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Unifying Concepts in Catalysis

UniCat Colloquium

PROF. ULRICH HEIZ

Physical Chemistry, Catalysis Research Center, Universität München, Germany

Cluster Activity Under Diverse Ambient Conditions

The study of size-selected clusters on surfaces has been growing into a vital research field within cluster science and catalysis since the discovery of the astonishing size-dependent activity of small gold clusters for the oxidation of CO in the late nineties,. More than one decade of research in a combined effort between theory and experiment has resulted in a detailed understanding of cluster's structural, electronic, optical, and magnetic properties. Furthermore, several chemical, catalytic, and photocatalytic processes on clusters are understood on a molecular level, today. This exciting advancement was only possible by a parallel development and introduction of novel, state-of-the-art methods, both in experiment and theory.
In the first part this talk strategies for optimizing cluster stability against ripening will be presented, where both, the binding of the clusters to the surface and that of the individual atoms, must be controlled. Such tuning of the interactions may be achieved through the judicious selection of surfaces with laterally modulated wettability. Furthermore, we observed that the broadening of cluster size distribution induced by Ostwald ripening is efficiently suppressed even under reaction conditions for size-selected cluster samples.
In the second part of the presentation the chemical action on such size-selected cluster materials under diverse ambient conditions are presented. Under low pressures the hydrogenation of ethylene on Ptn clusters shows a strong size dependence with an onset of reactivity going from Pt_9 to Pt_{10} and Pt_{13} being the most active cluster size. The origin of the size dependent reactivity is discussed using results from extended ab initio calculations. In a second example the photochemistry of size-selected Pt_N clusters on CdS nanotubes, explored under ambient conditions, i.e. aqueous solution, is discussed. Solar hydrogen production has recently gained renewed interest in photocatalytic hybrid nanoparticle systems, utilizing colloidal semiconductor nanoparticles as sunlight absorber with additional noble metal nanoparticles as the hydrogen production catalyst. By soft-landing size-selected Pt clusters under UHV conditions, a novel decoration method for colloidally synthesized CdS-nanorods is presented. Subsequently, quantum efficiencies were measured in an aqueous solution with triethanolamine (TEA) as hole scavenger under UV illumination in dependence of the average number of clusters per nanorod. Furthermore, size-dependent photocatalytic activity has been observed and is discussed within a simple model, where the cluster's level alignment with the band structure of the semiconductor is essential.

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TU Berlin, Institute of Chemistry
Straße des 17. Juni 115, 10623 Berlin

Building C, Lecture Hall **C 264**

Prof. Schwarz (TUB)
Organizer

Coffee and cake will be served 30 minutes before the lecture. Guests are cordially invited to attend!
Prof. Dr. Matthias Driess - Chair of the Cluster of Excellence UniCat - www.unicat.tu-berlin.de