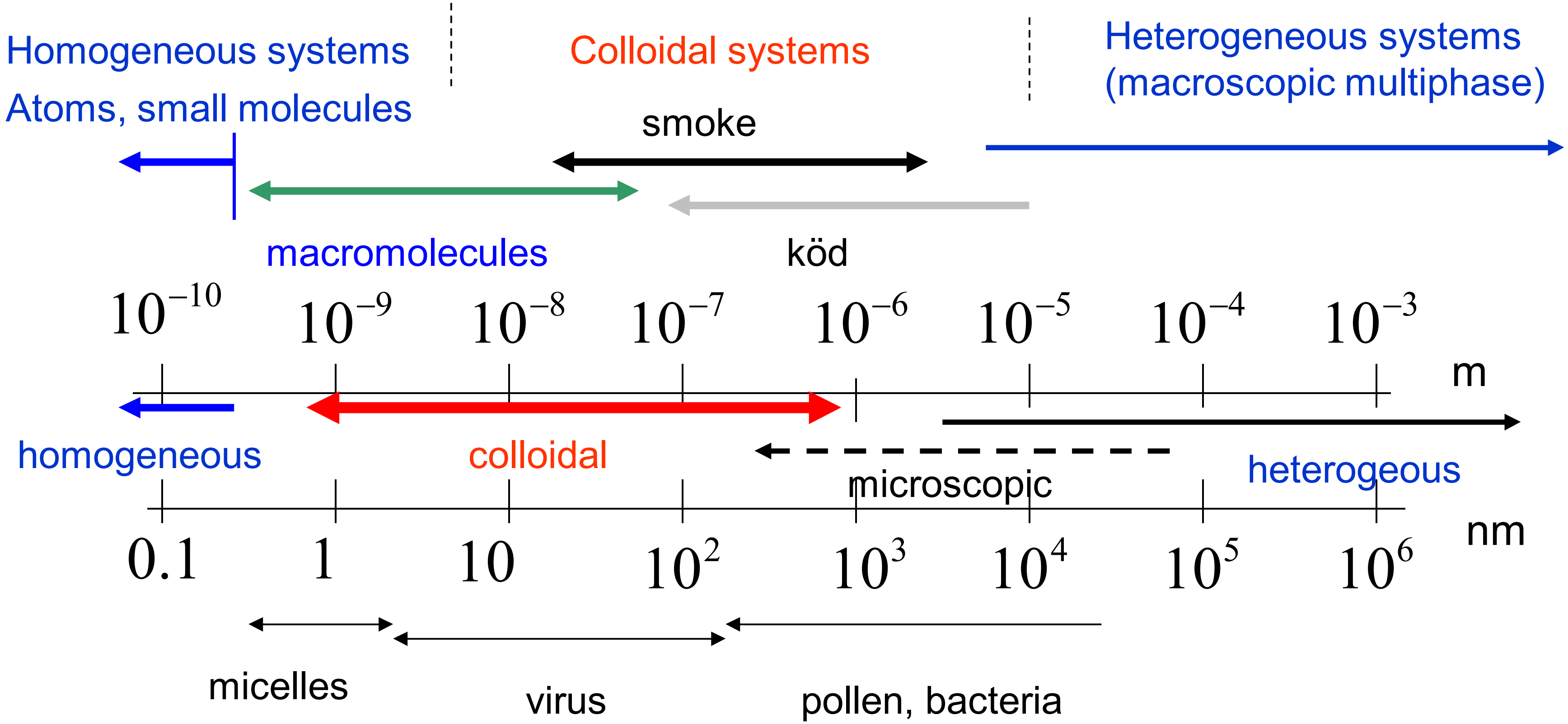
INTERFACIAL PHENOMENA

Lecture notes +

konyvek/fizkem/
PHYSICAL CHEMISTRY OF SURFACES

Colloidal systems

- **At least one of the dimensions is between 1 nm and 500 nm**
- **Surface has a defining role in the behaviour of the system**



