INTERNSHIP PROPOSAL

Laboratory name: INSP é LPENS
CNRS identification code: UMR7588
Internship director'surname: Emmanuel Lhuillier (INSP) and Angela Vasanelli (LPENS)
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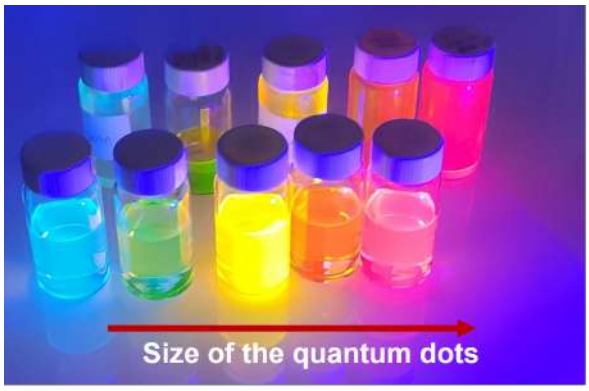
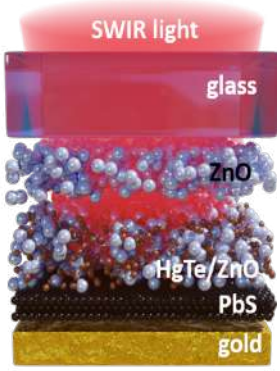
Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: ANR nanomirage

Infrared electroluminescence from colloidal quantum dots

Summary Colloidal Quantum Dots (CQDs) are size-tunable semiconductors, as shown in the left figure. They received the Nobel Prize in 2023 after being integrated into displays thanks to their spectrally narrow luminescence. While visible CQDs are now commercially available, their infrared counterparts have not yet released their full potential, whereas the short-wave infrared range lacks efficient non-coherent sources.





The project aims to explore the design of light-emitting diodes operating in the 1 to 5 µm range; typical targeted structures are depicted in the right figure. The infrared light-emitting layer is sandwiched between charge injection layers that selectively inject electrons and holes. In the visible range, the quantum efficiency can be as high as 20%, but it quickly drops as longer wavelengths are targeted (1% at 1.3 µm and 0.1% at 2 µm) due to the lengthening of the radiative lifetime and inefficient shielding, which makes non-radiative processes dominant. Thus, new concepts need to be introduced to circumvent this drop in efficiency.
The project will explore new concepts related to charge injection based on energy transfer and cascade effects as strategies to generate electrical gain. A second aspect of the project will relate to the design and fabrication of photonic structures to achieve better light outcoupling.

The project will be collaboratively conducted between INSP (material and device aspects) and LPENS (electromagnetic design and fabrication). As the project is part of ANR Nanomirage, some punctual time-resolved measurements conducted at ENSTA will also be planned.

Reference Nature Photonics 16, 38(2022)

Condensed Matter Physics: YES Soft Matter and Biological Physics:NO
Quantum Physics: YES Theoretical Physics: NO