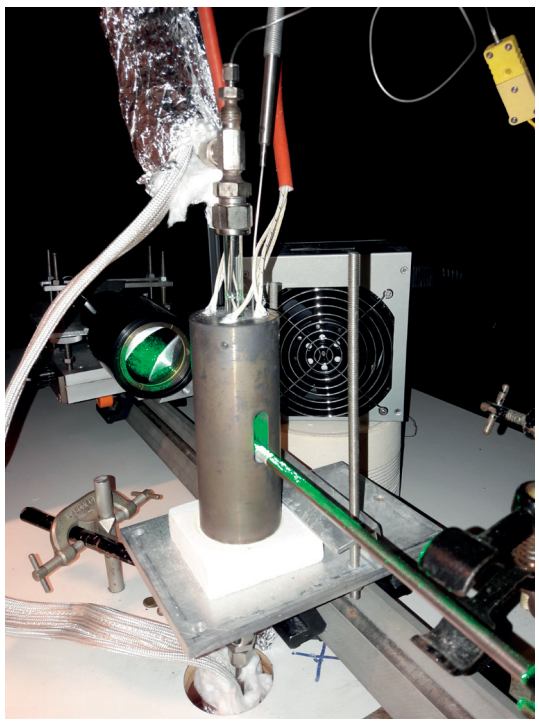
Research team under Prof. Eric GAIGNEAUX Institute of Condensed Matter and Nanosciences – Molecular Chemistry, Materials and Catalysis

Specialized in heterogeneous catalysis, the research team of Prof. E. Gaigneaux of the Bioengineering Faculty is part of a group of 26 collaborators including two professors, five post-doctoral fellows and seven doctoral fellows. Its aim is to make catalytic processes more effective and less energy demanding.

Internationally recognized (quadrennial symposium on the preparation of heterogeneous catalysts, the Operando Spectroscopy group, World Congress on Oxidation Catalysis, International Congress on Environmental Catalysis and guest professor at the EPN in Quito, Ecuador), Prof. E. Gaigneaux has developed comprehensive expertise in the field of heterogeneous catalysts, i.e. solids that accelerate chemical reactions without being consumed and thus that can be reused several times. This expertise is based on four lines of laboratory studies: the preparation of heterogeneous catalysts, their physico-chemical characterization, measuring their performance in liquid or gaseous reactions and post-catalysis characterization to probe and improve the life cycle and the possibility of reusing the catalysts. In addition, the laboratory of Prof. E. Gaigneaux is one of the few ones in the world to combine characterization and performance measurement in *in situ* and *operando* modes to improve the understanding of the process at work.



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Close-view of the operando reactor allowing Raman and UV-Vis spectroscopies of a catalyst at work (here in the methanol-to-dimethylether reaction)

Historically focused on petrochemical reactions (oxidation of hydrocarbons), the research of Prof. E. Gaigneaux expanded 10 years ago to include bio-sourced chemistry. In this context, he is working, for example, on the production of acrylates using acid catalysts via the dehydration of fermentation-derived lactates (in partnership with a lactic acid producer) and on the conversion of biomethanol into dimethyl ether, a clean bio-based fuel that could in time replace diesel. The team of Prof. E. Gaigneaux is also involved in fine chemistry, which means intensifying processes of the pharmaceutical industry by providing it with solid heterogeneous catalysts capable of ensuring continuous operation of reactors (and not intermittent as is often the case today). Finally, the team of Prof. E. Gaigneaux is working on air depollution (development of catalysts to destroy indoor air pollutants and to depollute industrial gas waste – with more than 15 years of experience working on volatile organic compounds and chlorinated aromatics). They are also working on water depollution (removal of dyes by combining plasma and heterogeneous catalysis, in collaboration with the University of Yaounde in Cameroon).

Prof. E. Gaigneaux has formed several partnerships with manufacturers as part of projects funded by the Walloon Region. His fundings have enabled the transformation of plant oils to industrial-grade bio-lubricants (in partnership with an oleochemical company) and the formulation of a new catalyst to produce oxygenated water and to develop air-depolluting catalytic coatings (in partnership with a glass company) The capacity of the laboratory to produce catalysts at a small pilot scale enables preindustrial trials. Manufacturers can also benefit from services to regenerate spent catalysts and physico-chemical characterization, standard (*ex situ*) or *in situ* and *operando* (see above).

On the strength of its expertise, the team of Prof. E. Gaigneaux contributes to overcoming the challenge of intensifying chemical processes (smaller reactors and more local production that is limited to requirements, FEDER project "Flow-4Reactor"). Prof. E. Gaigneaux shares a mutual interest in the transition from the petrochemical era to that of bio-sourced chemistry (see above) with his former doctoral fellow and now colleague, Prof. D. Debecker, who is working mainly on the promotion of CO_2 through its conversion into useful molecules (methane, methanol, formate, etc.), and on enzymatic catalysis. As a final string to his bow, Prof. E. Gaigneaux is doing research on more ecological production of ammonia. Actually, hydrogenation of nitrogen represents 50% of the energy consumption of the chemical sector and 3% of overall global consumption. In addition to its extensive industrial use, ammonia could be an alternative solution for energy storage. Manufacturers who are interested and the European Commission, get in touch!

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