CEA – Saclay, 91191 Gif-sur-Yvette Cedex
**Service de Physique de l'Etat Condensé - UMR 368**

Visio **SÉMINAIRE**

**Mercredi 24 novembre 2021 à 11h**

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# Recent progress in organic optoelectronic materials and devices

Organic semiconducting materials have been widely investigated in the last decades due to their applications in organic optoelectronics including organic light-emitting diodes (OLEDs), organic solar cells and organic field-effect transistors. In particular, OLEDs are now recognized as one of the most promising flat-panel display technologies and have already achieved significant penetration in the commercial market. In this seminar, I will mainly talk about two important recent achievements in this research field: (i) the realization of the first electrically-pumped organic semiconductor laser diode[1] and (ii) the development of new organic monolithic hyperbolic metamaterials.[2] Those works open up new opportunities for a range of applications in the fields of chemistry, photonics and optoelectronics.

The demonstration of the first organic laser diodes has represented the "holy grail" in the organic optoelectronic community for nearly 30 years. The challenges that have prevented the realization of lasing by direct electrical excitation of organic semiconductors for so long are in fact essentially related to the higher lasing threshold under electrical pumping. To achieve electrical lasing, injection and transport of current densities over few kA/cm$^2$ are necessary and it is also essential to substantially reduce all the optical and excitonic losses taking place in the operating devices. In the first part of my talk, I will discuss about the different approaches that we have explored to improve the triplet exciton management and the performances of optically-pumped organic lasers working under long pulse photo-excitation.[3,4] I will then present results providing evidence of current injection lasing in an organic thin film and show how it is critical to develop new organic semiconductor lasing materials exhibiting a clear spectral separation between the lasing emission and the absorption of the excited states and polarons.

The second part of my talk will be devoted to uniaxial anisotropic materials with in-plane and out-of-plane components of the real part of the permittivity possessing opposite signs, that are referred to as hyperbolic media, and their potential for organic optoelectronics. Metallic nanowire arrays and metal-dielectric multilayers are two well-known examples of such hyperbolic metamaterials (HMMs). After showing that such HMMs can be used to control various photophysical processes of organic semiconductor thin films such as their spontaneous emission rate or the charge transfer dynamics,[5,6] I will discuss about the recent development of organic materials exhibiting hyperbolic dispersion.[2] Those organic hyperbolic materials provide indeed a promising alternative to artificial metal-dielectric HMMs and open new prospects for engineering organic optoelectronic devices

*[1] A. S. D. Sandanayaka et al., **Appl. Phys. Express** 12, 061010 (2019).*
*[2] Y. U. Lee et al., **ACS Photonics** 6, 1681–1689 (2019).*
*[3] A. S. D. Sandanayaka et al., **Science Adv.** 3, e1602570 (2017).*
*[4] D. H. Kim et al., **Nature Photon.** 12, 98 (2018).*
*[5] K. J. Lee et al., **Nature Mater.** 16, 722 (2017).*
*[6] K. J. Lee et al., **Nano Lett.**, 18, 1476 (2018).*

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