Stark effect on self-assembled semiconducting nanoplatelets at the vicinity of a ferroelectric substrate.

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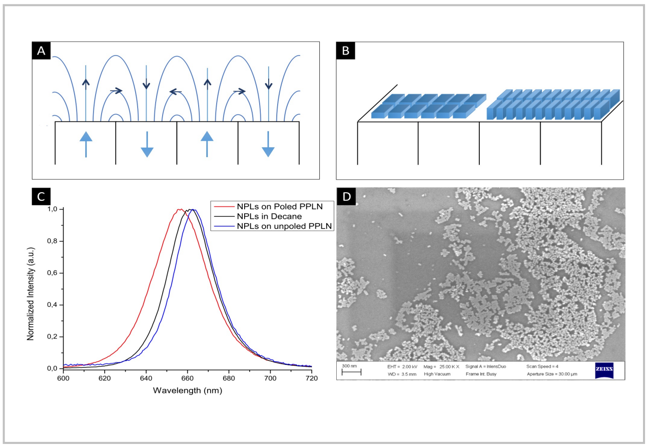
Scientific Context :

Colloidal nanoemitters (quantum dots -QDs- and nanoplatelets -NPLs-) are fluorescent semiconductor nanocrystals that are exploited in a broad range of applications, from optoelectronics to biological imaging. These nanocrystals depict fluorescence emission energy and intensity highly sensitive to their morphological assembly and surrounding electric field (Stark effect). On the other hand, ferroelectrics are a class of materials that exhibit a permanent internal polarization even in the absence of an applied electric field. It is possible to structure these polarization domains in single crystals and generate substrates with well-defined up and down periodic domains that will in turn generate strong permanent electric fields at the substrate surface (figure 1A). At the interface between domains, the electric field can be of the order of a few kilovolts per centimeter, a value that can strongly modify the optoelectronic properties of colloidal nanoemitters.1



We recently demonstrated that this strong electric field can indeed induce a blue shift of the emission of core/shell nanoplatelets deposited on periodically poled Lithium niobate (PPLN). The aim of this internship is to clarify these preliminary results by creating ordered assemblies of nanoplatelets on the ferroelectric substrate (figure 1B). The assembly will allow us to orient the NPLs emission dipoles and enhance the global observed Stark effect. As such Stark effect should be dependent of the local electric field intensity and orientation, it will then be possible to take advantage of this to map the electric field at the surface of the ferroelectric through hyperspectral fluorescence imaging.

Missions :

During the project, the student will first synthesize highly fluorescent core/shell NPLs following established literature protocols.2 He will then develop self-assembled films, either through slow drying of the NPLs solution on an anti-solvent or directly using a microfluidic channel on the ferroelectric substrate. After AFM and SEM characterizations (Figure 1D), the films will be transferred by stamping on the ferroelectric substrate for hyperspectral imaging.

Outlooks :

The project can be extended to a PhD through doctoral school funding depending on the student examination success.

Bibliography :

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