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**Ru/La<sub>2</sub>O<sub>3</sub>-ZnO as catalyst for the selective hydrogenation of benzene in a difficult four-phase system (G/L/L/S)****Hendrik Spod, Martin Lucas and Peter Claus**  
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The previously known processes of selective benzene hydrogenation to cyclohexene require high loadings of ruthenium supported on different metal oxides and large quantities of inorganic salts, organics or ionic liquids. This results in a difficult four-phase reaction composed of water, catalyst, organic phase and hydrogen (G/L/L/S). The technical challenge in the design of a continuously operated reactor forming cyclohexene is the handling of the four-phase reaction and furthermore to find a catalyst system without any additional additives. Using small amounts of ruthenium nanoparticles impregnated on a binary oxide (La<sub>2</sub>O<sub>3</sub>-ZnO) without further additives (organic or inorganic) shows yields of cyclohexene up to 30% under optimized conditions in a batch reactor. The optimization was performed by the statistical software Design of Experiments. Furthermore, we studied the influence of different preparation parameters and the catalysts were characterized by XRD, TEM and *in situ* XPS measurements. A special reaction set up allows an *in situ* observation of the reaction mixture during the reaction, showing the emulsion of this complicated four-phase system. The droplet size of the organic compound and the rate of hydrogenation are correlated with different stirring rates excluding mass transfer limitations. Subsequently, the most effective catalyst was transferred to a specially designed continuous process to enhance high yields of cyclohexene over a period up to 250 hours.

**Biography**

Hendrik Spod is currently a PhD student at the research group of Prof. Claus at the Technical University of Darmstadt since 2013. He has received his BSc in 2010 and his MSc in 2012 at the Technical University Darmstadt in direction of heterogeneous catalysis.

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