Deactivation of Au/CeO$_2$ catalysts in the CO oxidation reaction:
Influence of pretreatment and reaction conditions

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Abstract
The influence of the pretreatment procedure on the activity and deactivation behavior of a high
surface area 4.5 wt.% Au/CeO$_2$ catalyst in the low temperature CO oxidation reaction ($T_{\text{react}} = 80^\circ\text{C}$) was studied by kinetic and spectroscopy / microscopy measurements. Pretreatment
procedures included annealing at 400°C in oxidative, reductive or inert atmospheres. Furthermore, the influence of changing from a close-to-stoichiometric reaction gas mixture (1% CO, 1% O$_2$ rest N$_2$), to O$_2$-rich (1% CO, 5% O$_2$ rest N$_2$) and CO-rich (5% CO, 1% O$_2$ rest N$_2$) gas mixtures was investigated. Findings from kinetic and deactivation measurements are
 correlated with detailed information on the Au particle size, Au and Ce oxidation state, and on the nature of adsorbed species after the different pretreatment procedures and during / after subsequent reaction, where the latter was obtained by operando and in situ methods such as operando X-ray absorption spectroscopy and IR spectroscopy, as well as ex situ X-ray photoelectron spectroscopy, supplemented by X-ray diffraction and transmission electron microscopy analysis. Based on this information possible origins of the deactivation and different effects of the pretreatment procedure thereon and on the reaction characteristics are
discussed. In particular it will be demonstrated that during extended times on stream the catalyst
surface composition approaches a dynamic equilibrium state which is largely independent of the pretreatment procedure.

Keywords: CO oxidation; catalyst pretreatment, deactivation; Au catalyst; Au/CeO$_2$; XPS; DRIFTS; XAS

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