RESEARCH AREAS / THEMES

The research works of the CATEN team focus on the upgrading of fossil and renewable resources via catalytic routes by converting them into alternative ultraclean fuels and platform molecules with high added value (wax, olefins, methanethiol, amines...).

Our team is the leader in France in the field of syngas utilization (mixture of hydrogen and carbon monoxide produced from biomass, natural gas, coal and organic waste). The originality of our work is based on a scientific approach combining development of new catalytic materials and new reactors, understanding the mechanism of catalytic reactions as well as development and coupling of reactor operating modes.

Another area of our team’s research is catalyst development for hydrotreating of oil cuts and their evaluation under realistic conditions: mixed trimetallic Ni(Co) MoW or double-promoted CoNiMo catalysts for hydrodesulfurization, efficient and long life catalysts for oxydesulfurization of real fuels and heavy cuts. The treatment of marine fuel oil is also an emerging area of research in our team, stimulated by the development of environmental standards in SECA areas. We are also the only french laboratory working on optimization of direct synthesis of methylmercaptan from H₂/CO/H₂S and CO₂/H₂/H₂S, this research being supported by the ARKEMA Group (LRG).

Our team is also developing shaping of new catalytic materials which are very reactive and with functional properties as well as the intensification of reactors (from microreactors to fluidized bed). We also have expertise in the control of the material behavior (attrition) and characterization of physical, rheological, structural and textural properties of solids.

FOREWORD OF TEAM LEADER

The research work of our team addresses implementation of new catalysts and catalytic sustainable processes to meet the societal challenges: “Clean, Safe and Efficient Energy” and “Sustainable Chemistry and Associated Processes”. The synergy between fundamental and applied research is the primary goal of our team. The specificity of our approach is to cover the entire technological chain of processing and synthesis of clean fuels and platform-molecules for modern chemical industry.

Heterogeneous catalysis

FOREWORD OF TEAM LEADER

Andrei KHODAKOV

FOREWORD OF TEAM LEADER

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KEY FIGURES

8 researchers and teaching staff
20 publications per year
38 invited lectures in 2013-2016
Participation in European contracts (Eurobioref, Interreg)
4 ANR projects (including 3 coordinated by our team), ADEME GAYA project, CEFIPRA projects
Industrial collaborations : TOTAL, ARKEMA, IFPEN, SOLVAY, ENGIE, SEGULA
International collaborations : China, India (LIA), Brazil, Russia, Tunisia, Lebanon.

A. Khodakov, M. Virginie, C1 Chemistry, Fischer-Tropsch, reforming, amination, photocatalysis
N. Fatah, Engineering technologies/Powder processes
The team benefits from the new Catalysis Pilote Hall, a high-tech platform of 400 m², dedicated to fossil and renewable resources in the field of energy and synthesis of molecules (methylmercaptan, amines). The Catalysis Pilot Hall is a unique platform of catalytic reactors in the academic community in France which allows to accelerate the development of catalytic technologies at the University level, and their transfer to industrial exploitation. The Hall pilot reactors operate under the conditions close to the industrial reactors (high pressure, high temperature, toxic gases) in a secure environment. In addition, 4 reactors are also available at Centrale Lille including a SSITKA setup and a photocatalytic reactor. The reactors are batch, fixed bed or slurry.

We have also two platforms:
- Powder Processing and Technology (http://www.ppts.fr/)
- Analysis of fuels and waxes (including determination of total sulfur by XRF and gas chromatography detectors specific to sulfur and nitrogen).

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**Equipment**

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**Equipment**

**Flagship Projects**

Implementation of new strategies to control the selectivity of catalytic reactions by containment phenomena

The nanoreactors represent a new generation of heterogeneous catalysts with excellent catalytic stability due to their specific structure, which consists of a nucleus, usually the active phase, surrounded by a porous shell.

Our results show that encapsulation of metal nanoparticles in porous spheres of silica increases the activity and stability of Fischer-Tropsch catalysts. The nanoreactors can also control the selectivity of the reaction.

Development of sulfided catalysts based on molybdenum and tungsten for desulfurization of heavy cuts: control of the formation of mixed Ni(Co)MoWS active phase by using heteropolyanionic precursors.

Mixed Mo - W heteropolyacides were used as precursor of active phase of hydrotreating catalysts. These compounds allowed the formation at the nanoscale of mixed (Co)MoWS active phase, validated by X-ray absorption and HAADF. This mixed phase led to an improvement of hydrogenating properties of the catalysts, beneficial for hydprocessing of heavy oil cuts.

Design, hydrodynamic study and numerical modelling from the microreactors to fluidized beds.

Optimization and intensification of the new microreactors and fluidized beds offer benefits such as thermal stability (security controlled), miniaturization of reactors (minimum size and weight) and better control of the catalytic reaction (thermal runaway, catalyst deactivation). The results show good control of hydrodynamics by diagnostocs and pressure frequency analysis, as well as identification of fluidization regimes (bubbling, bubbling-swabbing, swab-turbulent and turbulent). The digital modelling (Euler-Euler - StarCCM+) allows better extrapolation of the microreactors at the industrial scale.

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