



European XFEL Science Seminar

Tuesday, 15th October 2019, 13:00

Campus Schenefeld, XHQ, room E1.173 (coffee & biscuits will be served from 12:30)

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FB Physik

Operando investigations of heterogeneous catalysts: overcoming the spatio-temporal average

Heterogeneous catalysts are composed of oxide supported catalytically active 4d and 5d transition metal nanoparticles, which are exposed to gas mixtures at atmospheric pressures and elevated temperatures under reaction conditions. The catalytic reactions involve spatio-temporal patterns with mesoscopic to nanoscopic spatial heterogeneities and slow reaction kinetics to ultrafast dynamics during chemical bond making and breaking.

One important ingredient of catalytic reactions are nanoparticle shape changes under reaction conditions, since they may have implications on the activity and selectivity of the catalyst. Nanoparticle shape changes involve atomic surface diffusion, which is a process with typical time constants from 1 s at room temperature to 100 fs at 1200 K. In the presence of gases, surface self-diffusion may be further enhanced.

In my presentation, I will highlight our recent attempts to overcome the complexity of a real catalyst under working conditions by operando surface x-ray diffraction experiments [1]. I will present operando studies of surface restructuring of PtRh nanoparticles under CO oxidation conditions [2] and MgO supported Pd nanoparticle shape changes [3]. Further on, I will address possibilities for future time resolved surface structure characterization using x-rays during fast kinetic processes or during photo-induced reaction dynamics. In the last part of my presentation I will address recent results of ultrafast optical pump x-ray photoemission probe experiments during photo induced CO oxidation over anatase TiO₂ obtained at FLASH.

[1] A. Stierle, J. Gustafson, E. Lundgren in "Operando Research in Heterogeneous Catalysis,, Springer Series in Chemical Physics, Vol. 114 (2017)

[2] U. Hejral, D. Franz, S. Volkov, S. Francoal, J. Stremper, A. Stierle, Phys. Rev. Lett. 120, 126101 (2018)

[3] P. Nolte, A. Stierle, N. Kasper, N. Jeutter, H. Dosch, Nano Lett., 11, 4697 (2011)

Host: Robert Carley