Master thesis project in:

Synthesis of charge-transfer complexes using ball-milling and in-deep characterization using electron microscopy and electrochemistry

Background and objective of the project

Charge-transfer complexes (CTC) are a specific class of materials obtained by combination of an electron-donating molecule (named generally D or p-type in battery field) and an electron-accepting molecule (noted A or n-type in battery field).[1] While the donor part tends to be semiconductors, the CT complex can have entirely different properties. Indeed, associated D-A systems can be an ambipolar semiconductors, can present metallic behaviour, or even display superconductor properties. Charge transfer complexes have been studied since the 1970's for their conduction properties which can reach values equivalent to metallic compounds.[2] The most famous CT complex is TTF-TCNQ presenting a tuneable electronic conductivity depending of the stack architecture.[3] These remarkable performances make them excellent materials for conception of optoelectronic devices, for organic photovoltaic applications and even in catalysis.

In the field of electrochemical energy storage, charge transfer compounds have recently started to appear with a first study on TTF-TCNQ, which revealed the high potential of this family of compounds to solve conductivity issue in energy storage (especially for organic battery).

Description of the project

As part of a national project, we are aiming to develop new molecular materials based on charge-transfer complexes and understand their physicochemical and electrochemical properties for an integration in a battery device. To this end, we are looking for a motivated and dynamic trainee for a 6-months 2nd-year master internship. The aims of this project are i) synthesising charge-transfer complexes using ball-milling, ii) studying their physico-chemical properties and iii) determining their electrochemical properties with a view to their use in ion-battery. A specific attention will be paid to the characterization of such materials using electron microscopy (SEM, TEM) and associated techniques (EDX, EELS).

For this project, you should have an interest in material chemistry, molecular materials, electrochemistry and electron microscopy. Previous experience of material synthesis and characterisation by spectroscopy would be beneficial. English language skills as well as writing and speaking skills and team working abilities are highly recommended.

References

[1] Geiser, U. ; Schlueter, J. A. *Chem. Rev.* **2004**, *104* (11), 5203–5241.
[2] Wudl, F. *Acc. Chem. Res.* **1984**, 17, 227–232.
[3] Kirtley, J. R.; Mannhart, J. *Nat. Mater.* **2008**, *7* (7), 520–521.
[4] Guan, Y. S. *et al. Chem. Commun.* **2019**, *55* (50), 7179–7182.
[5] Lee, S. *et al. Energy Storage Mater.* **2019**, *20*, 462–469.

How to apply ?

Apply by sending a CV, motivation letter and name of two previous advisors (if possible) to the following email address: matthieu.becuwe@u-picardie.fr (LRCS) and carine.davoisne@u-picardie.fr (LRCS)

For more information about the hosting laboratory: https://www.lrcs.u-picardie.fr/