ESRF	**Experiment title:** Chemistry of indium oxide during CO2 hydrogenation to methanol	**Experiment number**: CH5114
Beamline: ID24	**Date of experiment**: from: 170628 to: 170704	**Date of report**: 180223
Shifts: 15	**Local contact(s)**: Debora Motta-Meira	*Received at ESRF:*

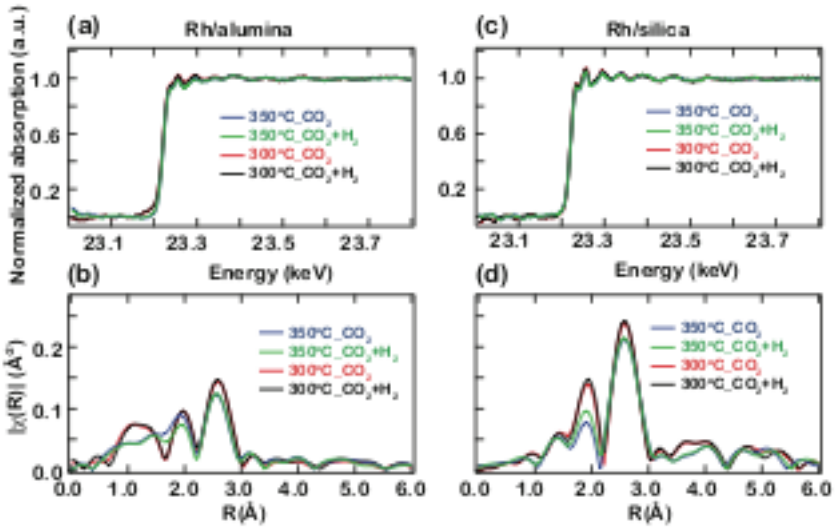
Names and affiliations of applicants (* indicates experimentalists):

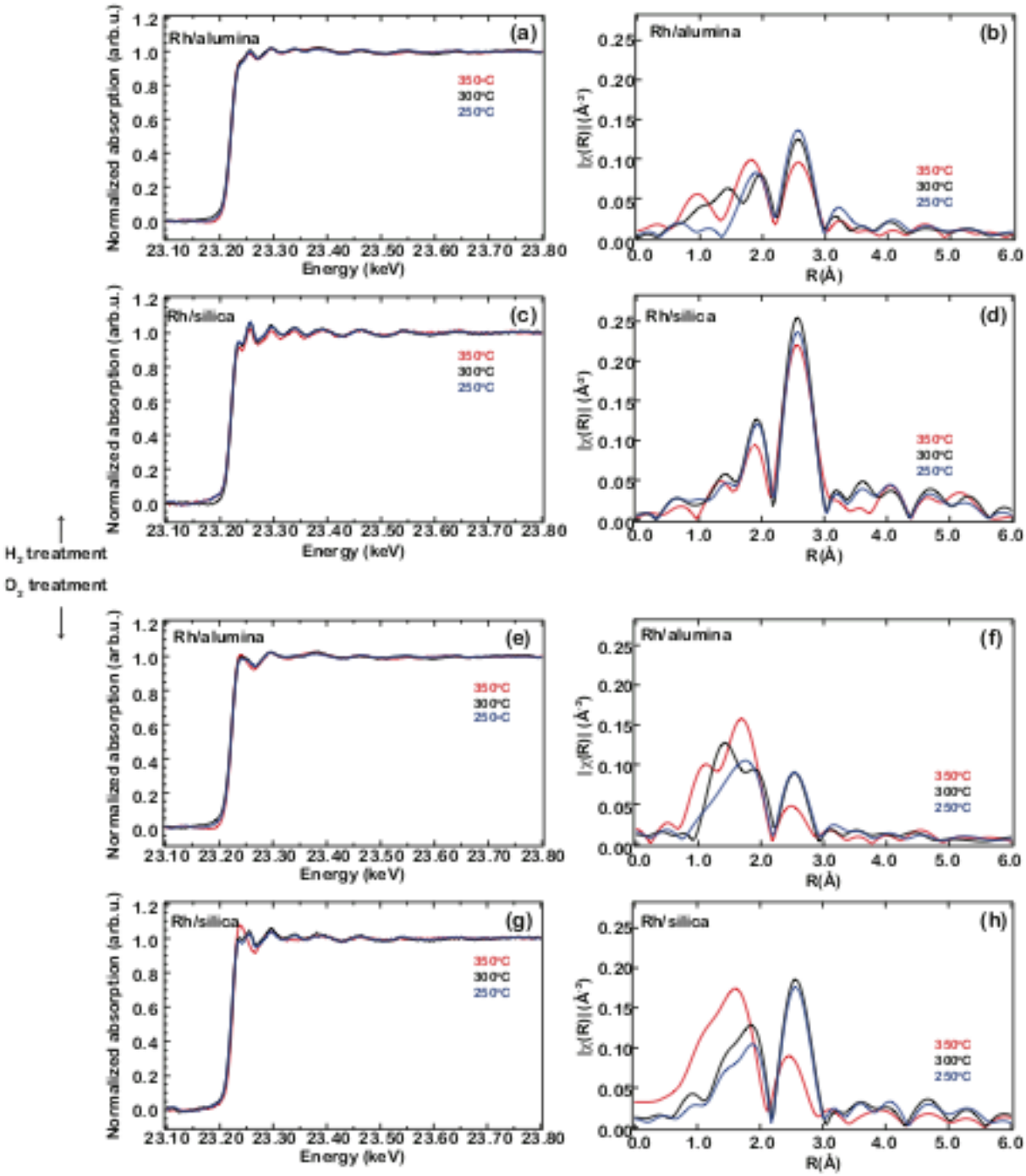
Per-Anders Carlsson*, Natlia M. Martin*, Johan Nilsson*, Felix Hemmingsson*, Lindsay R. Merte*, and Magnus Skoglundh*
Department of Chemistry and Chemical Engineering and Competence Centre for Catalysis, Chalmers University of Technology, 412 96 Gothenburg, Sweden