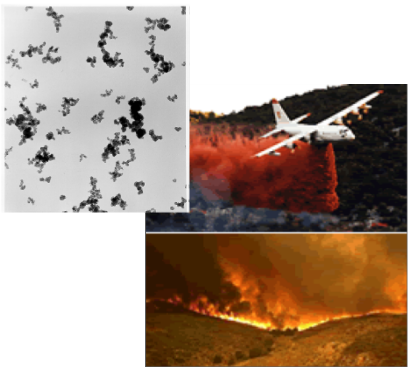
Classification
Physical state

Dispersion medium: gas

aerosols

L/G fog
S/G smoke

smog



Dispersion medium: liquid

liosols

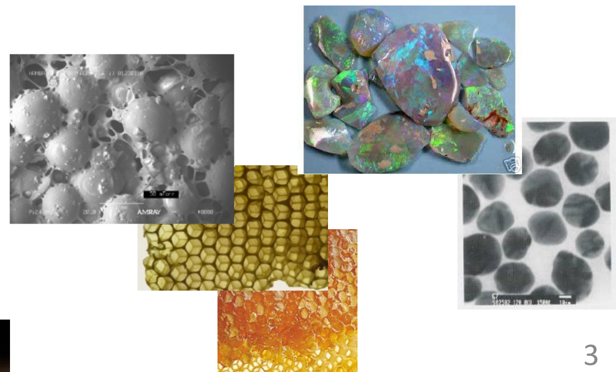
G/L foam
L/L emulsion
S/L suspension

