Controlling emissions of global and local pollutants by heterogeneous reactions

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Abstract

Heterogeneous chemical reactions are a corner stone in the development of current and future technologies for reduction of emissions of local pollutants and greenhouse gases. *In situ* and *operando* experimental techniques using laser and X-ray absorption spectroscopy, for instance, are able to resolve spatial and temporal concentration and temperature profiles in the near-wall gas phase, the interphase and inside the solid bulk. They have been exploited for a better understanding of the interaction of chemical reactions and transport processes. The experimental elucidation of chemical conversion on the microscopic scale leads to elementary step-like surface reaction mechanisms. The microkinetic description of gas-surface reactions is still challenging due to the complex influence of the modification of the solid material itself on the microscopic scale during the chemical reaction, which is caused by intrinsic materials' modifications due to adsorbed species and temperature variations. Furthermore, transient inlet and boundary conditions on the reactor scale have a strong impact on the material and reaction rate. In addition to thermochemical reactions, an additional complexity comes into play with electrochemical ones.
This contribution will discuss heterogeneous chemical reactions in the light of emerging technologies such as emission control of natural gas and hydrogen fueled engines, use of CO_2 in chemical (methanation, dry reforming) and steel industry (off-gas reforming), hydrogen production by pyrolysis of methane, small-scale ammonia synthesis and use, and recyclable carbon-free energy carriers.