



Foreword/Avant-propos

## Catalysis: From academic research to industrial applications



## Foreword

This thematic issue entitled *Catalysis: From academic research to industrial applications* is a tribute to Edmond Payen, Emeritus Professor at the National Graduate School of Engineering Chemistry of Lille, founder and Director of the Catalysis and Solid State Chemistry Laboratory of Lille (UCCS) from 2006 to 2009.

As a matter of fact, this tribute includes two events. The first one took place on 22 May 2015, with a special scientific day gathering renowned researchers – Prof. Israel Wachs, from Lehigh University (USA), Prof. Krijn de Jong, Utrecht University (The Netherlands), and Dr. Valérie Briois, SOLEIL Synchrotron, Saclay (France) –, and outstanding people coming from industry in close connection with academia – Dr. Jean-Luc Dubois, Scientific Director Arkéma, Paris (France), Dr. Jean-Pierre Dath (Raffinage-Chimie, “Direction stratégie, développement recherche Total Feluy” (Belgium), and Dr. Antoine Daudin, “IFP Énergies nouvelles” (France). The scientific content of that day tackled important academic and practical issues reflecting the main concerns that governed the scientific career of Edmond and are still a matter of interest today, considering the gap between academia and industry. In other words, this could be summarized through a key question: how is it possible to implement fundamental research methodologies in order to properly answer industrial practical issues?

Since the construction of the first industrial plant for ammonia synthesis over iron-based catalysts at the beginning of the 20th century, catalysis, and more particularly heterogeneous catalysis (but not only), has largely contributed to the development of chemical processes, becoming more efficient for the transformation of natural resources and especially fossils for the production of fuels and chemical intermediates.

Successful achievements were obtained through the introduction of solid catalysts inside reactors capable of working under severe operating conditions, sometimes at very high pressure. Unfortunately, these successes remained “enigmatic” for a long time, the catalytic

reactor being usually considered as a black box, but fortunately efficient. The understanding of the catalyst's behaviour changed deeply with the emergence of new theories and the development of new spectroscopic and microscopic tools. At the end of the 1980s, the concerns of academia and industry converged with the expectation that a better description of catalysts and chemical processes taking place at their surface could potentially help in their optimization. Suddenly, industry was ready to understand how a catalyst can run at nanoscales if potential gain in activity, selectivity, and durability could be envisioned.

It is clear that the introduction of novel characterization techniques capable of probing the surface of catalysts at different scales under working conditions, sometimes mimicking those encountered in industrial catalytic processes, largely contributes to get a deeper insight into the nature of active sites at the surface, the nature of intermediates and elementary steps involved at the surface of a solid catalyst. Nowadays, microscopic and spectroscopic techniques allow a better description. However, a good interpretation provided by the response given by these techniques needs virtuosity sometimes, and one has to say that in spite of the huge number of technological advances, numerous challenges remain.

Today, we have to face the energy transition with the use of carbon renewable sources: how to replace fossil resources with more friendly ones to improve air quality, especially by lowering the emission of greenhouse gases, and to ameliorate the yields, thus minimizing the production of wastes? New perspectives arise with the emergence of biomass, but they imply smart catalytic formulations more complex in their optimization.

It is clear that the UCCS deeply appreciated the dedicated efforts of Edmond Payen to facilitate their entry into this new era, anticipating and stimulating the development of new methodologies to investigate the catalysts under running conditions thanks to the utilization of spectroscopic tools of high technicality and convincing industry that this can produce added values if they are enough patient.

The second step of our tribute represents in fact a continuation of the first one, but with the aim of offering Edmond Payen a kind of a gift, and we would like to warmly thank the Editorial Committee of the journal *Comptes rendus Chimie*, who supported our project with this thematic issue. The idea to make this a reality seemed obvious at the end of the successful scientific day that was held in Lille, gathering more than one hundred participants to this friendship event, most of them coming from diverse locations in France and having developed and maintained friendly and professional relationships with Edmond. Based on that, there was a growing expectation to invite Edmond's colleagues to contribute to this thematic issue, especially those from abroad, who could not participate in the scientific day. In the frame of these celebrations, we conserved the same title, *Catalysis: From academic research to industrial applications*.

Different topics have been selected (i) catalysis for energy, (ii) biomass conversion, (iii) environmental catalysis, (iv) catalyst preparation and related characterization, and (v) development of spectroscopic tools for in situ or *operando* investigations of catalytic reactions. Twenty papers will have been published in this issue, coming from Romania, Japan, Argentina, Brazil, Greece, India, Russia, and of course France, dealing with the conversion of biomass for the production of chemicals and biofuels, the synthesis of catalysts for oxidative and hydrotreating reactions including the use of heteropolyanions, environmental catalysis with NO<sub>x</sub> removal and production of more friendly

sulphur-free fossil fuels, as well as ex situ or in situ characterization through resonance Raman spectroscopy, near-ambient pressure XPS, and a quick EXAFS experiment. Finally, an article dedicated to theoretical calculation completes this series, covering an important topic earlier developed at UCCS by Edmond Payen.

We would like to warmly thank all the contributors who participated in the scientific day, and more specifically in this special issue, through writing something for Edmond.

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