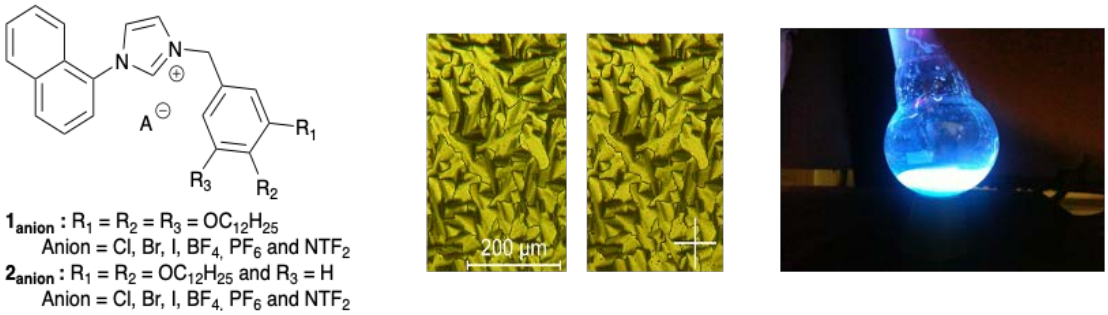
From luminescent imidazolium salts to tools for biology

DIRECTEUR DE THESE : LAURENT DOUCE
IPCMS, DMO, 23, RUE DU LOESS, 67034 STRASBOURG CEDEX 2
TEL : 03 88 10 71 07 ; E-MAIL : LAURENT.DOUCE@IPCMS.UNISTRA.FR

Over the last two decades, ionic liquid crystals have been booming and research in this field has led to the synthesis of many molecular structures with mesomorphic properties. This craze is due to the high stability (extremely low volatility, high thermal stability, non-flammability, high chemical and radiochemical stability, high ionic conductivity and large electrochemical window) of these salts but also to the weak interactions and bonds allowing the emergence of self-organized mesomorphic systems reinforced by ionic interactions. The anion variation makes it possible to finely adjust the physical properties of these salts such as viscosity, melting point, polarity and hydrophilicity/hydrophobicity. The organic skeleton cation affects the amphipathic character (balance between two antagonistic parts: rigid aromatic part/flexible alkyl chains) which controls the self-organization architectures in the liquid crystal state. These unique properties have led to applications ranging from display technology through templating media for synthesis to biological activity (targeting and transportation of drugs and gene materials).[1] Light and associated phenomena, *e.g* luminescence have revealed themselves to be powerful tools endowed with great sensitivity to explore the infinitely small. Molecular salts, especially those based on imidazolium units, have gained the attention of the scientific community due to their original properties and structural versatility. Once functionalized with fluorophores,[2] they constitute efficient and highly bioavailable platforms, for example, for ion detection and cellular imaging, opening-up the possibility of theranostics (therapy and diagnosis). The interactions they can engage with negatively charged species and biological membranes as well as their controllable cytotoxicity imparted them applications as anion receptors, but also a promising potential as antibacterial and anticancer agents whose mechanism of action can be observed using luminescence. The course will consist of multi-step synthesis in order to prepare ionic molecules, to characterize their mesomorphic characters and their luminescence properties. Studies of their properties in biology will be carried out in collaboration with biologists.



1_{anion} : $R_1 = R_2 = R_3 = OC_{12}H_{25}$
Anion = Cl, Br, I, BF_4, PF_6 and NTF_2
2_{anion} : $R_1 = R_2 = OC_{12}H_{25}$ and $R_3 = H$
Anion = Cl, Br, I, BF_4, PF_6 and NTF_2

Figure 1 : Luminescent ionic liquid-crystal molecules with different anions and decorated by two or alkyl tails.

[1] W. Dobbs, B. Heinrich, C. Bourgogne, B. Donnio, E. Terazzi, M.-E. Bonnet, F. Stock, P. Erbacher, A.-L. Bolcato-Bellemin, L. Douce, *Journal of the American Chemical Society* **2009**, *131*, 13338-13346.

[2] M. L'Her, Y. Atoini, J. Fouchet, B. Heinrich, N. D. Del-Giudice, E. Scrafton, E. Bordes, L. Karmazin, L. Charbonnière, L. De Cola, L. Douce, *New Journal of Chemistry* **2020**, *44*, 2669-2669.