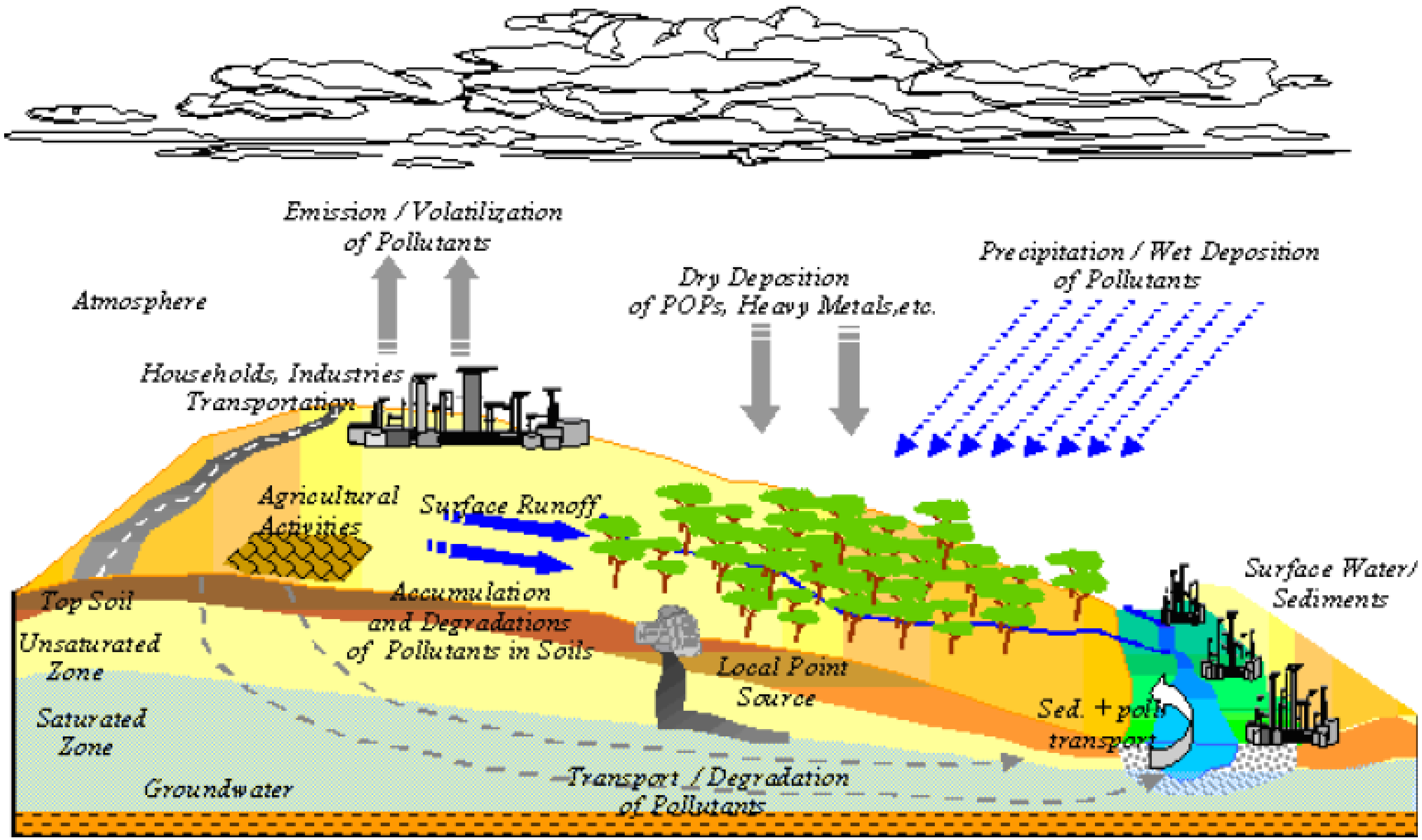
Dispersion medium: solid

xerosols

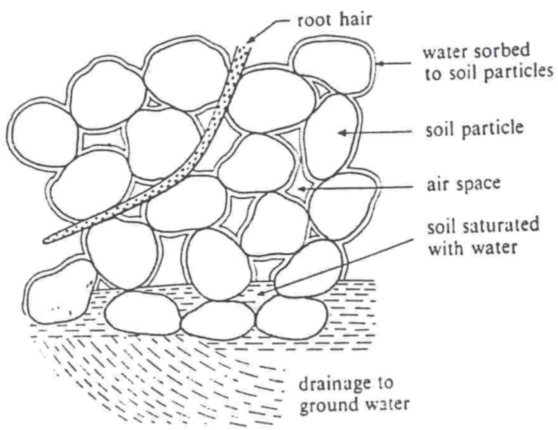
+ complex systems

G/S solid foam
L/S solid emulsion
S/S solid suspension



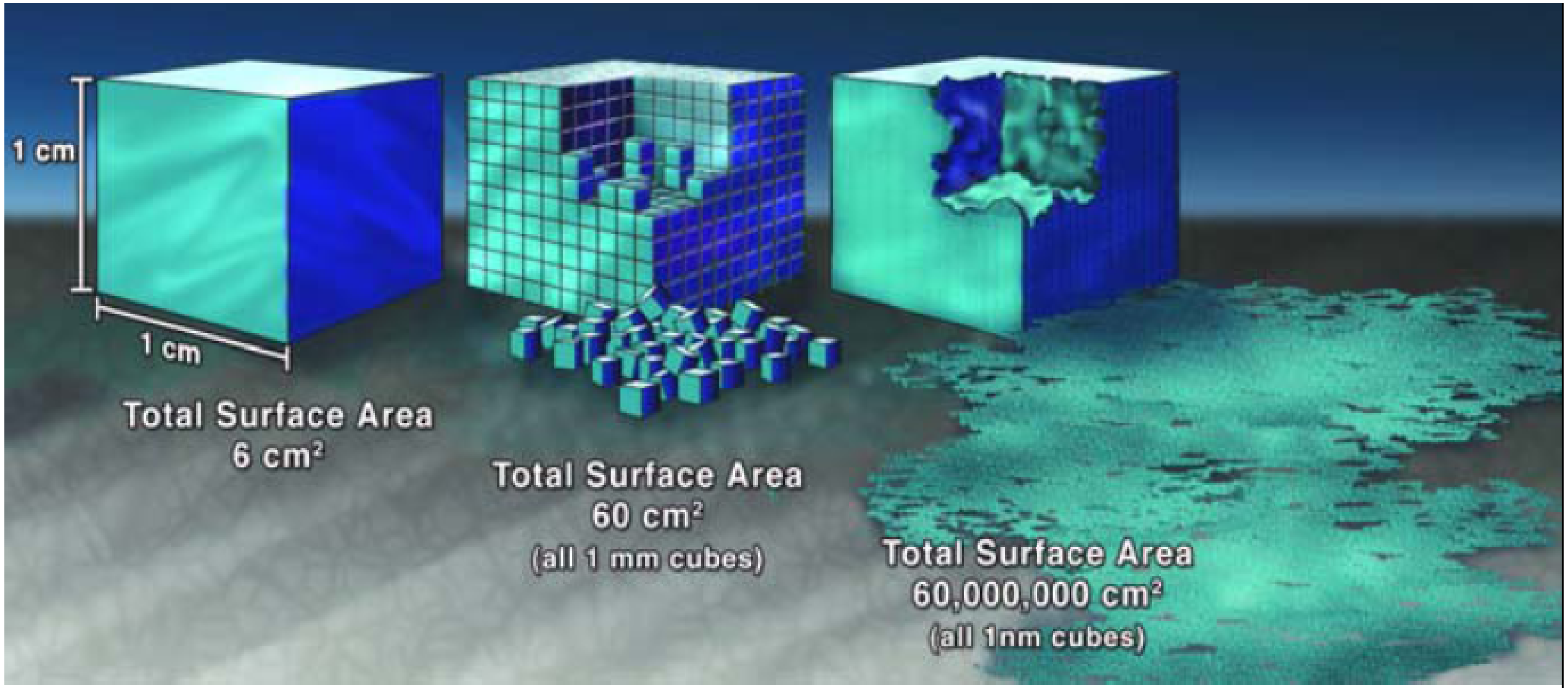


