
Exam Heterogeneous Catalysis

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The questions were all worth between 2 and 4 points from approx. 100 points (except the plot in exercise 4).

Excercise 1

- Draw a potential energy diagram of a catalyzed and a gas phase reaction without catalyst and note the steps of the catalytic cycle.
- Describe Sabatier's principle.
- How can you determine the most suitable catalyst for a reaction. Name and draw the corresponding graph.

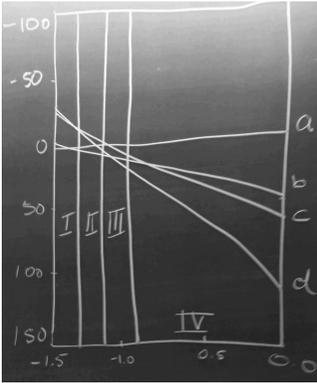
Excercise 2

- Name three industrial processes/catalytic systems that are used in the transport sector and good for the environment.
- Describe for each process the used catalyst.
- Write down the chemical equations for alle the three processes.

Excercise 3

- Give three reasons why thermodynamics are important for catalysis.
- What reaction takes place when a Pd(100) surface is exposed to oxygen?
- How do you make a phase diagram and what is displayed on the axes?
- Which structures belong to a-d and which structure is present in I-IV?

In this question the following diagram was given as help:



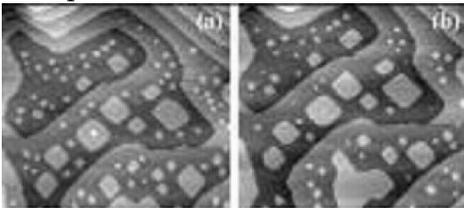
Exercise 4

- Give the Arrhenius equation.
- Draw a plot to determine the Arrhenius-parameters (6 values of T and matching k were given).
- Calculate the Arrhenius-parameters.

Exercise 5

- Explain and name three ways of catalyst deactivation.
- Explain and name two mechanisms to get bigger particles.
- Two STM images of different times of a Ir(100) surface were given. What mechanism of particle growth is probably present?

The picture was a bit like the following:



Exercise 6

- Which catalyst is used for Fluid-catalytic-cracking?
- Explain two types of acidities of zeolithes.
- Draw the mechanism of FCC. Consider a mechanism with in total 5 steps, the last step should have three different possibilities.

Exercise 7

- a) What is the surface science approach?
- b) Give three reasons why it is important to study surface science approaches.
- c) Name two gaps between industrial conditions and those used in surface science.
- d) Give your opinion on the importance of implementing industrial conditions into research.

Exercise 8

- a) What is epitaxial growth and by which factors is it determined?
- b) What are the different types of adsorption? Give a small description and an example.
- c) Explain the Frank-van-der-Merwe mechanism with the help of a cartoon.
- d) Draw schematic the Lennard-Jones potential for a dissociative adsorption and indicate the adsorption types.