CARL VON OSSIETZKY universität OLDENBURG
Institut für PHYSIK

PHYSICAL COLLOQUIUM

INVITATION

Monday, 14.01.2019, 4.15 p.m., W2-1-148

speaks

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about

" Dynamic material processes in response to interaction with an ambient gas or light"

The presentation will contain two parts covering the response of selected material systems to interaction with the surrounding environment in the form of a reaction gas or to an excitation by a short laser pulse. The results will include processes taking place at ambient pressures to ultrahigh vacuum and on time scales spanning picoseconds to seconds.

In the first part we will describe a recent study of a novel catalyst for hydrogen purification using preferential oxidation of carbon monoxide in hydrogen (PROX). Hydrogen purification is of importance to avoid the rapid deactivation of proton-exchange-membrane fuel cells due to poisoning by CO impurities, which typically comprises about 1 % of hydrogen fuel. However, purification through PROX is challenging because the catalyst needs to be active and selective towards CO oxidation over a broad temperature range so that CO is efficiently removed to below 50 ppm during continuous operation but also during cold-start periods. Here we will show that atomically dispersed iron hydroxide, selectively deposited on silica-supported platinum nanoparticles, enables complete and 100 % selective CO removal, by the PROX reaction, over the wide temperature range of 198 – 380 K. We find that the mass-specific activity of this system is about 30 times higher than that of more conventional catalysts comprised of Pt on iron oxide supports.

Through insights from transmission electron microscopy (TEM), scanning tunneling microscopy, X-ray photoelectron spectroscopy, and X-ray absorption fine-structure we show that most of the iron hydroxide exists as $Fe_1(OH)_x$ clusters anchored on Pt nanoparticles. The combination of experimental results and density functional theory calculations allows a description of the entire catalytic cycle showing that single interfacial sites of $Fe_1(OH)_x$–Pt readily react with CO and facilitate oxygen activation to CO_2 formation.

In the second half of the presentation I will introduce our development on ultrafast electron microscopy (UEM), a technique facilitating microscopic imaging, diffraction, and spectroscopy at picosecond timescales. UEM can be described as pump probe TEM where the probing electron bunches are generated by a femtosecond UV laser pulse while a synchronized laser pulse excites a change of state in the sample. We will present the design of the recently constructed UEM at KTH and results from the commissioning process and some model systems. The time and energy resolutions of the KTH microscope have been characterized using photoinduced near field electron microscopy using an effect where the probe electrons interact with the plasmonic field generated by the exciting laser in a conductive sample. The dynamics of the electron pulses are compared to simulation of the electron gun in the relevant 3D geometry, showing the benefits of tailored cathode designs in UEM. Time resolved electron diffraction results from a photoexcited charge density wave phase transition in $TaSe_2$ will be discussed as well as time resolved Lorentz microscopy of demagnetization and domain boundary dynamics in Permalloy.

All interested persons are cordially invited.

Sgd. Prof. Dr. Niklas Nilius