POP= persistent organic pollutants



Particle size vs. surface

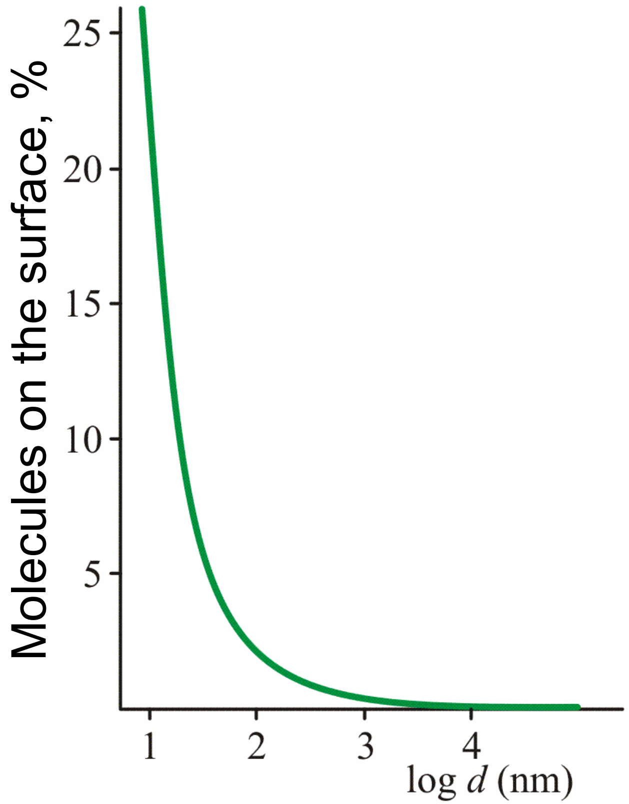
1 cube 1000 cubes 10^{21} cubes



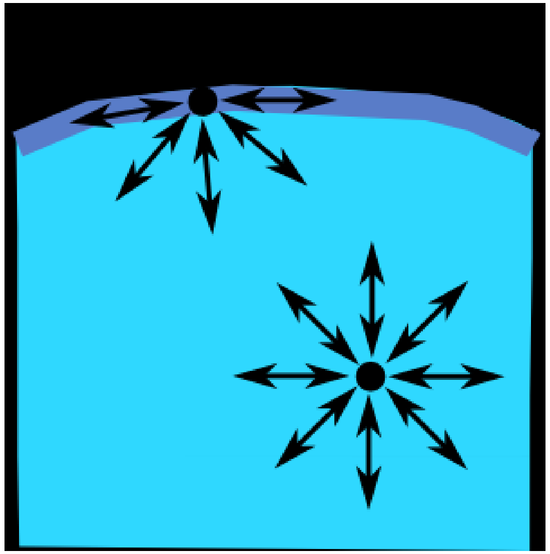
Surface/volume

„God created space, and the devil created surface"

