Inorganic solid chemistry & heterogeneous catalysis

→ versatile expertise offer for NMBP- 24-2018 (transformation of hydrocarbons)

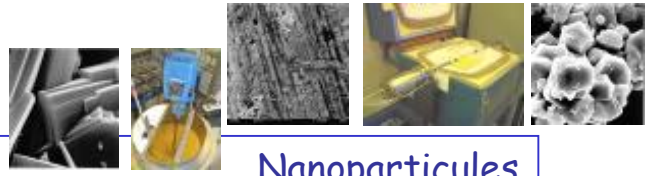
Université catholique de Louvain
Institute of Condensed Matter and Nanosciences
(about 30 profs + 150 researchers + 40 staffs)

Prof. E.M. Gaigneaux

UCL- IMCN, Place Pasteur L4.01.09, Louvain-la-Neuve (Belgium)

eric.gaigneaux@uclouvain.be (+3210473665) Oct, 2017

Overall expertise in hetero catalysis



Nanoparticules
Mixed oxides & Noble metals
Structuration : monoliths
Scaling-up & Shaping

Surface
XPS
Bulk
DRX
IR, Raman
XRF, ICP
Textural
Porosimetry
Chemical
Chemisorption

Preparation of divided inorganic solids

Measurements of catalytic reactivity

Physicochemical characterization

Acido-basic
Redox

Fine Chem (in liquid)
Petrochemistry (in gas)
Valorization of biomass
Air and water depollution
Valorization of CO_2
Production of NH_3

Pointing the parameters & understanding the mechanisms dictating the performances → Iterative improvement of the systems

Preparation of heterogeneous catalysts

Scaling-up (up to kg scale) and Shaping

Extrusion

Pelletization

Preparation of divided inorganic solids

Aerosol

Plasma synthesis

(Co-)precipitation

Complexation

Sol-gel

Micro-emulsion

Impregnation

Grafting

Deposition-precipitation

Ion-exchange

Hybridization

Bulk and supported oxides

Polyoxometalates

Spinels

Perovskites

Hexaaluminates

Phosphates

Oxynitrides

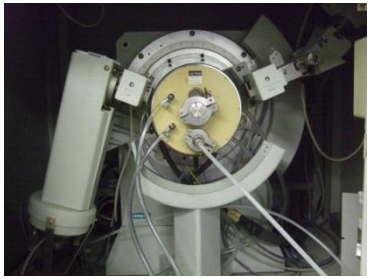
Nitrides, Carbides, Sulfides, etc.

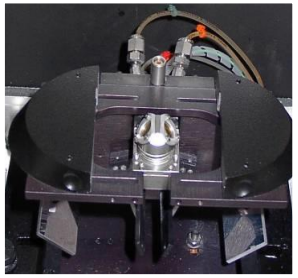
Supported or encapsulated (noble) metals

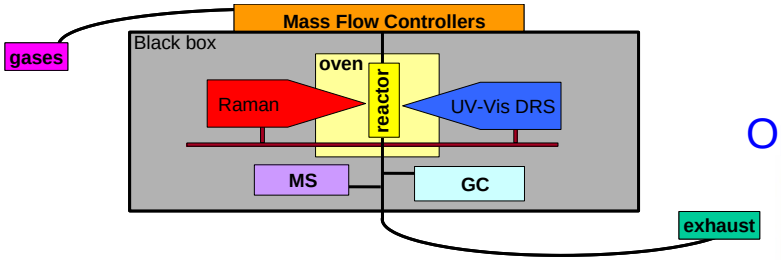
Characterizing heterogeneous catalysts

Texture (specific surface, porosity) : N_2 & Kr physisorption
Composition : XRF ICP-AES
Surface : TOF-SIMS XPS including pseudo in situ
Structure : XRD IR Raman UV-Vis
all including in situ at high T + operando
Chimisorption : acidobasicity (CO_2 or NH_3)
dispersion (CO or H_2)
oxygen exchange ability (TPR/TPO/etc)

Operando XRD & In situ DRIFT







Operando Raman and UV-Vis

Operando =
Ability to characterize the catalysts at work, under flowing gas and at reaction temperature
+ measuring the products (by MS and GC)

Catalytic systems : 4 selected cases

Dehydration of methanol (+ other alcohols) to DME on Keggin *polyoxometalates*

→ How to support them correctly to maintain intact superacidity and high performance

Oxidative dehydrogenation of propane on *mesoporous* Ni molybdates and ammoxidation on mixed V-Al *oxynitrides*

→ Double Mars-van Krevelen

Total oxidation of VOCs on supported V_2O_5, Ag, Au, and bulk MnO_2 catalysts

→ (Cl-)benzene, styrene, (methyl-)furane, methane, hexane, amines, thiols

Hydrogenation of N_2 to NH_3 on Ru catalysts

→ Best performance (200°C / 5 bars) when polydispersed size of Ru nanoparticules are used