



Clustomesogen containing devices generating polarized emission

PhD supervisors: Pr. Y. Molard, Dr. M. Amela-Cortes.

Contact: yann.molard@univ-rennes.fr

CSM team, Institut des sciences chimiques de Rennes, 263 Av. Gal Leclerc, 35042 Rennes cedex, France

Being able to produce in a sustainable manner circularly polarized luminescent (CPL) sources displaying low cost, efficiency and stability, is one of the main technological research forefronts in the field of optical devices. CPL attracts an increasing attention because of its remarkable advantages including its extensive optical information and lack of angular dependence. When a high luminescence dissymmetry factor (g_{lum}) and a high emission quantum yield are reached for a material, it can be promisingly applied in the design of chemical sensors, biological probes, stereoscopic displays, liquid crystal lasers, or for backlighting liquid crystal displays (LCDs).

CPL is usually found when emitters are chiral or when they are arranged in a chiral fashion. Hence, several strategies were developed to design high g_{lum} CPL emitters, such as chiral organic emitters, chiral aggregation induced emission (AIE)-active chromophores, chiral metal complexes, chiral supramolecular self-assembly or chiral emissive liquid crystals.^[1] Liquid crystal (LC) are an excellent and well-studied class of materials with highly controllable self-assembled architectures. LC can self-assemble in various forms (or phases) based on spontaneous symmetry breaking leading to helicoidal chiral structures. We wish to add emissive properties to such self-assembled helicoidal nanostructures to create a CPL-active material.

Thus, during this PhD, the candidate will develop emissive chiral hybrid organic-inorganic nanomaterials capable of efficiently providing circularly polarized luminescence (CPL) by integrating nanometric inorganic emitters in a host LC organic matrix.

To do so, stable, strong, and achiral inorganic emitters known as octahedral transition metal clusters, and of general formula $A_nM_6X_i8L^a_6$ (A = alkali cation, M = Mo, W, X_i : halogen inner ligand, L^a = halogen or organic apical ligand) will be used. These red NIR phosphorescent emitters are obtained at high temperature (700 – 1200°C) and show an unrivalled photostability with, for some of them, an emission efficiency close to unity. They will be functionalized with organic liquid crystalline moieties using electrostatic interactions^[2] that should enable their homogeneous integration in other host LC matrices showing related helicoidal (or helical) superstructures such as the range of LC B4 phases morphologies (BC_{us} **Figure 1**) developed by our partner at Kent State University (USA, Ohio).^[3]

Using strong and stable emitters in highly tunable chiral templates will allow the generation of highly efficient CPL devices with unique and better specifications compared to what is in the market to date. These efficient CPL-active devices can be envisioned as chiroptical probes and shall provide higher sensitivity and resolution in chemical and biological optical sensing or as chiroptical switch for encrypted integrated logic device with higher storage density and security through optical signals and chiral signals.

The successful PhD candidate will i) synthesize mesogenic cationic organic compounds using multi-step organic synthesis, ii) use those cations to obtain clustomesogens *via* the electrostatic approach with $[M_6X_i8L^a_6]^{2-}$ synthesized in CSM team; iii) study their mesomorphism and optical properties (birefringence, luminescence, CPL). The successful



Université
de Rennes



Ecole
Nationale Supérieure
de Chimie
de Rennes

INSA
RENNES



candidate will have the opportunity to stay at the Advanced Materials and Liquid Crystal Institute in Kent (Ohio, USA) to study the hybrids by SAXS and WAXS, integrate the most promising of them in devices using their cleanroom facilities.

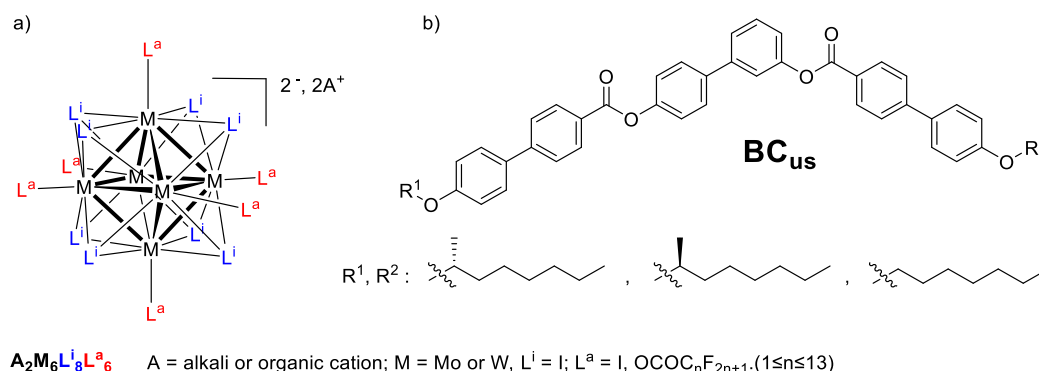


Figure 1. Schematic presentation of a) $A_nM_6X_iL^a_6$ metal cluster compound and b) BC_{us} bent-core compounds forming a range of B4 morphologies developed in Kent.

Profile: Master in molecular chemistry with skills in the synthesis, purification and characterization of organic compounds; good level in English required, ideally with some knowledge in optical spectroscopy.

- [1] a) S.-P. Wan, H.-Y. Lu, M. Li, C.-F. Chen, *J. Photochem. Photobiol. C: Photochem. Rev.* **2022**, *50*, 100500; b) T. Xu, H. Li, W. Liu, Y. Li, B. Li, Y. Yang, *Dyes Pigm.* **2022**, *200*, 110121; c) P. Sumsalee, L. Abella, S. Kasemthavechok, N. Vanthuyne, M. Cordier, G. Pieters, J. Autschbach, J. Crassous, L. Favereau, *Chem. - Eur. J.* **2021**, *27*, 16505-16511; d) B. C. Baciú, P. J. Bronk, T. de Ara, R. Rodriguez, P. Morgante, N. Vanthuyne, C. Sabater, C. Untiedt, J. Autschbach, J. Crassous, A. Guijarro, *J. Mater. Chem. C* **2022**; e) L. Poulard, S. Kasemthavechok, M. Coehlo, R. A. Kumar, L. Frédéric, P. Sumsalee, T. d'Anfray, S. Wu, J. Wang, T. Matulaitis, J. Crassous, E. Zysman-Colman, L. Favereau, G. Pieters, *Chem. Commun.* **2022**, *58*, 6554-6557.
- [2] Y. Molard, *Acc. Chem. Res.* **2016**, *49*, 1514-1523.
- [3] J. Liu, Y. Molard, M. E. Prevot, T. Hegmann, *ACS Appl. Mater. Interfaces* **2022**, *14*, 29398-29411.