

Project Outline for PhD President's Research Scholarship in Bioimaging

Title: Optical and Scanning probe imaging and manipulation of single colloidal quantum dots: Correlation between fluorescence and local environment

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Keywords: colloidal quantum dots, fluorescence microscopy, scanning probe microscopy, correlation analysis

Subject area: physics, biophotonics

Brief Description:

Colloidal quantum dots (CQDs) have significant advantages for bioimaging [1] and solar energy harvesting compared to fluorescent molecules, specifically regarding their photo-stability and their absorption cross-section. However, they show environment-dependent fluorescence intermittency, also called “blinking”, which limits their application specifically in single quantum dot techniques like fluorescence correlation spectroscopy [2]. On the other hand, one could use the dependence of the emission intensity, lifetime, and spectrum on the environment for local sensing applications. In this project, you will investigate the link between the charge state of the CQD and its emission properties using a combination of a scanning Kelvin-probe microscope measuring the CQD charge state [3], and optical microscopy of the CQD emission in terms of spectrum and lifetime. You will study the influence of local electric fields and mechanical pressure on CQDs in view of their potential applications as field or pressure sensors, e.g. to measure cell membrane potentials. You will investigate different CQD types, from the common ZnS/CdSe system, which is also available as rod-like shape for increased electric field sensitivity, to CdTe, InAs or PbS based CQDs.

The project combines the scanning-probe facilities and expertise of the Nanophysics group in PHYSX with the optical spectroscopy expertise and facilities of the Quantum Optoelectronics & Biophotonics group in PHYSX and BIOSCI. You will develop and use time-resolved single CQD fluorescence microscopy combined with the measurement of the time-resolved charge state by a scanning probe microscope (SPM) in the same instrument, in order to determine the influence of CQD charging on their fluorescence. You will be trained in the two important fields of optical and scanning probe imaging, and in the properties and the handling of single quantum emitters such as colloidal quantum dots, and their use as nanoimaging sensors for material and life sciences. Well equipped air-conditioned laboratories are available for the proposed experiments. You will receive additional training in the field of Biophotonics via the taught modules of the MSc Biophotonics course jointly run between the PHYSX and BIOSCI.

References

- [1] Larson et al., *Science* **300**, 1434 (2003), DOI: 10.1126/science.1083780
- [2] Lippitz et al., *ChemPhysChem* **6** 770 (2005), DOI: 10.1002/cphc.200400560
- [3] Stomp et al., *Phys. Rev. Lett.* **94**, 056802 (2005), DOI: 10.1103/PhysRevLett.94.056802

Funding notes:

The studentship is fully-funded, ie includes the payment of tuition fees at the Home/EU rate and a tax free maintenance stipend. Non-EU applicants are welcomed but successful applicants would have to self-fund the difference between the Home/EU and International Fee.

To fill an application form and for further information see:
<http://www.cardiff.ac.uk/presidents/bioimaging/index.html>