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View Abstract

ABSTRACT SYMPOSIUM NAME: Bridging Surface Science to Catalysis

ABSTRACT SYMPOSIUM PROGRAM AREA NAME: CATL

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PRESENTATION TYPE: Oral Only : Do not consider for Sci-Mix

TITLE: Nanoscale redox dynamics during cyclic reduction and reoxidation of CeO_x/Cu(111) inverse model catalysts

AUTHORS (FIRST NAME, LAST NAME): Linus Pleines[1], Lars Buß[2], Tevfik O. Mentes[3], Francesca Genuzio[3], Andrea Locatelli[3], Jens Falta[1, 4], Jan Ingo Flege[2]

INSTITUTIONS (ALL): 1. Institute of Solid State Physics, Universitat Bremen Fachbereich 01 Physik Elektrotechnik, Bremen, Bremen, Germany.
2. Applied Physics and Semiconductor Spectroscopy, Brandenburgische Technische Universitat Cottbus-Senftenberg, Cottbus, Brandenburg, Germany.
3. Elettra Sincrotrone Trieste SCpA, Trieste, Friuli-Venezia Giulia, Italy.
4. MAPEX Center for Materials and Processes, University of Bremen, Bremen, Germany.

ABSTRACT BODY:

Abstract: Cerium oxide (CeO_x) on Cu(111) is an inverse model catalyst with a high demonstrated activity for methanol synthesis from H_2 and CO_2, making it an attractive component in applications supporting the transformation to a carbon-neutral sustainable energy system based on renewables. In a reducing H_2 environment, oxygen vacancies are formed, which then activate the CO_2. Here, we have studied the interaction of H_2 and CO_2 with (111) and (100) oriented CeO_x islands grown on the Cu(111) single crystal surface using intensity-voltage low-energy electron microscopy (I(V)-LEEM), micro-illumination low-energy electron diffraction (μLEED), and X-ray absorption spectroscopy combined with photoemission electron microscopy (XAS-PEEM). This unique combination of methods is shown to yield nanoscale structural and chemical information about both the islands' atomic structure and local chemistry during each redox half-cycle. At a substrate temperature of 550 °C, exposure to H_2 leads to partial reduction whereas exposure to CO_2 facilitates reoxidation. This general chemical behavior is observed for both CeO_x orientations, yet only for the (111) facet the changes in atomic structure are fully reversible. Moreover, for the (111) surface subsequent redox cycles require significantly lower doses of H_2 and CO_2, indicating a conditioning effect on the reactivity of the system. Furthermore, depending on the reactant dose the local structure and oxidation state of the CeO_x(111) islands are determined with pixel resolution (diameter ~15-20 nm) for the whole investigated area, providing novel insights into the nanoscale dynamics of the fully reversible redox process.

(No Image Selected)

Presentation Preference: I wish to participate in an in-person session in Indianapolis.