

# Internal Structure and Catalytic Function of Metal/Metal Oxide Aggregates

Robert Schlögl

Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin

Aggregates of metals and of binary oxides are now available in controlled sizes supported on well-defined substrates. Such systems can be used as model structures for technical catalysts as well as to elucidate novel catalytic functions of a substance when prepared in a nanostructured fashion. Surface Science can determine the surface composition and surface morphology of these systems and study fundamental processes such as adsorption and reaction of small molecules.

These studies are complemented by high resolution electron microscopy and local electron energy loss spectroscopy. Examples of copper and platinum particles on several substrates exemplify the ability to discriminate particles with conventional structures (sections of the extended bulk structure) from others with non-close packed unusual structures.

The reactivity of copper particles with oxygen has been studied and a variety of sub-oxides co-existing with the element or the well-known stoichiometric oxides have been found.

The sub-oxides of copper are the active phases of practical copper catalysts for selective oxidation reactions. The conversion of methanol to formaldehyde is used as a model reaction for industrial applications with higher alcohols. Here, massive copper is used which will be shown to disintegrate under catalytic conditions into a nanostructured material allowing the efficient formation and participation of bulk-dissolved oxygen in surface reactions. Two different types of oxygen-copper bonding interactions were identified. These two species correspond to the C-H and O-H activating dehydrogenation function and to the C-O cleaving function being responsible for the formation of formaldehyde and of carbon dioxide respectively.

Chemical synthesis of copper particles in different sizes is very relevant to exploit the catalytic potential of controlling the kinetics of oxidation-reduction steps in the formation of metallic or (sub)oxidic particles. Examples of conventional copper-zinc oxide and novel copper-carbon systems will be demonstrated to exhibit quite different reactivity patterns against methanol.