

Ph.D. Course in Materials Science and Nanotechnology

University of Milano-Bicocca, Department of Materials Science, via Cozzi 55, 20125 Milano

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Seminar room - Department of Materials Science U5

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Can we control the charge state and structural dynamics of supported clusters?

It has been shown in several examples that the charge state of supported clusters can influence its catalytic activity. Negatively charged Au_8 clusters on MgO, for instance, are highly active CO oxidation catalysts whereas neutral Au_8 is inactive. Similarly, the internal structural fluxionality of clusters can also be responsible for a high catalytic activity, while sintering typically leads to catalyst deactivation. The question thus arises whether we can control the charge state and structural dynamics of supported clusters in order to optimize their properties as a catalyst.

We have accelerated our scanning tunneling microscopy (STM) to video frame rates to investigate the dynamics of clusters on single crystalline supports. In the case of Pt_n clusters on $\text{Fe}_3\text{O}_4(001)$, we find that the clusters are strongly bound to the support and thus do not sinter, but they appear to “sink” into the surface with increasing temperature. The STM images thus seem to indicate a change in cluster–support interface or lowering of the cluster surface electron density of states – e.g. by reverse spillover of oxygen onto the cluster. $\text{Pt}_n/\text{SiO}_x/\text{Si}(001)$ is another strongly interacting and thus highly sinter-resistant system. Here, we change the doping in Si to control the charge state of Pt clusters without altering the cluster–support interface. In ambient pressure X-ray photoelectron spectroscopy (AP-XPS), we observe a systematic difference in the interaction with oxygen and catalytic activity of Pt_n clusters on p- and n-doped Si wafers, which we investigated on the example of the ammonia oxidation reaction on different cluster sizes.

PhD students and all interested in the seminar are kindly invited to participate.

The PhD Coordinator
Prof. Marco Bernasconi