Wolfgang Pauli



% of surface molecules vs particle size



$$\gamma = \left(\frac{\partial G}{\partial A_s} \right)_{p,T}$$

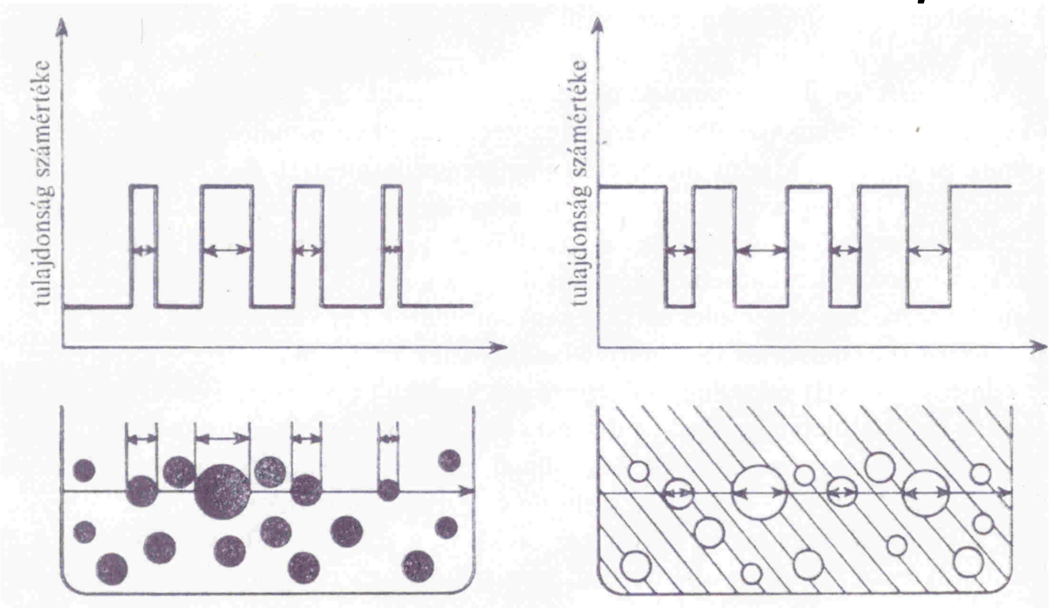
Surface tension

intensive property,
work/surface area; force/route

	$\gamma^{293\ K}$ mJ/m² or mN/m	interaction
He(l)	0,308 $^{2,5\ K}$	dispersion
n-hexane	18	dispersion
water	72	H-bridge
Hg(l)	472	metallic bond
$BaSO_4$	10^3	ionic bond

High surface area material

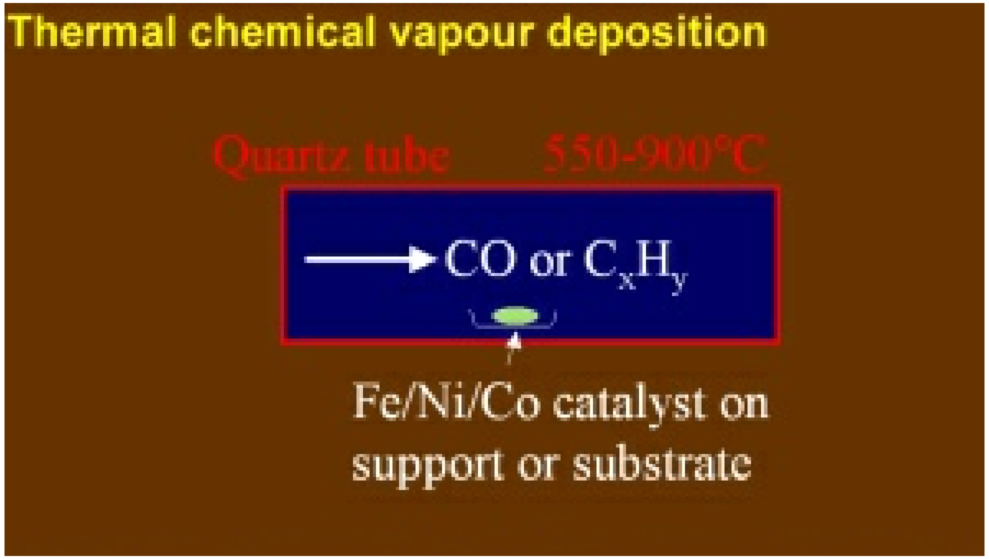
incoherent coherent systems



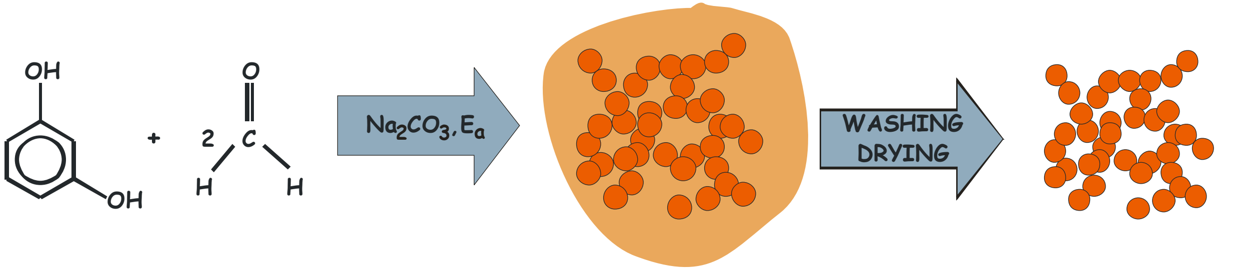
1. dispersion:

2. synthesis (bottom up)

