DOCTORAL THESIS

Laboratoire Hétérochimie Fondamentale et Appliquée
SYMAC team, http://symac.lhfa.fr
Université Toulouse 3 – Paul Sabatier, CNRS

Chemical technologies for the valorization of industrial wastes

Keywords: Metallic nanoparticles - Catalysis - Hydrogenation - Activation of C–Cl bonds - Multi-step processes - Valorization of industrial wastes - Glycerol

Supervisors: Daniel Pla and Montserrat Gómez

To illustrate how innovative methodologies can be applied in synthesis, this doctoral thesis project aims at the recovery of industrial wastes derived from the food industry and pesticides thanks to the design of new catalytic materials based on metals with high active surfaces, including abundant metals (*e.g.* Cu, Fe, Ni, Co) (Figure 1).

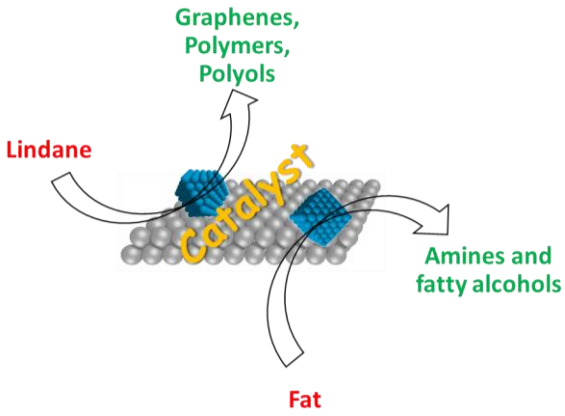

Figure 1. Valorisation of industrial wastes by catalytic means.

This project aims at the design and development of nanomaterials for applications in catalysis through the optimization of different parameters (nature of metal precursors, concentration, temperature, additives) with a particular interest in both the nature of the stabilizer (polymer, ligand) and support, towards enabling sustainable processes. In particular, the liquid phase-immobilized nanocatalysts will be prepared in solvents with negligible vapor pressures and low environmental impact (such as glycerol and derivatives, and choline-based ionic liquids) in order to immobilize the metallic species and thus avoid leaching, allowing their stabilization without deactivation.[1] Furthermore, we envisage strategies for catalyst heterogenization on solid supports in order to increase the efficiency of the catalytic materials by means of studying the synergies between catalyst and support, as well as their recyclability properties.[2] The new composite materials will be characterized both in solution and solid state by standard characterization techniques (TEM, HR-TEM, XPS, XRD, IR, ICP, elementary analysis, etc.).

These nanocatalysts will be applied for the transformation of raw materials arising from industrial wastes, in particular fats from the food industry, as well as lindane, a highly toxic organochlorine insecticide stored in large quantities in the Pyrenees area, towards products of interest. Thus, this PhD thesis will focus on the design of sustainable catalytic processes in terms

of high atom economy and energy efficiency by means of boosting reaction kinetics and thus permitting to work at moderate temperatures. Moreover, the as-prepared catalytic systems will be used in multi-step cascade processes, comprising the activation of C-Cl bonds (coupling reactions) and hydrogenations[3],[4] for the production of products with high-added value, such as fatty amines and alcohols. Standard analytical techniques will be used for the evaluation of the catalytic reactions (GC, HPLC, MS, NMR).

This PhD project is part of the TRIPyr network funded by the Interreg-POCTEFA program, a European network gathering other students (doctoral students and post-docs) from different laboratories (ICIQ, Tarragona), as well as companies (SAPOVAL, Toulouse) and technology centers in France (MEPI, Toulouse) and Spain (AIN, Navarre). This framework will offer the candidate a multidisciplinary environment, both academic and industrial, with the possibility of making short stays in other laboratories of the network and actively participating in the meetings and activities planned during the three year PhD thesis, including science divulgation in collaboration with ECOCENE (Pau), the partner of the project in charge of communication and public engagement aspects of TRIPyr.

Application

Motivated students have the opportunity to join the research group "Metallic Systems Applied in Catalysis" (SYMAC) at the Laboratory of Fundamental and Applied Heterochemistry (LHFA), Joint Research Unit of the CNRS and the University Toulouse 3 - Paul Sabatier.

This doctoral program is aimed at highly qualified students with an enthusiastic interest in the design and development of sustainable processes, including fundamental studies and going as far as applications. Students must have solid knowledge in organic and inorganic chemistry, with a knowledge of spectroscopic techniques; acquaintance of materials chemistry will be appreciated.

Requests must include a cover letter, a detailed Curriculum Vitae and the contact of at least one contact person.

Contacts : Prof. Montserrat Gómez (gomez@chimie.ups-tlse.fr) and Dr. Daniel Pla (pla@lhfa.fr)

References

[1] a) I. Favier, D. Pla, M. Gómez, *Chem. Rev.* **2020**, *120*, 1146; b) T. Dang-Bao, D. Pla, I. Favier, M. Gómez, *Catalysts* **2017**, *7*, 207.

[2] T. A. G. Duarte, I. Favier, C. Pradel, L. M. D. R. S. Martins, A. P. Carvalho, D. Pla, M. Gómez, *ChemCatChem*, doi: 10.1002/cctc.201902305.

[3] A. Reina, I. Favier, C. Pradel, M. Gómez, *Adv. Synth. Catal.* **2018**, *360*, 3544.

[4] a) T. Dang-Bao, C. Pradel, I. Favier, M. Gómez, *ACS Appl. Nano Mater.* **2019**, *2*, 1033; b) T. Dang-Bao, C. Pradel, I. Favier, M. Gómez, *Adv. Synth. Catal.* **2017**, *359*, 2832.