2019-2020

Master thesis proposal

Title: Degradation of organic pollutants by a new eco-compatible process: a spectroscopic study

Keywords: Environmental catalysis, organic contaminants, FTIR-ATR

Scientific description:

Organic contaminants are widespread in the environment due to energy production (hydrocarbons), agriculture (pesticides) and chemical industries (chlorinated solvents, plasticizers). In addition, so-called emerging contaminants such as pharmaceuticals, cosmetics and steroid hormones are now receiving special attention. Identifying eco-compatible chemical reactions able to degrade these organic contaminants and their by-products represents a major environmental challenge for water treatment and for preserving the quality of natural environments.

To meet these challenges, IMPMC (Guillaume Morin, CNRS), LRS (Xavier Carrier, Sorbonne University) and ECOSYS (Sylvie Nélieu, INRA) collaborate within the Labex Matisse to identify new mechanisms capable of degrading a wide range organic pollutants, without strong oxidants, under physicochemical conditions compatible with natural environments (soils, aquatic environments).
In this context, the proposed internship will include two parts:

1) A synthesis part which will consist in producing eco-compatible substrates capable of sorbing and degrading organic molecules on their surface, based on know-how already well established at IMPMC (Ardo et al., 2015).

2) A spectroscopic analysis part, which will aim to determine in situ, on the surface of these new substrates, the kinetics of degradation of three priority model pollutants. The disappearance of the molecule, and the formation of degradation products on the surface of the solid will be monitored by Fourier transform infrared spectroscopy in attenuated total reflection mode (FTIR-ATR). This technique will directly detect the adsorbed molecules on the surface of the nanoparticle film deposited on the ATR crystal and covered with circulating water at a fixed pH.

This second part, focused on *in-situ* monitoring of degradation kinetics by FTIR-ATR, will represent the largest part of the internship. It will firstly make it possible to precisely evaluate the efficiency of different substrates for the degradation of priority pollutants. In addition, by varying the physicochemical conditions of the experiment, the kinetic monitoring will help us to progress in understanding the reaction mechanisms involved at the solid-liquid interface.

Techniques/methods in use:

FTIR-ATR spectroscopy has the main advantage of only probing molecules located on or near the surface region of the sample. In this configuration, unlike the transmission mode, IR becomes a surface-sensitive technique since only the molecules in the first micrometers of the surface of the ATR crystal interact with the infrared light. Thus, ATR-IR is perfectly suited to the study of interfacial phenomena for solid-liquid reactions since it excludes most of the contribution of water used as a solvent.
This work can be completed by the use of spectroscopy RPE (Electron Paramagnetic Resonance) for the detection of reaction intermediates.

Applicant skills: Chemistry, Condensed matter physics, interest for spectroscopy and environmental issues

Industrial partnership: N (specify the company)

Internship supervisor(s) (name, email, phone, webmail):

Xavier Carrier (Prof. Sorbonne University, LRS), xavier.carrier@sorbonne-universite.fr
Alberto Mezzetti (MCF Sorbonne University, LRS), alberto.mezzetti@sorbonne-universite.fr

Guillaume Morin (DR CNRS, IMPMC), guillaume.morin@upmc.fr
Tiago Da Silva (Post-Doc, IMPMC), tiago.da_silva@upmc.fr

Internship location:

Laboratoire de Réactivité de Surface (LRS), Tour 33-43 E3, Campus Pierre et Marie Curie, Paris
Laboratoire de Minéralogie, Physique des Matériaux et Cosmochimie (IMPMC), 23-24 E5, 4 place Jussieu, Paris

Possibility for a Doctoral thesis: Y (specify if already financed)