~ chemical vapour deposition



~ sol/gel



RF hydrogel

dry RF gel

resorcinol
R

formaldehyde
F

3D polymer network

polycondensation

Stability of colloidal systems

Disperse systems

Sedimentation: gravity vs. friction

Conditions: r>>rmedium

slow motion
spherical particles
dilute soluition
good wetting
no swelling
1- 20 μm

$$V(\rho - \rho_{medium})g = fv$$

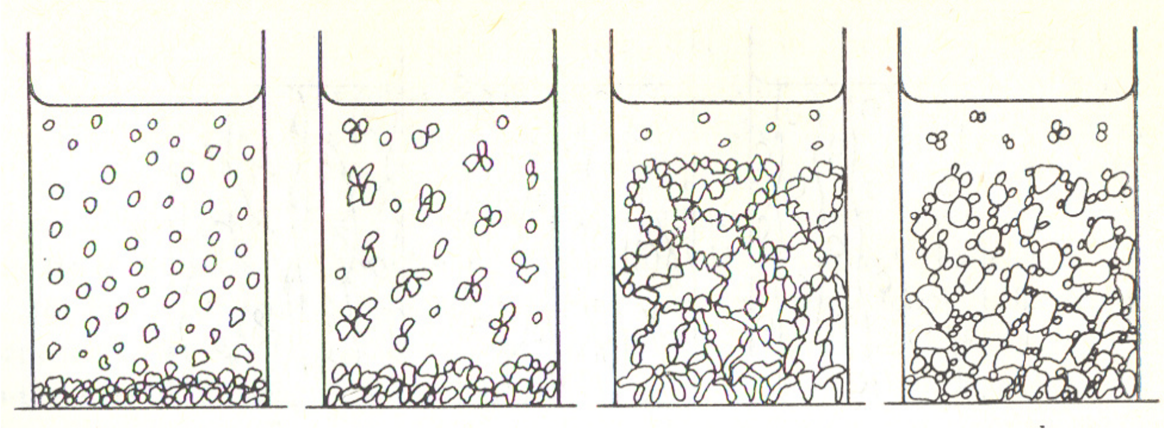
$$\frac{4}{3}r^3\pi(\rho - \rho_{medium})g = 6\pi\eta r v$$

$$v = \frac{2r^2(\rho - \rho_{medium})g}{9\eta}$$

Stokes

Equivalent radius
? Adhesion ?

Examples (types of sedimentation)



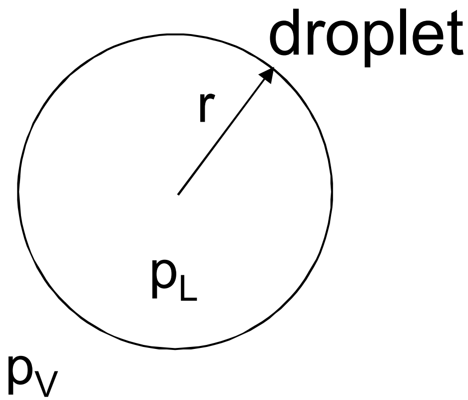
primary secondary collective

The structure of the sediment depends on the particle-particle interaction

Filtration: loose structure is required

Phenomena related to surface tension

1. Saturation pressure above curved surfaces



Due to the surface tension there is an extra pressure inside the droplet:

$$p_L = p_V + \frac{2\gamma^{LV}}{r}$$

Laplace

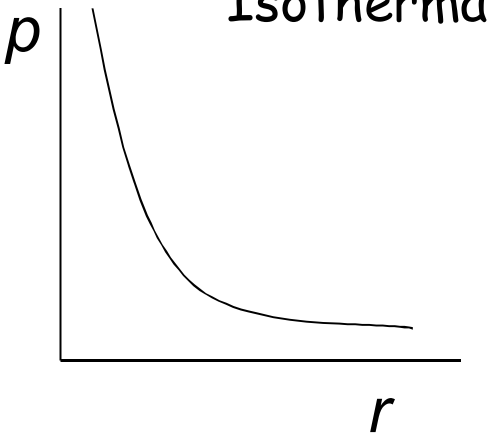
$$\Delta p = p_L - p_V$$

Δ*p* in water droplets of various radii 1 bar, 0 °C				
radius	1 mm	0,1 mm	1 µm	10 nm
Δ*p* (bar)	0,0014	0,0144	1,436	143,6

Liquid droplet

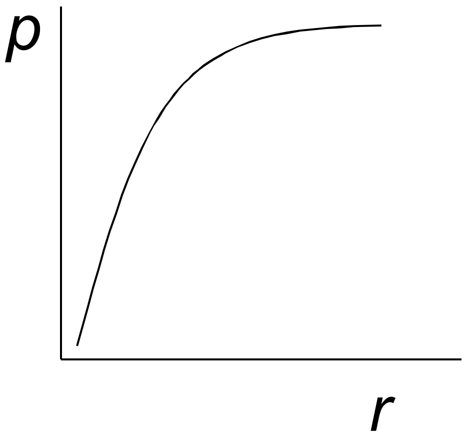
$$p = p_{\infty} e^{\frac{2\gamma V_m}{rRT}}$$

