Abstract

The presented work has its focus on the ruthenium catalysed transformations of formaldehyde in aqueous solutions. As catalysts $[RuX_2(arene)]_2$-complexes were utilised. In the first, fundamental publication the general characteristics of the system were explored. Besides the catalytic properties it was already possible to gain first insights about the mechanistic processes during the reaction. These were further investigated in an additional chapter harnessing NMR-spectroscopy, ESI-mass spectrometry, single crystal x-ray analysis, isotope labelling experiments and kinetic measurements via IR-spectroscopy to achieve a deeper understanding about the mechanism. Also, based on the results of the first publication a patent has been filed. In the following publication the metal catalysts were combined with enzymes and thereby methanol was made accessible as substrate. In this hybrid-catalytic system methanol is oxidised to formaldehyde by an alcohol oxidase and then decomposed to CO_2 and H_2. Further it was demonstrated that with $[RuX_2(arene)]_2$-complexes also transfer hydrogenations can be conducted. In a further publication it was shown that the equipped catalysts can also be utilised for the treatment of formaldehyde contaminated waste water. In the course of the associated work also a convenient protocol for microwave based complex syntheses was developed and a wide catalyst screening was conducted. Also in an other publication it was shown that, under use of $[RuX_2(arene)]_2$-complexes, amines can be methylated whereby formaldehyde acts as both the carbon and the hydrogen source. In the last publication of the thesis the bio-inspired, self-sufficient, ruthenium catalysed methanol synthesis from formaldehyde was investigated. The research papers and the mechanistic investigations are complemented by syntheses of new precursors for η^6 ligands and the corresponding complexes as well as by two review articles concerning formaldehyde and its synthesis in the context of a future environmentally friendly economy.