Nanoparticle synthesis using flame spray pyrolysis for catalysis

Roughly 85 to 90 % of the products from the chemical industry have been in contact with a catalyst and the production volume and financial turnover of the catalyst industry are expected to increase in the near future. This growth will be fueled by increasing demands for chemicals, new catalytic processes based on renewable feedstock, new or improved ways of preparing catalysts and a better understanding of the catalyst structure at operating conditions. This thesis explores flame spray pyrolysis (FSP) as a novel one-step preparation method for heterogeneous catalysts and investigates structure-activity-selectivity relationships. Specific catalysts studied are cobalt-molybdenum hydrotreating catalysts and vanadium and molybdenum oxide catalysts for oxidative dehydrogenation of propane (ODP). Hydrotreating is an established field in the petrochemical industry, driven by strict legislation on sulfur and nitrogen content in transportation fuels. Research is therefore performed to improve the commercial catalysts. In this thesis, FSP prepared catalysts are demonstrated to have an activity of up to 91 % of a commercial reference. This is promising for a new synthesis method which has not yet been optimized. The catalysts structure was investigated by spectroscopy and electron microscopy. ODP is an exothermic, alternative process to current highly energy demanding propene production methods; however the propene selectivity is a major obstacle for commercialization. FSP prepared vanadia catalysts with low vanadium loadings gave propene yields of up to 13 % at 33 % propane conversion and space time yields of up to 0.88 g-propene/(g-cat·h), which competes well with vanadia catalysts prepared by other methods. Kinetics of the reaction and the catalyst structure were investigated by in-situ and ex-situ by e.g. X-ray absorption and Raman spectroscopy.