**ROCK quick-XAS beamline at SOLEIL: opportunities for unveiling fast chemical processes with surface sensitivity**

Anthony Beauvois

*Synchrotron SOLEIL, L’Orme des Merisiers, Route Départementale 128, 91190 Saint-Aubin. France*

ROCK (Rocking optics for Chemical Kinetics) is the quick X-ray Absorption Spectroscopy (quick-XAS) beamline at SOLEIL synchrotron, operating in the range between 4 and 40 keV with a sub-second and micrometer resolution1,2. The beamline was funded by the French National Research Agency (ANR) as part of the “Investissements d’Avenir” program to take part in the development of energy-related materials with enhanced efficiency. The ROCK beamline is thus dedicated to the study of fast chemical processes with main applications being the *in situ*/*operando* XAS characterization of catalysts and batteries in working conditions3. The ROCK beamline offers a large portfolio of setups available to the scientific community and has a sound background in using chemometrics (Multivariate Curve Resolution-Alternating Least Squares, MCR-ALS) for data analysis in various scientific fields4–6.

After a short introduction to X-ray absorption spectroscopy, the ROCK beamline capabilities and the large portfolio of environmental setups available will be presented and illustrated with 3 different cases. First, the investigation of the *in situ* formation of nanoparticles will be discussed to illustrate the power of MCR-ALS analysis for quantitatively analyzing large dataset (hundreds of spectra acquired during a time-resolved experiment)7. A second example, focusing on the use of layered double hydroxides (LDH)-based catalysis for the ethanol stream reforming reaction, will allow to present the importance of coupling other technics such as RAMAN spectroscopy with XAS4.

A final recent example in which the electro-activity of LDH was probed8 will allow to illustrate how is it possible to differentiate the active from the spectator species during a chemical process. Indeed, X-ray absorption spectroscopy is a bulk technique, which can make it difficult to differentiate the spectator species from the active species in chemical processes such as catalysis, where the active sites are more often surface sites and then represent only a fraction of the total material. To overcome this bottleneck, we used the so-called modulation-excitation X-ray absorption spectroscopy (MEXAS) with phase sensitive detection (PSD) methodology to highlight the contribution of active species during a chemical process9,10.

1 V. Briois, C. La Fontaine, S. Belin, L. Barthe, T. Moreno, V. Pinty, A. Carcy, R. Girardot and E. Fonda, *Journal of Physics: Conference Series*, 2016, **712**, 012149.

2 V. Briois, J. P. Itié, A. Polian, A. King, A. S. Traore, E. Marceau, O. Ersen, C. La Fontaine, L. Barthe, A. Beauvois, O. Roudenko and S. Belin, *J Synchrotron Rad*, DOI:10.1107/S1600577524006581.

3 C. La Fontaine, S. Belin, L. Barthe, O. Roudenko and V. Briois, *Synchrotron Radiation News*, 2020, **33**, 20–25.

4 A. R. Passos, C. La Fontaine, S. H. Pulcinelli, C. V. Santilli and V. Briois, *Phys. Chem. Chem. Phys.*, 2020, **22**, 18835–18848.

5 C. Lesage, E. Devers, C. Legens, G. Fernandes, O. Roudenko and V. Briois, *Catalysis Today*, 2019, **336**, 63–73.

6 F. Eveillard, C. Gervillié, C. Taviot-Guého, F. Leroux, K. Guérin, M. T. Sougrati, S. Belin and D. Delbègue, *New J. Chem.*, 2020, **44**, 10153–10164.

7 D. Vantelon, M. Davranche, R. Marsac, C. La Fontaine, H. Guénet, J. Jestin, G. Campaore, A. Beauvois and V. Briois, *Environ. Sci.: Nano*, 2019, **6**, 2641–2651.

8 H. Farhat, C. Mousty, V. Prevot, A. Beauvois, S. Belin, V. Briois and C. Forano, *J. Phys. Chem. C*, 2024, acs.jpcc.4c03883.

9 P. Müller and I. Hermans, *Ind. Eng. Chem. Res.*, 2017, **56**, 1123–1136.

10 A. Urakawa, D. Ferri and R. J. G. Nuguid, in *Springer Handbook of Advanced Catalyst Characterization*, eds. I. E. Wachs and M. A. Bañares, Springer International Publishing, Cham, 2023, pp. 967–977.