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PhD project (36 months)

Development of Perovskite Quantum Dots for All-Optical Quantum Information Technology

Introduction

Halide perovskite $CsPbX_3$ (X=Cl,Br,I) quantum dots (QDs) have drawn significant research interest in the past three years due to their outstanding optical properties [1]: narrow photoluminescence (PL) band (10-40 nm FWHM) with room temperature quantum yield (QY) as high as 90%, and tunability of PL peak from 400 to 700 nm by varying either the halide composition and/or by playing with the quantum confinement effect (Fig. 1). Interestingly, doping of $CsPbX_3$ QDs with Mn^{2+} ions has also recently been reported [2, 3], opening up the potentiality of combining magnetic and semiconductor properties at the nanoscale.

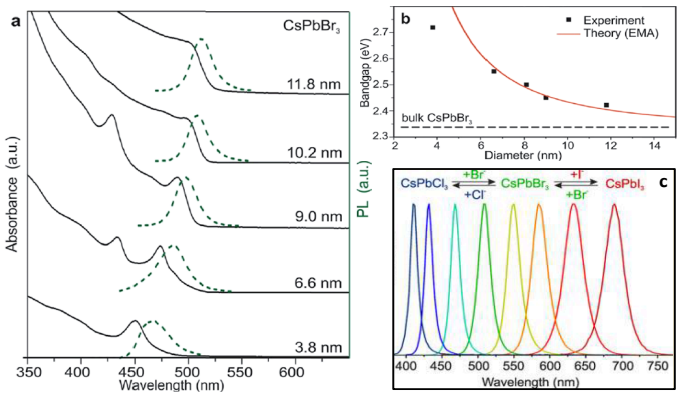

Figure 1: a) Quantum confinement effect observed in the absorption and emission spectra of $CsPbBr_3$ QDs.[4] b) Experimental and theoretical (effective mass approximation, EMA) dependence of the band gap energy from the QD size. c) Normalized PL spectra of 10-nm $CsPbX_3$ QDs with varying halide composition.[5]

Description of the PhD project

The PhD project is part of a local collaborative research project aiming at developing $CsPbX_3$ QDs as versatile building blocks for the all-optical Quantum Information Technology, involving two research institutes (CEA – INAC and CNRS – Institut Néel) and industrial partners (to be defined). The PhD candidate will explore two device applications using perovskite QDs as:

- Quantum emitters in solid-state single photon sources. This demands synthesis of high quality QDs featuring high PL QY at room temperature and their deterministic positioning in photonic structures.
- Spin quantum bits. This necessitates the controlled doping of perovskite QDs with transition metal ions down to the single dopant level per QD. [6]

The candidate will carry out chemical synthesis of perovskite QDs and their structural and optical characterization in CEA – INAC. In CNRS – Institut Néel, he will participate in the study of the QD physical properties using advanced spectroscopy (measurements of PL dynamics, applied magnetic field effects, quantum optics, …) and in clean room processing (deterministic positioning of QDs on solid substrate, integration of single QDs in single photon source structures). This PhD project includes as well a 6-month internship in industrial environment.

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