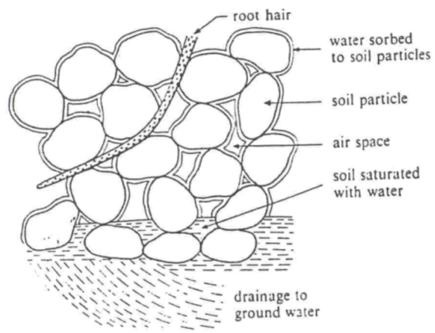
Isothermal distillation



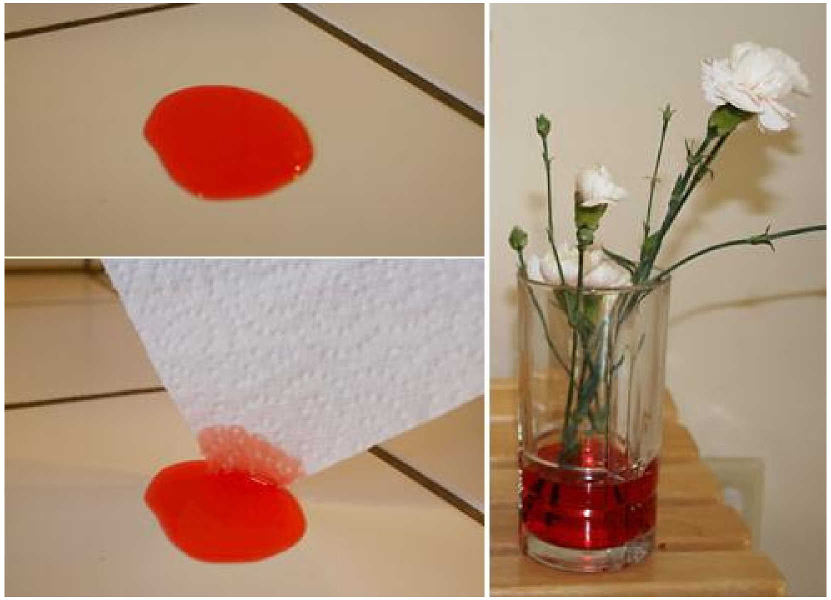
Bubble (pore)

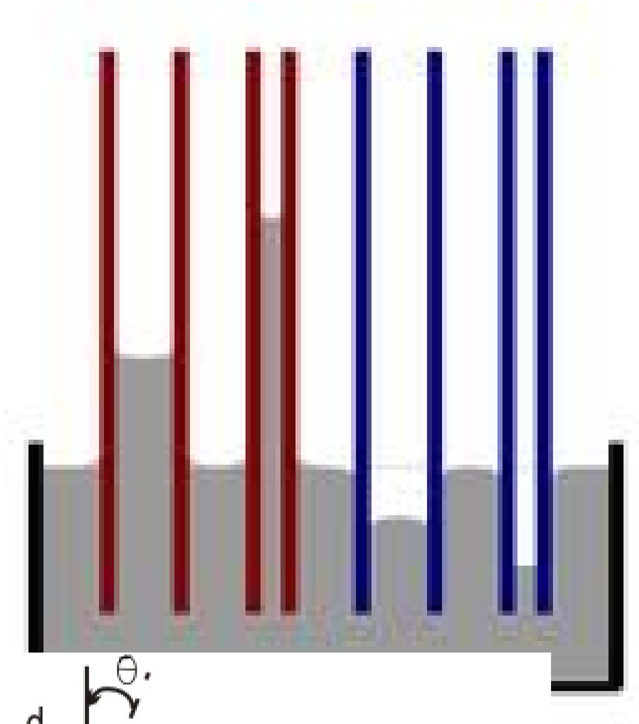
$$p = p_{\infty} e^{\frac{-2\gamma V_m}{rRT}}$$



