Seksjon for komplekse materialer

Properties of surface nanostructures

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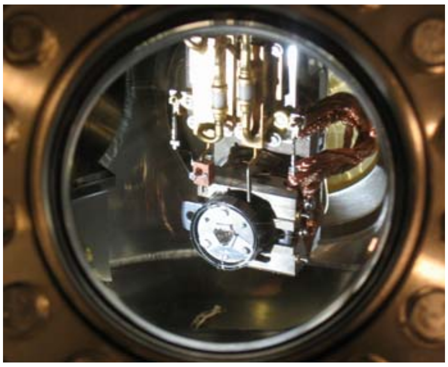

Sample mount

Vacuum chamber

The research activity consists of fabrication and investigation of the properties of nanostructured surfaces. The sample specimens are made by self-assembly on well characterized surfaces. A range of surface analytical tools are available to study the nano-systems: Monochromatized photoelectron spectroscopy (XPS, UPS), differentially pumped temperature programmed desorption (TPD) spectroscopy, and scanning electron microscopy (SEM) in collaboration with other NTNU groups. In addition, sample preparation techniques are available including ion sputtering, gas treatment, high pressure preparation chamber and different evaporation sources.

Background

Although metal nanoparticles possess many of the properties of single crystalline substrates from the same material, experiments have shown that a nanoparticle array contains new degrees of freedom due to concentration of defects and rapid reconstruction due to the many lower coordinated atoms. In addition, changes in electronic structure due to interaction to the support of the nanoparticle array are important. Technologically, this is of importance in catalytic processes, but also has bearing on e.g. use of nanoparticles in solar energy conversion. It has been known for decades that metal nanoparticles in the range 2 to 10 nm that are dispersed on catalytically inactive oxide supports may have catalytic turnover rates of more than ten times that of a metallic substrate.

Scope

The aim of the present activity is to study model two-dimensional metal nanoparticle systems in order to obtain knowledge to contribute to the understanding of the complex phenomena that take place in such systems. The model 2D systems enable the study of various processes that takes place in actual 3D systems. The ultimate goal is to obtain comprehensive knowledge of processes involved in heterogeneous catalysis on nanostructures/nanoparticles in order to design optimal catalysts for important technological applications.

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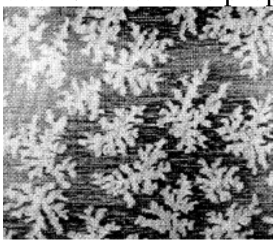
Examples of research projects

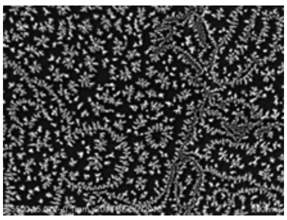
- *Nanostructures on metallic substrates*. Sub-monolayer amounts of a catalytic active metal are deposited onto a substrate. Both deposition rate and substrate temperature may be varied. Self-assembled structures form which may be refined by use of ion beam sputtering. The reactivity of the samples is studied by adsorption and desorption of model gases in the temperature range from 100 to 1000K. Electronic properties are probed by photoelectron spectroscopy.



Au deposited on Ru

- *Metal nanostructures on thin oxide films*. The metal-support interaction may be varied by changing the oxide substrate and by varying the thickness of the oxide film. The effects of the support interaction which is of prime importance in many reactions may thus be studied by TPD and photoemission.

- *Nanostructures on graphite*. We have found that several different nano-structures are formed when depositing metals on graphite substrates. Due to the weakly interacting substrate the patterns are formed by diffusion limited aggregation (DLA). Hot electrons that escape in the adsorption process leave the metal nanoparticle in a charged state. The conductivity of the support determines how fast the unit charge is neutralized. This may influence the adsorption properties of the nanostructure.



Pt on C

Au on C

- *Supported metal nanoparticles*. Another way of studying size effects on adsorption on metals is to use mono disperse particles, e.g. Pt particles. These nano particles may be distributed on a substrate or contained in a carbon matrix. Particles of sizes between 2 and 7 nm are of most interest for reactivity studies. Two-dimensional particle arrays may be formed by Langmuir-Blodgett deposition onto various substrates.