

Séminaire SOLEIL

## Following catalytic surfaces during reaction

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Invitée par Antonio TEJEDA

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Grand Amphi SOLEIL

Séminaires

Catalysts' surfaces have largely been studied with traditional surface science techniques down to the atomic level. Those techniques are typically used under vacuum conditions. However there is a difference of many orders of magnitude in pressure between those vacuum studies and the industrial conditions at which catalysts work. Even though the studies in vacuum can be very revealing [1], the "pressure gap" leads to dramatic differences between laboratory and industrial conditions. The reaction mechanisms and the changes on the catalyst surface during the reaction [2] can be intrinsically different under the fore mentioned pressures.

In our lab we study catalysts at the atomic scale making use of two innovative experimental techniques that approach the conditions at which catalytic reactions take place in industry in terms of pressure and temperature. Scanning tunneling microscopy (STM) [2,3] and surface X-ray diffraction (SXRD) [4] are used *in-situ* to follow catalytic surfaces at high pressures and elevated temperatures. The two techniques are complementary, i.e. real space versus reciprocal space. The STM gives information on local structures on the catalytic surface whereas SXRD detects the periodic structures that appear during the reaction. Both instruments contain a small gas flow reactor inserted in a UHV chamber where traditional surface science techniques are used to prepare and characterize the samples, before exposing them to reaction conditions.

I will show different examples of relevant reactions which have been studied with those systems. First the text-book-example of CO oxidation illustrates the strength of the two techniques, clarifying the mechanisms underlying this emblematic reaction. Second I will show our recent studies on NO reduction where arrays of steps develop spontaneously on the catalyst surface during the reaction.

Finally I will give some insight into the synthetic production of hydrocarbons from a mixture of CO and H<sub>2</sub>, Fischer-Tropsch synthesis (FTS), on a cobalt catalyst. This reaction is of extreme industrial relevance but the fundamental mechanisms are still not completely understood [5]. We have observed how the very active cobalt catalyst develops a polycrystalline layer on its surface during the reaction.

## References :

- 1- G. Ertl. *Angewandte Chemie International Edition*, **52**, 1, 52–60, (2013).
- Y.D.Yin, *et al.*, *Science*, **304**, 5671. 711 (2004). R. Schaub, *et al.*, *Phys. Rev. Let.* **87**, 26 (2001).
- 2- B.L.M. Hendriksen, *et al.*, *Topics in Catalysis*, **36**, 1–4 (2005).
- 3- C.T. Herbschleb. To be published.
- 4- R. van Rijn *et al.*, *Rev. Sci. Instr.* **81**, 014101 (2010).
- 5- J. Wilson *et al.*, *J. Phys. Chem.* **99**, 7860 (1995).



Ce séminaire sera suivi d'une pause-café



Formalités d'entrée : accès libre dans l'amphi du Pavillon d'Accueil. Si la manifestation a lieu dans le Grand Amphi SOLEIL du Bâtiment Central, merci de vous munir d'une pièce d'identité (à échanger à l'accueil contre un badge d'accès).

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