

Quantum Dots: 0D Semiconductors for Optoelectronics

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Quantum Dots (QDs) are termed 0-D semiconductors. Their optoelectronic behaviour is governed by size effects which give them characteristics between macro-molecules and nano-crystals. Their size is typically in the 1-10nm range and are synthesised through wet chemical methods. The main size effect of interest is the lack of any phonon density of states as in a larger semiconductor crystal of a given material. This also leads to a discretised electronic density of states in 3-dimensions. Electronic transitions are therefore purely governed by energy absorption or emission. Therefore, a semiconductor such as Si which in bulk crystalline form is an indirect gap semiconductor for electronic transitions becomes a pseudo-direct band gap semiconductor in QD form. Additionally the main energy gap from occupied to unoccupied states (band-gap) is inversely proportional to the size (diameter) of the QD. This opens up a rich vein of material systems to explore for the emission and absorption of light through electronic transitions across the visible spectrum.

The presentation gives an introduction to QD synthesis and design for LEDs and full colour displays. An intriguing ability which QDs enable is the realisation of a full colour palette based on many primaries rather than the Red, Green, Blue emitters to which most displays are limited at present. An advantage of using more than 3 primaries is the opportunity it gives to optimise power consumption in generating a colour range. QD based photodetectors are also presented. The major limitations of in the development of QD based optoelectronic devices including efficient electron and hole transport in the active QD layer is also discussed.

Bio:



Gehan A. J. Amaratunga has held the 1966 Chair and Professorship in Engineering at the University of Cambridge since 1998. He is also Honorary Professor at Yunnan University and Peking University Graduate School, Shenzhen in China and been the Tan Chin Tuan Visiting Professor at Nanyang Technological University, Singapore. He was also the Chief of Research and Innovation at the Sri Lanka Institute of Nanotechnology (SLINTEC) 2011-19. He is a Fellow of the Royal Academy of Engineering UK, National Academy of Sciences of Sri Lanka, Royal Society of Arts and the Institution of Engineering and Technology (formerly the IEE). He has published over 600 archived academic papers and is an inventor on 54 granted patents. His research is in the broad area of materials, devices and technologies for electrical energy and power. It intersects electrical and electronic engineering with physics, chemistry, materials science and information systems. He is also a founder of six start-up companies which have successfully commercialised research from his group, in recognition of which he was awarded the Silver Medal of the Royal Academy of Engineering in 2007.