Dual-Color Lasers Could Lead to Cheap and Efficient LED Lighting

Institute of Physics

A new semiconductor device capable of emitting two distinct colours has been created by a group of researchers in the U.S., potentially opening up the possibility of using light emitting diodes (LEDs) universally for cheap and efficient lighting.

The proof-of-concept device in IOP Publishing's journal Semiconductor Science and Technology [1], takes advantage of the latest nano-scale materials and processes to emit green and red light separated by a wavelength of 97 nanometres—a significantly larger bandwidth than a traditional semiconductor.

Furthermore, the device is much more energy efficient than traditional LEDs as the colours are emitted as lasers, meaning they emit a very sharp and specific spectral line—narrower than a fraction of a nanometre—compared to LEDs which emit colours in a broad bandwidth.

One of the main properties of semiconductors is that they emit light in a certain wavelength range, which has resulted in their widespread use in LEDs. The wavelength range in which a given semiconductor can emit light—also known as its bandwidth—is typically limited in the range of just tens of nanometres. For many applications such as lighting and illumination, the wavelength range needs to be over the entire visible spectrum and thus have a bandwidth of 300 nm.

Single semiconductor devices cannot emit across the entire visible spectrum and therefore need to be 'put' together to form a collection that can cover the entire range. This is very expensive and is, to a large extent, the reason why semiconductor LEDs are not yet used universally for lighting.

In this study, the researchers, from Arizona State University, used a process known as chemical vapour deposition to create a 41 micrometer-long nanosheet made from Cadmium Sulphide and Cadmium Selenide powders, using silicon as a substrate.

Lead author of the study, Professor Cun-Zheng Ning, said: "Semiconductors are traditionally 'grown' together layer-by- layer, on an atom-scale, using the so-called epitaxial growth of crystals. Since different semiconductor crystals typically have different lattice constants, layer-by-layer growth of different semiconductors will cause defects, stress, and ultimately bad crystals, killing light emission properties."

It is because of this that current LEDs cannot have different semiconductors within them to generate red, green and blue colours for lighting.

However, recent developments in the field of nanotechnology mean that structures

such as nanowires, nanobelts and nanosheets can be grown to tolerate much larger mismatches of lattice structures, and thus allow very different semiconductors to grow together without too many defects.

"Multi-colour light emission from a single nanowire or nanobelt has been realized in the past but what is important in our paper is that we realized lasers at two distinct colours. To physically 'put' together several lasers of different colors is too costly to be useful and thus our proof-of concept experiment becomes interesting and potentially important technologically.

"In addition to being used for solid state lighting and full color displays, such technology can also be used as light sources for fluorescence bio and chemical detection," continued Professor Ning.

For more information visit http://www.iop.org [1].

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[1] http://www.iop.org