SCIENCES SORBONNE UNIVERSITÉ

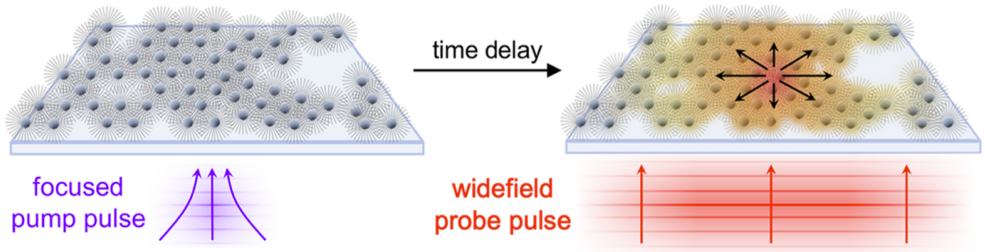
Master thesis proposal

Institut des NanoSciences de Paris (INSP)
Sorbonne Université
Website : https://w3.insp.upmc.fr/

Pump-Probe Spectroscopy of Energy Carrier Transport in Nanocrystal Optoelectronics

Keywords: ultrafast spectroscopy, nanocrystal, charge transport, thermal transport, excited-state dynamics

Scientific description: The aim of this experimental project is to use a pump-probe optical microcopy method to spatiotemporally study microscopic charge and thermal transport and relaxation dynamics in nanocrystal-based optoelectronics systems. Energy carrier transport at the nanoscale is fundamental to energy conversion applications. While advanced spectroscopic methods grant an understanding of excited-state dynamics in isolated materials,[1] many physical questions about the microscopic nature of transport in optoelectronics devices remain underexplored. To address this area, one needs a probe of local charge transport with sub-nanosecond time resolution and sub-micron spatial resolution in a material in realistic device conditions. Our approach is to do ultrafast microscopy and fabricate nanocrystal-based optoelectronics. These studies will reveal microscopic structure–property relationships that connect nanoscale carrier dynamics to macro-scale energy conversion.



During the timeframe of the master's internship, the student will perform state-of-the-art experiments on nanocrystal optoelectronics, and perform analysis and modeling of nanoscale energy transport. The goal is that the student continues on to do a PhD, during which the student will spatiotemporally measure the microscopic charge and thermal transport characteristics to resolve fundamental problems in colloidal semiconductor nanocrystal systems and advanced energy conversion devices.

The team: The student will be advised by Dr. James Utterback, a CNRS Chargé de Recherche at the Institut des NanoSciences de Paris (INSP, Sorbonne Université). Dr. James Utterback's background is in pump-probe optical spectroscopy and microscopy of nanomaterials at the University of California Berkeley and University of Colorado Boulder.[2] The student would also benefit from the environment of the Chemical Physics and Dynamics of Surfaces team, whose expertise spans across nanocrystal synthesis, characterization, spectroscopy, and nanocrystal device integration.

Student Background and Learning: The student will gain expertise in spectroscopy, semiconductor physics, optics, nanoscience, data acquisition, and data analysis. Students with background in the above areas are preferred. Experience with Python is ideal. The lab is international so the student must speak English.

[1] Delor *et al. Nature Materials*, 2020, 19(1), 56. [2] Utterback *et al. Nano Letters*, 2021, 21(8), 3540.

Possibility to go on with a PhD ? Yes, ANR or École Doctorale.

Internship supervisor:
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If you are interested, please email James Utterback directly.