Report:

During the session we struggled to record indium absorption spectra for indium oxide catalysts but achieved no reliable spectral quality. To study indium at ID24 is challenging in the first place due to the high energy needed but test measurements on foils made by the beam line staff before the submission of the proposal showed that it should not be impossible. Due to this, however, we changed focus and studied instead rhodium-based supported catalysts. The support material was systematically varied between being silica, alumina and ceria. We stuck to the proposed reaction, *viz.*, CO2 hydrogenation. Several successful measurements were performed. The obtained XAS data has been analysed and combined with the corresponding data achieved by high-energy X-ray diffraction data at PETRA III during summer 2017. A first manuscript comparing Rh/silica and Rh/alumina is to be submitted in mid-march 2018 [1] and a second manuscript on Rh/ceria will be submitted in May 2018 [2].

The figure to the right shows results from transient CO2 hydrogenation. It shows the Rh K-edge *in situ* XANES (upper panels) and EXAFS (lower panels) for the Rh/alumina (left panels) and Rh/silica (right panels). The selected spectra are recorded after the samples have been exposed to pulses of either 0.8% H_2+0.2% CO2 or 0.2% CO2 for 10 min at different temperatures.





The figure above shows results from redox measurements. It shows the Rh K-edge *in situ* XANES and EXAFS for the reduced (a-d) and oxidised (e-h) Rh-based catalysts at 350 (red), 300 (black) and 250 °C (blue), respectively.

[1] Structure-function relationship during CO2 methanation over Rh-based catalysts at atmospheric pressure conditions,
N. M. Martin, F. Hemingsson, X. Wang, L. R. Merte, Utta Hejral, J. Gustafson, M. Skoglundh, M. Bauer, D. Motta-Meira, A.- C. Dippel, O. Gutowski and P.-A. Carlsson
To be submitted Phys. Chem. Chem. Phys.

[2] Catalyst structural dynamics during CO2 methanation over Rh/ceria at atmospheric pressure conditions,
N. M. Martin, F. Hemingsson, X. Wang, L. R. Merte, Utta Hejral, J. Gustafson, M. Skoglundh, M. Bauer, D. Motta-Meira, A.- C. Dippel, O. Gutowski and P.-A. Carlsson
To be submitted Catal. Sci. Technol.