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Abstract:

Structured catalytic systems play a key role in many commercial applications for energy conversion, emissions control, and chemical synthesis. During the last years our group has been focused on structured catalysts for energetic applications using monoliths and m-reactors (**Fig.1**). Reactions relevant for hydrocarbons reforming reactions and H_2 clean-up. These activities have recently derived in the study of production of fuels keeping in mind the EU Renewable Energy Directive that aims to integrate renewable energy in the transport sector using Renewable Fuels of Non-Biological Origin and the Carbon Capture & Utilisation (CCU) concept for dealing with the reduction of CO_2 emissions transforming it into synthetic fuels. The Power-to-X concept allows to provide the intensive energy required to these transformations.

One of the most relevant aspects in these technologies is the critical role of water in the reaction mechanisms. In this talk we will discuss the methods that we have developed for *in-situ* and *operando* characterization of working catalysts at industrially relevant operating conditions to understand the role of water in several catalytic processes. Water diffusion of the support surface through the Grotthuss' mechanism, the role of water in the chain growth mechanism of the Fischer-Tropsch (FT) synthesis or the role of surface hydroxyls in the selectivity of the methanation reaction will be considered. These fundamental insights on the surface reaction chemistry have been instrumental in the development of improved catalysts and processes for energy conversion and fuels production. As an example, the Water-Gas-Shift (WGS) reaction described by Lavoisier as earlier as in the 18^{th} century plays a key role in H_2 production as well as in adjusting CO and H_2 ratios in synthetic fuel synthesis. In fuel processors it is critical to reduce the reactor volume, for this reason it is necessary to increase the specific reaction rate of the catalyst. By designing Pt catalysts supported on proton conductors we have been able to demonstrate the role of adsorbed molecular water on the catalytic activity. This critical data obtained from IR *operando* spectroscopy of the catalyst in a 10%H_2O/Ar atmosphere have shown the presence of molecular water at temperatures as high as 350ºC as determined by the presence of the δ(HOH)+ν(OH) combination band at 5138 cm^{-1}. Furthermore, *operando* studies in the presence of water have clearly shown at 5 bar that in the presence of water the intensity ratio of the stretching frequencies corresponding to CH_2 and CH are strongly modified pointing to the role of water in the reaction mechanism of the FT reaction.

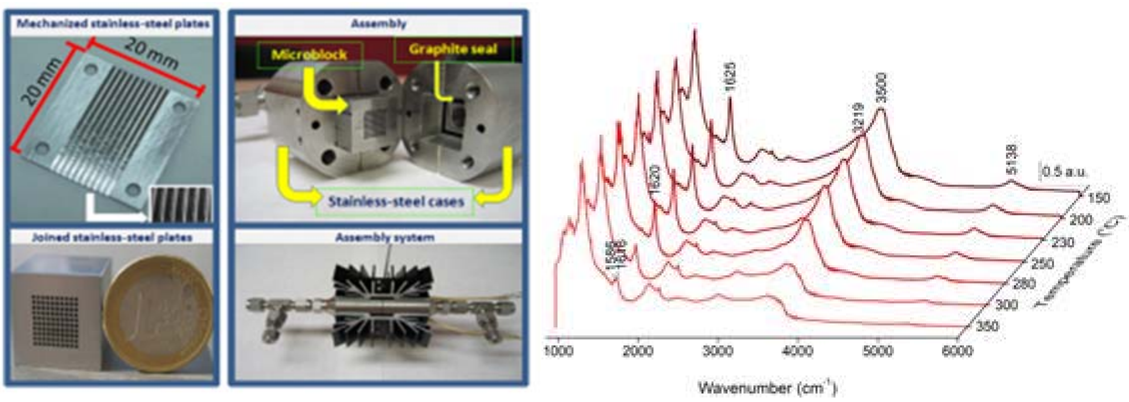

Figure 1: Microreactors systems (left) and operando IR spectroscopy of catalysts at high-pressure and high-temperature (right).

Biography:

Dr. J. A. Odriozola (1955) graduated from the Chemistry Faculty of the University of Seville in Spain in 1976 and in 1981 he obtained his PhD from the same university working on catalysis. After his PhD he did postdoctoral studies at Lawrence Berkeley Laboratory under Gabor Somorjai's supervision. Since then, he has been visiting or Invited Professor at Lawrence Berkeley Laboratory, University of Rennes, Universidad Nacional Autónoma of Mexico and University of Strasbourg. He is currently the Chair of Inorganic Chemistry Department of the University of Seville and Research Professor of the Materials Science Institute of Seville, Spain. He is a fellow of the Spanish Society of Catalysis and the American Chemical Society and a founder partner of CO2 Value Europe, which is a non-profit organization devoted to Carbon Capture & Utilization. He is the head of the Materials Science and Technology Panel of the Spanish National Agency for Evaluation and Prospective, and the Head of the doctoral School of the University of Sevilla and Extremadura on Science and Technology of Materials.

As the head of the Surface Science and Catalysis Laboratory since 1996, his group is focused on the surface chemistry of materials. Among these studies, catalyst synthesis and characterization of surface species under reaction conditions (operando spectroscopies) are especially noteworthy. Moreover, as a result of the strong cooperation with copper and steel mills of the region the group has acquired a reputed expertise on the surface characterization of steels and other metallic substrates. This expertise together with the background on catalysis has driven the group to develop a new research line focused on the manufacture and study of micro-monoliths and microchannel reactors for energetic and environmental catalytic applications. He is a leading expert in the field of surface science with ~ 287 published research articles, 5804 citations in the past 5-years (h-index 41), 11 patent applications and 27 PhD thesis.