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Photophysical Characterisation of Perovskite Quantum Dots

Perovskite Quantum Dots are a promising new class of light emitters. In this paper a complete photophysical characterisation, comprising of absorption spectra, photoluminescence spectra, photoluminescence lifetime, and quantum yield of two perovskite quantum dots is carried out using the versatile FS5 Spectrofluorometer. In this article we researched: Measurement of absorption and photoluminescence spectra of perovskite, QDs Determination of the photoluminescence quantum yield of perovskite, QDs Photoluminescence decays of perovskite, and QDs measured using TCSPC.

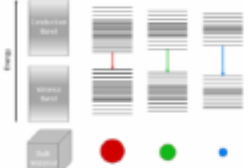
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APPLICATION NOTE
Photophysical Characterisation of Perovskite Quantum Dots
 AN_FS5_22 Oct 2018, Stuart Thomas



Introduction
 Semiconductor quantum dots possess an array of attractive properties, including: high photoluminescence quantum yields (PLQY), solution processability and highly tunable band gaps. These properties make quantum dots ideal for optoelectronic devices such as light emitting diodes and semiconductor lasers where they serve as emitters or in photodiodes and solar cells where they serve equally well as light absorbers. In addition, their light emission properties also make them a promising new class of fluorescent probe for biomedical fluorescence imaging to replace traditional organic small molecule probes.

The key attraction of quantum dots is the superb control available over their band gap due to quantum confinement. In a bulk semiconductor the number of atoms is very large and the overlap of its high number of atomic orbitals creates a continuum of closely spaced 'molecular' orbitals which form the valence and conduction bands. However, if the semiconductor is reduced to a nanoscale size the situation changes. There are fewer atomic orbitals overlapping and the valence and conduction bands are no longer continuous and are instead formed of discrete energy levels, and more importantly the band gap between the valence and conduction bands becomes wider which is known as quantum confinement (Figure 1). Nanoparticles that are small enough to have their band gap influenced by quantum confinement are known as quantum dots and by precisely controlling the size of the quantum dots during synthesis the photoluminescence emission and absorption wavelengths can be finely tuned, which is ideal for optoelectronic applications.



Materials & Methods
 Perovskite quantum dots were purchased from PflanzChem GmbH. A solution of each quantum dot was prepared in cyclohexane and diluted to achieve an absorbance of 0.1 OD at the band edge in order to prevent reabsorption errors during spectral and PLQY measurements. The solutions were loaded into 10 mm pathlength quartz cuvettes and measured using the FS5 Spectrofluorometer equipped with a PMT-P20 detector and TCSPC lifetime electronics. For absorption spectra, photoluminescence emission spectra and photoluminescence decay the cuvettes were held using the SC-02 Cuvette Holder Module. To calculate the PLQY the quantum dots were measured using the SC-30 Integrating Sphere Module.

Results & Discussion
 The photophysics of two halide perovskite quantum dots, hereafter known as PQD-A and PQD-B, were investigated using the FS5 Spectrofluorometer. The FS5 contains an absorption detector as standard which enables the photoluminescence and absorption spectra to be measured using a single instrument. The absorption and emission spectra of PQD-A are shown in Figure 3a. The emission is centred on 450 nm and is characteristically narrow with a FWHM of only 14 nm. It can be seen that the emission occurs at the band edge of the quantum dot as the emission peak is coincident with the sharp drop in the absorbance that marks the band edge. The absorption and emission spectra of PQD-B tell a similar story with a narrow emission centred

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