Übungen zur Oberflächenphysik
Blatt 1 – 6. und 7.3.2014

1) **Pressure**

a) A vacuum chamber contains a residual gas of $5x10^{-10}$ mbar. By analyzing with a mass spectrometer it is found that the residual gas is water. How can it be removed?

b) The vacuum chamber contains gas at the atmospheric pressure at room temperature, what will be the pressure after baking temperature of 120 °C is reached (assume that the vacuum chamber is not pumped and neglect adsorption/desorption processes)? What would be the pressure in the chamber if the gate connecting it to another chamber with the same volume and pressure of $p=10^{-9}$ mbar is opened?

c) A cubic chamber with a 10 cm edge is being pumped by a pump which is assumed to be ideal (everything that enters it is removed), the size of the pump-opening is 1 cm^2.

a) What is the pumping speed of this ideal pump?
b) How long does it take to pump from ambient pressure down to 10^{-9} mbar?
c) What is the number of particles contained in that cubic chamber if the pressure is i) p=1atm ii) p = 1 mbar iii) p = 10^{-6} mbar at room temperature (T=25^oC)

d) An end-station at synchrotron is 20 meters far away from the valve which protects synchrotron ring against accidents. Estimate how fast the valve has to be closed to avoid that the vacuum in the ring is affected if there is vacuum break at end-station. The tube which connects ring and endstation has 40 mm in diameter.

2) **Absorption/desorption**

a) A reactive sample needs to be stored in the UHV chamber for 8h (e.g. during the night) and during that time it can be covered up to 0.1 ML (Monolayer) upon the adsorption of residual gas from the chamber. What is the highest acceptable pressure in the chamber so that sample can be stored in it in given conditions (assume „sticking coefficient“ 1 and 100% partial pressure of reactive gases)

b) If a surface is initially covered with a single monolayer of 10^{15} molecules/cm^2, having E_{des} = 30 kcal/mol, how long does it take to reduce the coverage to 10^{13} molecules/cm^2 at the temperature of 600 K. Assume $\tau_0 = 10^{-13}$ s and that re-adsorption can be neglected. (τ_0 is inverse of the attempt frequency).

c) The average time for which an oxygen atom remains chemisorbed to a tungsten surface is 0.36 s at 2548 K and 3.49 s at 2362 K. Find the activation energy for desorption

3) **Mean free path**

Derive a formula for the mean free path of molecules (diameter d) in a gas (pressure p, temperature T) ($\lambda = k_B T / pd^2 p$), e.g. the path between two collisions.
Use the following assumptions:

- molecular density: n = N / V, where N - number of molecules, V – volume
- all molecules are fixed except for one under consideration