Proceedings Paper:
Leitao, M., Santos, J., Foucher, C. et al. (2016) Colloidal quantum dot and epitaxial quantum-well platelet colour-converters for visible light communication. In: Semiconductor and Integrated Optoelectronics SIOE'16. Semiconductor and Integrated Optoelectronics SIOE'16, 05-07 Apr 2016, Cardiff, Wales.

Colloidal quantum dot and epitaxial quantum-well platelet colour-converters for visible light communication

M. Leitao[1], J. Santos[1], C. Foucher[1], B. Guilhabert[1], S. Watson[2], S. Rajbhandari[3], H. Chun[3], A. Krysa[4], G. Faulkner[3], D. O'Brien[3], A. E. Kelly[2], E. Xie[1], E. Gu[1], N. Laurand[1] and M.D. Dawson[1]

[1] Institute of Photonics Department of Physics, SUPA, University of Strathclyde, 99 George St, Glasgow G1 1RD, UK
[2] School of Engineering, University of Glasgow, Glasgow G12 8LT, UK
[3] Department of Engineering Science, University of Oxford, Oxford OX1 3PJ, UK
[4] Electronic & Electrical Engineering, University of Sheffield, Sheffield, UK

With higher efficiency than fluorescent lights and regular enhancements to their performance, solid-state light sources (LEDs and laser diodes) based on GaN technology are becoming key elements for improving energy consumption in lighting. Besides their high power, efficiency, longer lifetime and compact size, these sources are also characterised by relatively high modulation speeds, making them attractive for visible light communication [1]. In most current lighting applications, white light is produced by blue-emitting GaN LEDs coated with yellow, or green and red, phosphors. However, the phosphors' long excited state lifetimes do not allow capitalising on the bandwidths of LEDs and laser diodes. Here, we are reporting on our study of alternative colour-converters to phosphors in the form of (i) Colloidal Quantum Dot (CQD) composites and (ii) AlInGaP Multi-Quantum Well (MQW) platelets, suited for integration with blue GaN-based sources.

Red (630 nm) and green (540 nm) alloyed CdSe/ZnS CQDs were incorporated into a PMMA matrix, with different weight ratios of CQDs-to-PMMA (Figure 1 (a)). A 450nm GaN LED was used to optically pump these composite samples, with the green CQDs presenting higher forward power conversion efficiency (9%) than the red CQDs (<2%) (Figure 1 (b)). The photoluminescence quantum efficiency of the CQD composites was measured to be 14% and 60%, respectively for the red and green CQDs. The modulation bandwidths of the red and green samples were measured to be 25 MHz and 14 MHz. Free-space 2-PAM data transmission using a micro-size LED colour-converted by these CQD samples was demonstrated with data rates up to 530 and 395 Mb/s for red and green CQDs, respectively.

We have previously demonstrated the potential of red-emitting AlInGaP MQW platelets grown by MOCVD as a full inorganic colour-converting solution for VLC [2]. Here, we will also report on our recent results using a yellow-emitting MQW platelet structure (Figure 1 (c)).

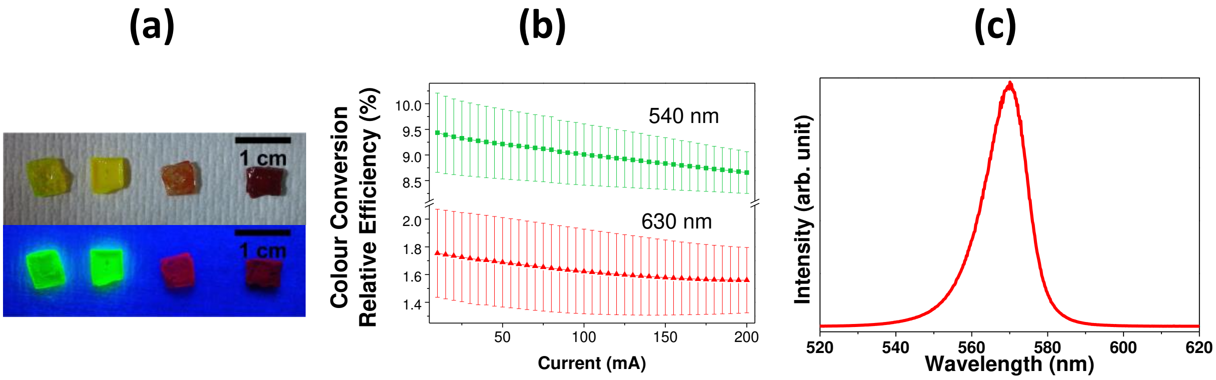

Figure 1 – (a) Composite samples of green and red CQD at different concentrations under ambient (top) and UV light (bottom); (b) Forward power conversion efficiency of the CQD samples; (c) Photoluminescence spectrum of the AlInGaP blue-to-yellow converter.

References:

[1] – C. W. Chow et al, Digital signal processing for light emitting diode based visible light communication *Proc. IEEE Photon. Soc. Newslett., Res. Highlights*, pp. 9 -13, 2012

[2] – J.M.M. Santos, et al, "MQW nanomembrane assemblies for visible light communications," in Photonics Conference (IPC), 2015, vol., no., pp.523-524, 4-8 Oct. 2015