

Written on 02 July 2021 15 minutes of reading

News

Training and Careers

Chemical sciences | Catalysis and reaction kinetics | Analysis and characterization | Structural analysis and Imaging | Physical chemistry | Surface, interface and materials science

In “C’est pas Soufré” (Sulfur power), Ted and Denis explain the hydrotreatment process used in refineries to reduce fuel-related pollution, along with one of the research strategies developed at IFPEN to improve the catalyst used via the presentation of recent results on the modification of the ?-Al_2O_3 support surface chemistry by phosphorous [1].

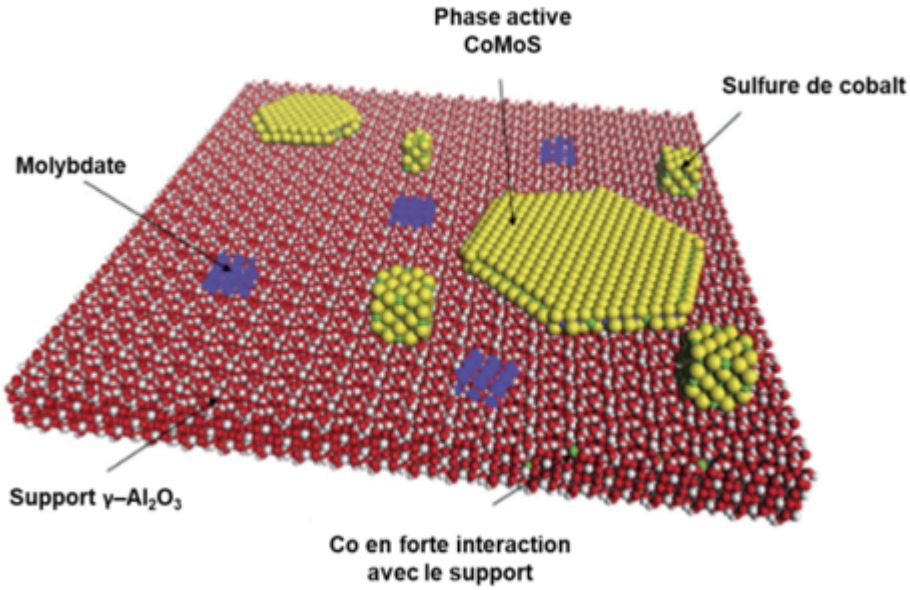
Catalyst preparation improvement central to the thesis’ research work

The research conducted by Teddy Roy, a PhD student at IFPEN from September 2018 to September 2021, falls within the framework of one of the research priorities of the “Sulfide Catalysis” department in IFPEN’s “Catalysis, Biocatalysis and Separation” division, aimed at gaining a better understanding of the sulfided supported catalyst and enhancing its synthesis. The **objective** of the « **Role of the support in the physico-chemical processes of impregnation of additive-impregnated hydrotreating catalysts** » thesis is **to provide new rational guides to improve the preparation of catalysts by impregnation of a solution of metal precursors**, one of the central focuses of the “Catalysis, Biocatalysis and Separation” division. Teaming up with Grégory Lefèvre (Thesis Director - ChimieParis Tech) is key to gaining a better understanding of the solid/liquid interface properties. The first half of this thesis was actually conducted at the ChimieParis Research Institute (IRCP) in the

Materials, Interfaces and Soft Matter (MIM2) team. At IFPEN, the thesis, sponsored by Thibaut Corre (Sulfide Catalysis), Olivier Delpoux (formely Materials Characterization and now Finely Divided Materials Engineering) and Gerhard Pirngruber (Finely Divided Materials Engineering), promotes exchange between departments and draws on their respective expertise.

The significance of hydrotreatment processes

Hydrotreatment processes - and particularly the hydrodesulfurization process - are **important processes present at various levels in refineries**. Operating under high hydrogen pressure, their principal aim is to remove impurities (heteroatoms, metals) from oil cuts. They are catalytic processes that generally use catalysts made up of transition metal sulfides (for example CoMo or NiMo) deposited on an oxide (?-Al_2O_3).



Représentation schématique d'un catalyseur CoMoS supporté sur ?-Al2O3

The design of more active hydrotreatment catalysts remains a major challenge for research and industry. Improving catalytic processes is necessary in order to meet strict regulations governing heteroelement contents in fuels (10 ppm of S) and protect the environment, as well as for economic reasons. However, **the design of more efficient catalysts goes hand in hand with an understanding of the physicochemical processes developed during their preparation**.

Understanding physicochemical processes to improve efficiency

During impregnation, the first step in the preparation of a catalyst, several parameters must be taken into account to rationalize the physicochemical processes developed. Among these parameters, the surface chemistry of the support and, more precisely, the density and nature of the surface hydroxyl groups are critical since they determine the interaction between the metal precursors of the active phase and the support. It has always been suspected that the alumina surface chemistry influences

metal impregnation (and consequently catalytic activity) but there has never been any real scientific proof. **This thesis will provide an understanding of the role of the support's surface chemistry during impregnation of additive-containing solutions, as well as better prediction of catalytic performance as a function of the nature of the solution and the support**.

To achieve these goals, the research strategy involves a first step whereby the surface chemistry of the support is modified using modifying agents (phosphorous, malonic acid, TEG). It also hinges around the characterization of the modified support, along with the study of the impact of the modified surface chemistry on the adsorption of active phase precursors, on the formation of the latter and on catalyst performance.

[1] *Ref : T. Roy ; D. Wisser ; M. Rivallan ; M. C. Valero ; T.Corre ; O. Delpoux ; G. D. Pirngruber ; G. Lefèvre, G. - Phosphate Adsorption on ?-Alumina: A Surface Complex Model Based on Surface Characterization and Zeta Potential Measurements. - J. Phys. Chem. C. 2021. https://pubs.acs.org/doi/10.1021/acs.jpcc.0c11553*

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Sulfur power! Watch the video on the thesis by Teddy Roy, PhD researcher at IFPEN
02 July 2021

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