Surface phenomena

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1 11-03-25: — Introduction

What is a surface? It is a boundary between 2 different phases, there's a change of density, but it is a continues transition. The interaction between the two are just all the possible scenarios where one phase changes into the other. It is not a sudden change.

Porosity: We can different types of pores, follow the slides (*pag. 10*). These are all the possible construction.

Pores: Classification (Important for exam):

- Micropores: $w < 2nm$
- Mesopores: $2nm \leq w \leq 50nm$
- Macropores: $w < 50nm$

Possible applications are adsorption and filtration.

Why surfaces? Catalysis, micro/nanoelectronics, Energy, Biological (brain, photosynthesis). Remember that there's a gigantic gap between the experimental conditions and than the practical applications.

2 12-03-25: — Thermodynamics

All surfaces are energetically unfavourable, since the have a positive free energy. This is because they are obtained by breaking bonds. So to increase a surface the energy required will be:

$$-dw_s = dG_S = \gamma d\sigma \tag{1}$$

$$\gamma_{hkl} = \left(\frac{\partial G_S}{\partial \sigma}\right)_{P,T} = \left[\frac{J}{m^2}\right] \tag{2}$$

Which can be related to the surface tension, so an energy that contrasts the generation of new surface.

Sulfactants: They decrease the surface tension of a surface. Which is not the natural tendency of systems. For example water tends to generate spheres to reduce the surface. The difficulty in removing an atom from the surface is the fact that the atoms try to get inside the bulk, where energies are lower.

In crystals we don't have spheres, this is because the forces applied to the atoms are anisotropic. We can try with adsorption of a gas phase and finally altering the local surface to decrease the energy. Just remember that surfaces with higher density are the more stable ones.
In order of stability:

- (111) FCC
- (100) BCC

But according to just this we should find just octahedron, since they are made only of (111). But remember that we also want to minimize the surface, this means that cutting it (creating a nano-sheet / bipiramid) we mantain a main (111) structure and a (100) just to reduce the area.

Based on different values of surface tension, we will obtain different geometrical forces. And this can be done by using a sulfactant that will affect just certain types of surface directions.

Alterating structure: Relaxation and reconstruction. The first one is very low energy and just changes the interatomic distances by a bit. Reconstruction on the other hand changes the periodicity near the surface. The change happens after the cut, so we can observe the before and after.

Gas adsorption: It always occours in the atmosphere. There's difference between adsorption (molecules DO NOT enter the material) and absorption (molecules enter the material). From the formula, we obtain the 'heat of adsorption' given from the stability increase of the system.

3 14-03-25: — Recupero Fra

4 18-03-25: — Ab/Adsorption

Remember the difference: Absorption enters inside the bulk, adsorption the remain on the surface.

5 19-03-25: — Recupero Fra

6 20-03-25: — Textural Properties

- SSA: Specific Surface Area is the total surface area
- PSD: Pore Size and Pore Size Distribution is size of the pores and their distribution
- CPV: Cumulative Pore Volume is the totale volume of pores (empty space)

Trovi tutto sulle slide, ha solo letto, l'unica roba importante da ricordare è questa qua sopra. So we have two different ways to classify the pores: Size and Shape. Can consensation occour in micro-pores? **NO!**

To measure the adsorption, we use liquid nitrogen (inhert), so that we are sure to cover completely the surface.