Master Internship/PhD

Title	**Plasmonic Semiconductor Nanocrystals for Solar Energy Control**
Location	Laboratoire PMC – Ecole Polytechnique – Route de Saclay – 91120 Palaiseau
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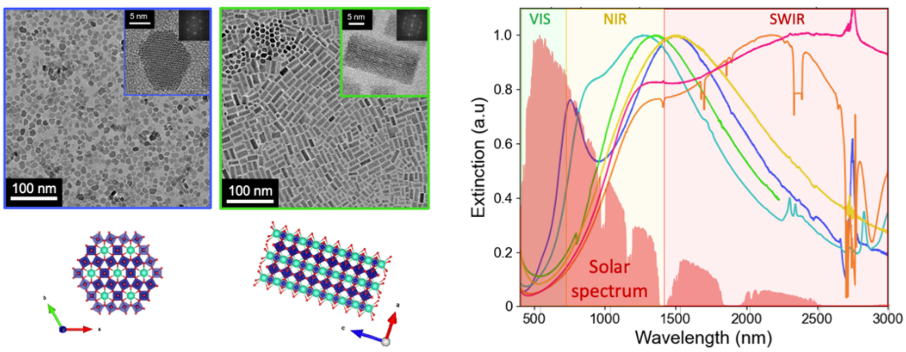
Starting date	Spring, 2024

Near-infrared (NIR) range of light is of rapidly growing interest for solar energy, imaging, telecommunication, and biomedical technologies. However, there exist not many choices of materials efficiently interreacting with this invisible range of light. New NIR-optical materials are thus highly demanded for future technologies toward energy harvesters, sensors, biomedical probes, etc.

Our group has been developing nanocrystalline materials that can strongly absorb, reflect, or scatter NIR light based on their effect of 'localised surface plasmon resonance' (LSPR). This phenomenon is typically exhibited by noble metal nanoparticles containing free electrons. We replace metals with semiconductors in order to extend the accessible spectral range of LSPR. As the free electron density in semiconductors can be controlled by doping rate, the LSPR in semiconductor nanocrystals becomes largely tuneable across the entire infrared region (700 ~ 10000 nm)[1]. And the variable crystal structures and morphology of semiconductors enable a unique multi-band LSPR nature[2,3].



This internship project aims first to chemically synthesize dope metal oxide nanocrystals with controlled crystal structure and particle morphology performing dual-band LSPR in the targeted NIR region. Highly anisotropic shapes (e.g. rods and disks) of particles will be attempted for the next step of self-assembly. Second, by controlling the nanocrystal self-assembly, novel plasmonic structures with separately tunable LSPR dual bands will be fabricated. The oriented assembly of particles will enable separating different LSPR modes by polarization effect. Finally, the assembled structures and thin films of plasmonic nanocrystals will be used to design solar energy harvesting devices[4] and smart windows that can selectively tune the light absorption/transmission in different wavelengths.

Diverse synthesis and characterization techniques will be used: Schlenk line synthesis, Colloid chemistry, Film deposition, Electron microscopy (TEM & SEM), NIR-Spectroscopy, Optical microscopy, NMR, FTIR, etc.

This internship can be continued as a PhD thesis.

[1] Luther et al, *Nature Materials.* 10, 5, 361 (2011) – DOI : 10.1038/nmat3004
[2] Kim et al, *Nano Letters*. 16, 6, 3879 (2016) – DOI : 10.1021/acs.nanolett.6b01390
[3] Cheref et al, *Chem. Mater*. 34, 21, 9795, (2022) – DOI : 10.1021/acs.chemmater.2c02879
[4] Daugas et al, *Adv. Func. Mater.* 33, 2212845 (2023) – DOI : 10.1002/adfm.202212845