

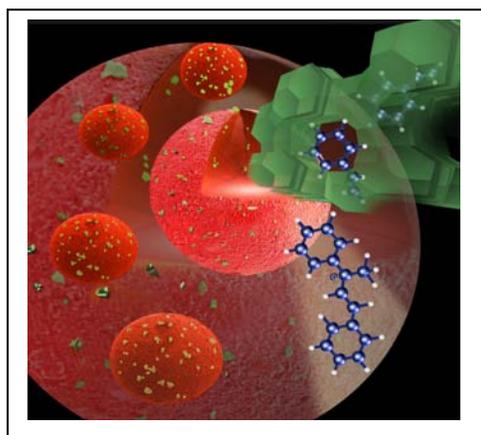
In-situ Spectroscopy of Catalytic Solids at the Single-Particle Level

Bert M. Weckhuysen^a

*^aDebye Institute for Nanomaterials Science, Utrecht University,
Universiteitsweg 99, 3584 CG Utrecht, The Netherlands.*

Introduction and Objectives

The past years have witnessed the introduction of spatiotemporal spectroscopy for the characterization of catalytic solids. These advances allow observation of catalysts at previously unattainable resolution and sensitivity. They reveal that catalytic solids are even more heterogeneous than often anticipated. Dynamic changes in the nature of active sites, active site distribution and accessibility are found to occur at both the intra- and interparticle level.



Scientists have now the tools at hand to improve the understanding of catalyst heterogeneities and exploit this knowledge to design new or improved catalysts. This lecture highlights the latest developments of this field of research, with special emphasis on research from our own group. The trends include single particle/molecule detection, super-resolution imaging, 3-D imaging, selective staining, integration of spectroscopy with electron microscopy or scanning probe methods, and measuring under realistic reaction conditions.

Results and Discussion

The dynamic properties of individual catalyst particles will be highlighted by recent literature examples for both structured porous oxides and supported metal nanoparticles.

Significance

Catalysts display heterogeneities in terms of structure, composition and reactivity, all of which change not only as a function of position within a catalyst particle, but also in time. Within individual catalyst particles, even for simple model systems, structural and compositional differences clearly exist and these intraparticle heterogeneities largely impact the overall performance of a catalyst. Within a catalyst batch, interparticle heterogeneities complicate matters even more. Spatiotemporal spectroscopy has opened up new vistas that allow visualization of how catalyst materials work and change during operation.