| DEPARTMENT
CATALYTIC PROCESS ENGINEERING
LGPC - UMR 5285, CNRS – CPE LYON

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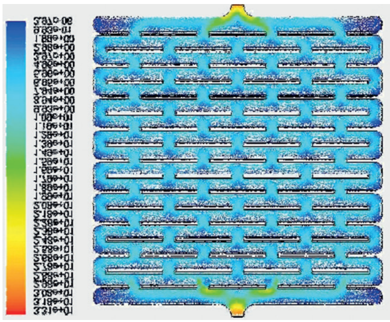
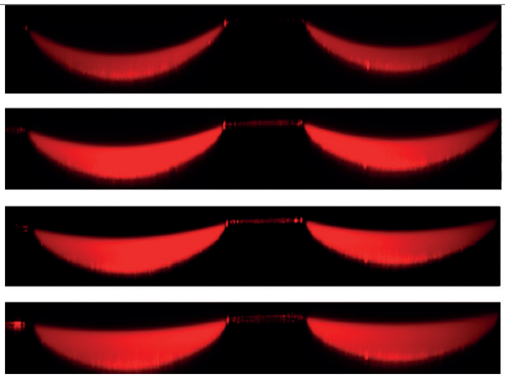
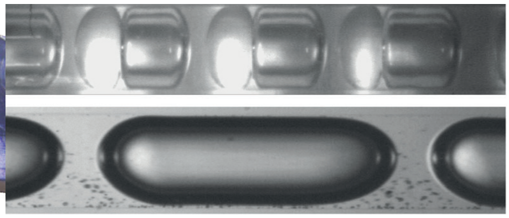






Catalysis is a key for designing integrated, selective, safe, clean, and intensified processes. However, the catalytic material, the reaction pathway, the necessity for new raw materials, and the environmental constraints induce specific design problems. The aim of the Team is to provide solutions to these issues, from catalyst to reactor design.

TOPICS

Energy – Hydrogen storage – Refinery of oil - Use and transformation of bioresources – Fine chemicals – Pharmaceuticals – Waste water treatments – Small-scale & distributed production – Methodology for process intensification.

KINETIC OF CATALYTIC REACTIONS

Efficient reactor design requires accurate rate expressions and parameters. They are obtained using suitable reactors where hydrodynamics, mass and heat transfer processes, electric potential, photon transfer, catalyst ageing, etc. are carefully controlled.

Research challenges include:
- Multi-component kinetics
- Deactivation and kinetics modelling
- Mechanism elucidation.
- Design of reactors for data acquisition.
- Experimental design and parameter identification.
- Coupling of ab initio computation with experimental kinetics.

CATALYTIC REACTORS

Reaction kinetics being known, the efficient reactor design requires understanding, modelling and controlling numerous competing processes: surface or homogeneous reactions, heat and mass transfer, deactivation, hydrodynamics, etc.

Research challenges include:
- Advanced structured reactors (micro, foam)
- Coupled processes (adsorption/reaction)
- Pollution control (monolith, photocatalysis)
- Heat & mass transfer in structured reactors
- Photon transfer in photoreactors.
- Unsteady-state (reverse flow, deactivation)
- New technologies: foam, microwaves...
- Micro-fluidics for catalytic reactions.
- Reactor modelling and simulation.

CATALYST DESIGN

When the catalytic phase is available, remain to be selected the appropriate carrier and shape of the catalyst, and the conditions suitable for the reaction.

Research challenges include:
- New catalysts shapes (grid, fabrics, monolith, foams, micro-structures,...).
- Impregnation of new carriers (metal, UV-transparent supports).
- Carriers for homogeneous catalytic complexes (fine chemicals).
- Extrapolation of catalyst preparation.

| Figures

Centre: CFD computation of the gas velocity map in the structured plate showing the flat velocity profile obtained. Stainless steel plates machined from CFD studies. Application: hydrogen storage.

Right top: Effect of liquid flow rate on the liquid profile in 600x300 µm channels of a Micro Falling Film Reactor (Fluorescence Confocal Microscopy).

Right bottom: High speed camera visualisation of gas-liquid-liquid and gas-liquid segmented (Taylor) flow in micro-channels.

| EQUIPMENT

› Three-phase batch reactors and fixed-bed reactors

› Robinson-Mahoney (basket) type reactors

› Gas-solid and Gas-liquid-solid foam reactor

› Microreactors, including silicon chip reactors

› Photoreactors with different UV sources and sizes

› Analysis : gas, liquid and ionic chromatography, porosimeter, BET, GC/MS, zetasizer, rheoviscosimeter...

› Workstations, on-line data acquisition

| EXPERTISES

› Catalytic reactors

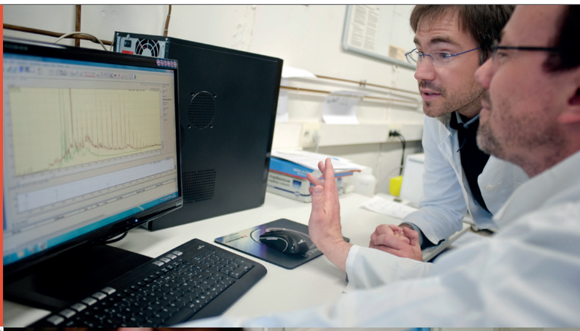
› Catalysis (heterogeneous, homogeneous)

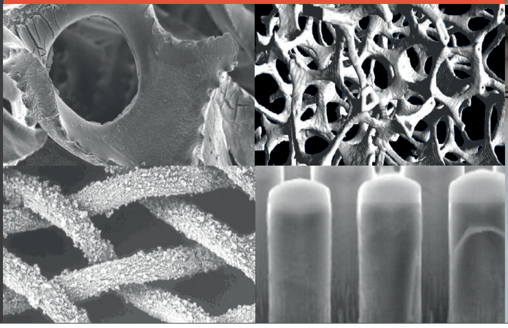
› Meso- and micro-structured reactors

› Kinetic modeling

› Chemical reactor engineering

› Reactor modelling and simulation





COLLABORATION

The LGPC was born in 1994 from joint research teams between chemical companies Elf, Rhône-Poulenc, IFP and the French National Centre for Scientific Research (CNRS).

Today, the team continues this historical and strong partnership with many chemical companies (IFPen, Rhodia, Arkema, Total, Renault, etc.) as well as with academic teams (IRCELyon, LRGP Nancy, LGC Toulouse, C2P2 Lyon, ICM Orsay-Paris, Chemical Engineering TU/e, IMM Mainz, Åbo Akademi, ...).

KEYWORDS

Structured catalytic reactors – microfluidic - micro-reactors - photocatalytic reactors - kinetic modelling - water treatment - hydrogen storage - silicone chemistry - hydrogenation - catalyst regeneration - catalytic cracking - VOC abatement - hydrotreatment - reverse flow reactor.

STAFF

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3-6 Post-Docs
6-9 PhD Students
4-6 Graduate Students

| Figures

Left: Selected examples of structured microreactors and foams with catalytic layers.

PUBLICATIONS

Catalysis Today 147 2009 S305.
Chemistry European Journal 15 2009 6267.
Chemical Engineering Journal 165 2010 290.
Industrial Engineering Chemistry Research 49 2010 817.
Chemical Engineering Science 66 2011 6358.
Journal of Catalysis 278 2011 153.
Applied Catalysis A-General 427 2012 66.
Catalysis Science & Technology 2 2012 359.
Chemical Engineering Journal 227 2013 174.
Applied Catalysis A-General 453 2013 28.
Chemical Engineering Journal 227 2013 182.

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