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Surface property studies on modified VO_x/TiO_2 catalysts for the NO_x abatement in mobile sources

Emissions of nitrogen oxide gases (NO_x) originating from combustion processes attract significant attention due to their role as a major source of atmospheric contamination, along with health risks and a series of environmental issues.[1] Since combustion processes in mobile sources (e.g. heavy-duty vehicles such as trucks or ships) are expected to be used for a foreseeable future, many efforts have been invested in the development of suitable deNO_x technologies. The selective catalytic reduction with ammonia (NH_3-SCR) is one of the most established technologies, where the formed NO_x gases are catalytically converted into harmless nitrogen and water. Vanadium oxide-based (VO_x) catalysts are one of the most commonly used catalyst types given to the low material costs and high chemical resistance (such as sulfuric compounds).[2] However, the application in mobile sources provokes several challenges, as the catalyst has to work under dynamic conditions in a broad temperature window. Both low-temperature activity and stability at high temperatures are required.[3] Since the operation temperature in automobiles varies between ambient and maximum temperature, the effects of temperature and time, are weighted together in a defined aging procedure considered representative of the application at hand.[4] Promising solutions have emerged with the modification by metal oxides to stabilize both the active vanadium oxides as well as the TiO_2 support.

For a rational design of a new generation of NH_3-SCR catalysts, a scientific understanding of the fundamental limitations for catalyst activity, selectivity and stability must be achieved. Our work will present systematic studies of the surface properties on modified VO_x/TiO_2 catalyst in terms of structure, the interaction between the support and additives as well additives and vanadium with the aid of various *ex situ* characterization techniques such as N_2-physisorption, temperature programmed desorption, XRD. In addition, the catalysts were thermally treated to mimic a long-term use and to study the respective impact. Infrared spectroscopic methods such as Raman and *in situ* DRIFTS allow the identification of surface vanadium oxide species and band assignments for the surface hydroxyl groups along with the formation of adsorbed surface species of the main reactants (NH_3, NO). The deconvolution of the NO_x adsorption spectra gives insights to the distribution of the surface species among the samples.

References

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