Colloidal Quantum Dots in Perovskite Diodes

Laboratory : Institut Lumiere Matiere
In Cooperation With : Luminescence team
Level : M2
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Scientific Context :

The aim of the internship is to characterize optically and understand the emission of quantum-dot-doped thin-films of lead-based perovskite, at the single quantum dot level, as a function of an applied electric field. Colloidal quantum dot (CQDs) are solution-processed, nanometer-sized objects which emit light under electrical or photo-excitation. II-VI single CQDs emission suffers from blinking. Blinking behavior is associated to an ON/OFF characteristics in the emission timetrace of a single CQD. Blinking is the consequence of a charged CQD and affects negatively potential applications, such as lasers and LEDs, as well as prevent them from being used as Q-bits for the quantum information. In order to suppress this behavior, we propose an experiment where we control the CQD charge state by embedding them in a perovskite crystalline matrix connected electrically, which forms a field-effect device. We have demonstrated that a thin film (~100 nm) of halogenate, lead-based perovskite (MAPbBr3) can be doped with various concentrations of colloidal quantum dots (CQDs) emitting in the visible range, from diode-required concentrations down to the single CQD level. We are now developing the electrode processing to apply a controlled electric-field at the CQDs location which will be operational by January 2020.

Missions :

Job descirption The trainee will have first to produce field-effect devices with CQD-doped thin perovskite films following the method previously developed in the team. The trainee will test the electrical response of the device on a newly acquired I-V test setup. If the electrical response follows that of a diode, the trainee will characterize it optically under a state-of-the-art confocal microscope. Optical characterization will include nanosecond lifetime measurement, fast antibunching for single photon emission spectral fingerprint etc. as a function of an externally applied electric field. The trainee will then perform a detailed study of the blinking behavior of single CQDs as a function of an external electric field, and, if time allows it, perform a study of the Stark effect on the emission spectral-fluctuations at liquid helium temperature. Competences acquired during internship · Thin film fabrication · Electrical I-V characterization · Confocal microscopy of single nano-objects · Spectroscopy of single/ensemble of nano-objects · Nanosecond lifetime and antibunching measurements

Outlooks :

This internship, which is part of the ANR project NEOGate, can be extended to a PhD via an ED PHAST founding.

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