Advanced Fluids as Reaction Media: From Molecular Control to a Systems Approach in Organometallic Catalysis

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Organometallic catalysis has numerous important applications in synthetic chemistry from the laboratory scale to the productions of bulk chemicals. The molecular nature of the active species allows for systematic optimization of the catalyst structure through variation of the ligands. At the same time, it is well established that the performance of the "homogeneous" catalyst is greatly influenced by the reaction medium. Whereas the details of structure/performance-relationships are often quite well established, it remains a major challenge to understand, control, and master the interactions of the organometallic catalysts with the reaction medium on different times and length scales.

In the present lecture, we will discuss recent examples from our laboratory on catalytic transformations where we take a systems approach from the defined molecular structures to the environment of the reaction media. This will include the use of Ruthenium hydride complexes for the hydrogenation of CO_2 to formic acid[1,2] as an example for a bulk/commodity chemical. For fine chemicals and pharmaceuticals, we will present systems for continuous-flow operation using supercritical carbon dioxide ($scCO_2$) in combination with supported ionic liquid phase (SILP) catalysts.[3] In particular, we will discuss the possibility to adaptively control the performance in enantioselective catalysis through dynamic interaction with chiral ionic liquids (ILs) as immobilization matrix.[4]

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