O 41: Poster: Supported Nanoclusters

Time: Tuesday 18:00–20:00   Location: P2/EG

O 41.1   Tue 18:00   P2/EG

Nano-SMSI - FePt clusters on graphene/Rh(111) — •Natalie J. Waleska[1], Eva Marie Freiberger[1], Felix Hemauer[1], Valentin Schwaab[1], and Christian Papp[1,2] — [1]Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany — [2]Freie Universität Berlin, Germany

Strong metal-support interaction is found for particles supported on particular metal oxide surfaces leading, inter alia, to the encapsulation of the particle by a thin layer of the metal oxide support. As a result the adsorption ability is decreased strongly but also specific site blocking is found, offering new opportunities for site selective reactions.

In this work, we investigated graphene-supported FePt clusters on the Rh(111) single crystal surface by in situ high-resolution XPS and the utilization of CO as a probe molecule. The FePt clusters were prepared by successively depositing Fe (1.27 ML) and Pt (0.14 ML) on the graphene/Rh(111) substrate. Oxidation of Fe was achieved by beam induced CO dissociation. Heating of the FePt/graphene/Rh(111) sample to 550 K results in cluster ripening and the encapsulation of Pt by a thin FeO layer due to SMSI. Further increase of the temperature to 900 K, leads to the decomposition of the Fe oxide layer and the intercalation of Fe. Additionally the formation of a FePt alloy was observed at elevated temperature.

We thank Helmholtz-Zentrum Berlin for allocation of synchrotron-radiation beamtime and BESSY II staff for support during beamtime. This work was funded by the DFG within SFB 953 "Synthetic Carbon Allotropes" (Project #182849149).

O 41.2   Tue 18:00   P2/EG

Beyond Amorphous Carbon as an Embedding Material for Cluster Superlattice Membranes — •Stefan Schulte[1,2], Tobias Hartl[1], Alexei Preobrajenski[3], Jan Knudsen[3], and Thomas Michely[1] — [1]II. Physikalisches Institut, Universität zu Köln, Germany — [2]Peter Grünberg Institut (PGI-3), Forschungszentrum Jülich, Germany — [3]MAX IV Laboratory, Lund University, Sweden

Cluster super lattice membranes constitute a novel 2D template material that has recently been described (T. Hartl et al., ACS Nano, 2020). So far, metal nano clusters on a graphene or hexagonal boron nitride support were embedded in an amorphous C matrix. This provides mechanical and thermal stability to the clusters, but a non-conductive embedding material, that allows for selective removal of the support structure is sought after. Here, embedding of cluster superlattices in B is presented and embedded clusters are characterized by STM and XPS. Embedding in B exhibit mechanical and thermal stability similar to amorphous C, e.g., Ir clusters on a graphene support embedded by a few monolayers of B remain in excellent order up to 750 K. This opens the pathway to electronic characterization of the nano clusters as well as removal of the support layer to expose stable clusters to ambient conditions. Further, preliminary results on CeO_2 embedding will be presented. CeO_2 embedded metal clusters are a promising material in few-atom catalysis processes.

O 41.3   Tue 18:00   P2/EG

H_2 **Evolution from Methane Activated by** Ta_8 **Clusters on Pt(111)** — •Matthias Knechtges, Tobias Hinke, Kevin Bertrang, Sebastian Kaiser, Nikita Levin, Martin Tschurl, and Ueli Heiz — TU Munich, School of Natural Sciences & Catalysis Research Center, Chair of Physical Chemistry

Methane as the main component of natural gas contains the highest energy density of all hydrocarbons but the activation poses great challenges, due to the high activation barrier of the C-H bonds.

Pathways to convert methane into valuable products at mild conditions are investigated in the UHV. Gas phase studies revealed that $Ta_8O_2^+$ catalytically converts methane to ethane and hydrogen at room temperature. The charge and oxygen density of the clusters appear to have great impact on their activity towards methane[1].

By employing a substrate manipulating the electronic and geometric structure of the clusters, the model system approaches to industrial heterogenous catalysis. Therefore, metallic Ta_8 clusters were deposited on different surfaces known for their electron drawing properties in analogy to the oxygen atoms in the $Ta_8O_2^+$. While no activity towards methane was observed Ta_8/SiO_2, hydrogen evolution was found after methane exposition on $Ta_8/Pt(111)$ in temperature programmed desorption(TPD) experiments.

Characterization by scanning tunnel microscopy showed randomly monodispersed flat arrangements and XPS to observe oxidation states.

[1] N.Levin et.al *J.Am.Chem.Soc.* **2020**, 142, 12, 5862-5869

O 41.4   Tue 18:00   P2/EG

Influence of Strong Metal-Support Interactions on the Photoactivity of Pt-loaded TiO$_2$(110) — •Lucia Mengel, Philip Petzoldt, Moritz Eder, Martin Tschurl, and Ueli Heiz — Chair of Physical Chemistry, School of Natural Sciences & Catalysis Research Center, Technische Universität München, Lichtenbergstr. 4, 85748 Garching, Germany

Pt-loaded TiO_2(110) is well-known for its capability of alcohol photoreforming. The hole-mediated photooxidation reaction yields hydrogen next to valuable organic compounds such as formaldehyde. The concept of encapsulation of clusters or nanoparticles by a metal oxide overlayer under reductive conditions is well established and has been extensively studied using a variety of techniques. Such encapsulations caused by strong metal-support interactions (SMSI) are a promising tool in photo-/electrocatalysis to improve catalyst selectivity and high-temperature stability. However, there is a lack of mechanistic understanding on the influence of an SMSI overlayer on the photocatalytic hydrogen evolution reaction.

In this poster, we discuss the influence of SMSI on the photoactivity of Pt-loaded TiO_2(110). As model reaction, methanol photoreforming is studied by catalytic measurements. We focus in particular on effects with relevance to the evolution of hydrogen, as TiO_x layers may impede the back reaction in full water splitting and thus have potential to replace currently predominant chromium oxide compounds.