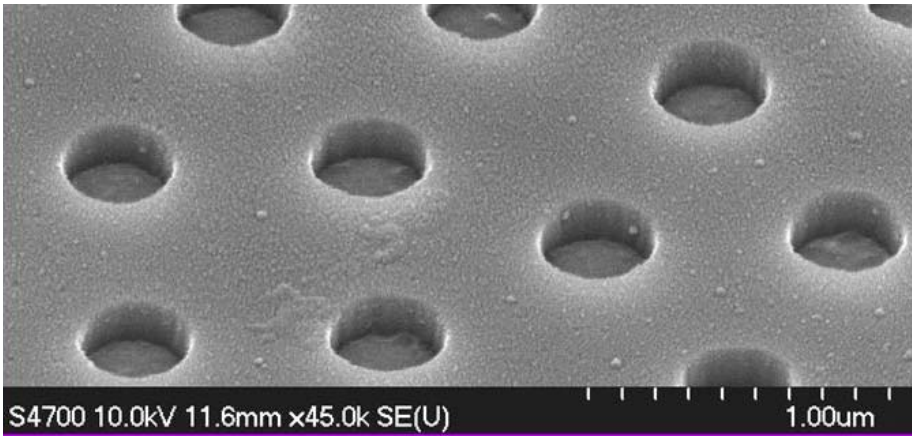
One way out of this difficulty is to tailor the light emission from LEDs such that it is spread out over a wider cone. This can be achieved with so-called photonic crystals that consist of an array of shallow holes etched on the top emitting surface of LEDs. By applying photonic crystals to the LEDs, different illumination patterns can be formed that effectively result in the light being distributed in a more uniform way.

Dr Faiz Rahman and his colleagues at the School of Engineering at the University of Glasgow – working with colleagues at the Institute of Photonics at the University of Strathclyde – have devised an attractive manufacturing route for mass-producing photonic crystal LEDs that allow for significantly increased brightness and improved picture quality on thinner television screens.

Not only can the television sets be thinner than previous using this technology, but they use significantly less electrical power as well. Dr Rahman's research has also paved the way for high performance photonic crystal LED technology being introduced for mass market everyday lighting in homes and businesses.

Building on previous research that was funded from the Engineering and Physical Sciences Research Council (EPSRC), Dr Rahman worked with researchers at Sharp Laboratories of Europe, MacDermid Autotype and Luxtaltek to develop the technology.

Some photonic crystal LEDs have been in production in the United States but, because they are so expensive to produce, they have been limited to high end products such as film projectors. Dr Rahman and industry partner MacDermid Autotype, the global supplier of materials into the electronics applications industry, developed a cost-effective way of producing photonic crystal LEDs that means it is now commercially viable to mass produce them for everyday appliances such as LED lights.



Photonic structure on an LED device.

In co-operation with MacDermid Autotype, they devised a mass production method of creating sheets of photonic crystal patterns on a minute scale known as soft mask nano imprint lithography. In conventional nano imprint lithography, a master stamp is used to directly stamp or emboss very fine patterns onto special resist materials and afterwards these imprinted devices are etched onto gallium nitride. The technique devised by Dr Rahman and MacDermid is much cheaper because once the master stamp is made, it can be replicated onto many meters of soft mask, which can then be used for embossing LED chips.

Using the technology devised by Dr Rahman, Taiwanese company Luxtaltek is beginning to make photonic crystal LEDs that will enable other companies to mass manufacture new high performance LED light bulbs. This next generation of photonic crystal LED bulbs will be significantly brighter than those currently on the market.

In addition to these LED lights using less energy than conventional lighting, they are also more environmentally friendly because they do not contain any hazardous materials such as mercury.

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