Contribution submission to the conference Berlin 2024

Oxide formation and oxide/metal interaction in CeO_x/Ni(111)

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Ni/ceria catalysts exhibit a high activity for methane to methanol conversion, making them very promising for applications within a sustainable economy. Possibly, their activity may be strongly enhanced due to the facile exchange between Ce^{4+} and Ce^{3+} states, with the latter likely responsible for activating O-H and C-H bonds. Here, we aim to unravel the complex metal-oxide interactions in the inverse CeO_x/Ni(111) system under oxidizing and reducing environments. Using low-energy electron diffraction (LEED) we find that the CeO_x(111) grown by reactive molecular beam epitaxy preferentially aligns with the main directions of the Ni(111) substrate or is azimuthally rotated by $\pm 10°$. By using X-ray photoelectron spectroscopy (XPS) and ultraviolet photoelectron spectroscopy (UPS), we find that less NiO is formed during deposition of CeO_x than when it is held without ceria at the same conditions (O_2 partial pressure and temperature). Finally, we observe a complex behavior of the cerium and nickel oxidation states when exposing the system to O_2 or H_2 atmospheres.

Part: O
Type: Poster
Topic: Heterogeneous catalysis
Keywords: Inverse model catalyst; Ceria; XPS; LEED
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