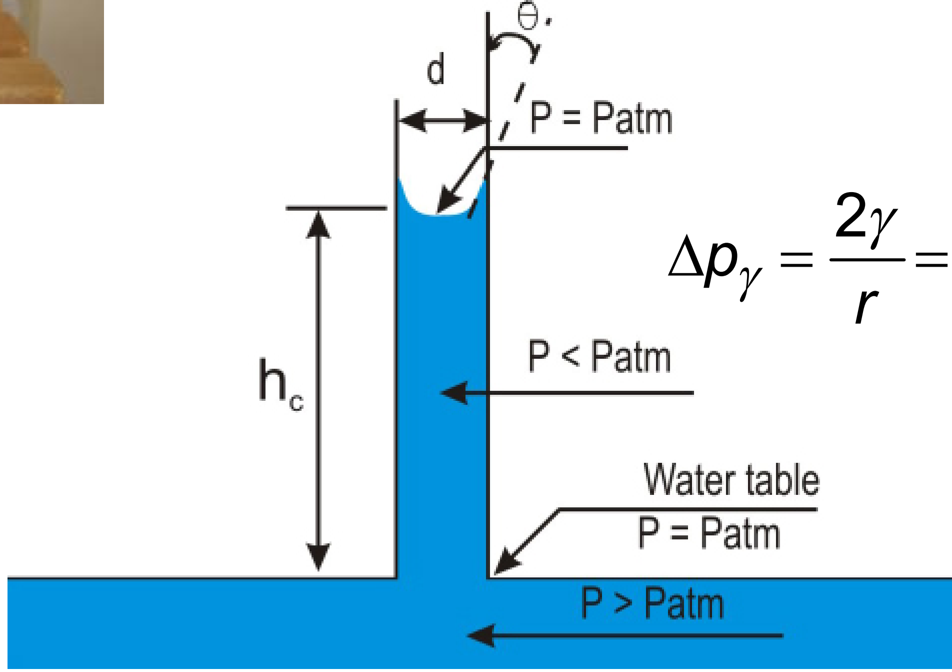


2. Capillary action



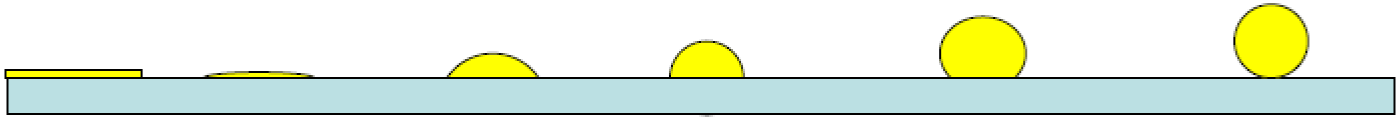


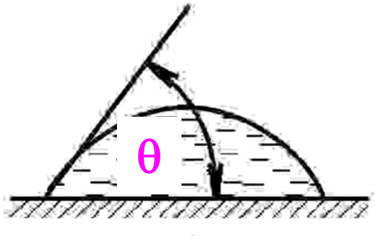
θ contact angle



$$\Delta p_\gamma = \frac{2\gamma}{r} = h\rho g$$

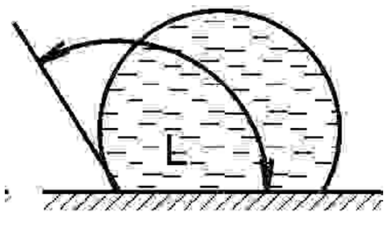
3, Contact wetting





θ contact angle

$\gamma_{SG} = \gamma_{SL} + \gamma_{LG} \cos\theta$ Young equation



Complete wetting $\theta = 0°$

hydrophilic/hydrophobic surface

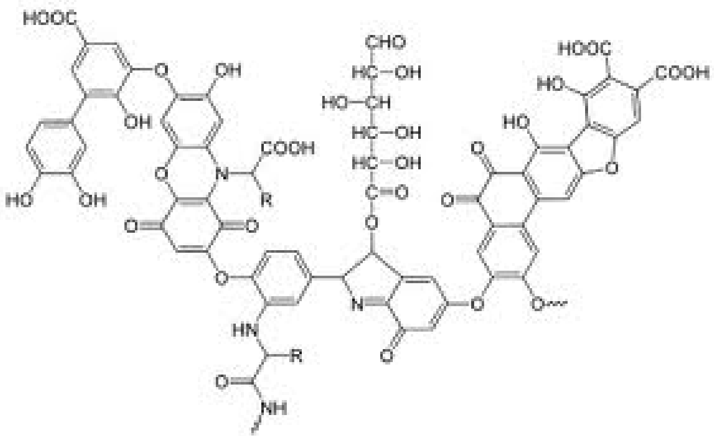
Influenced by
- quality of the surface
- surface roughness
- liquid phase (dissolved material)

Surface active materials   Amphiphilic character

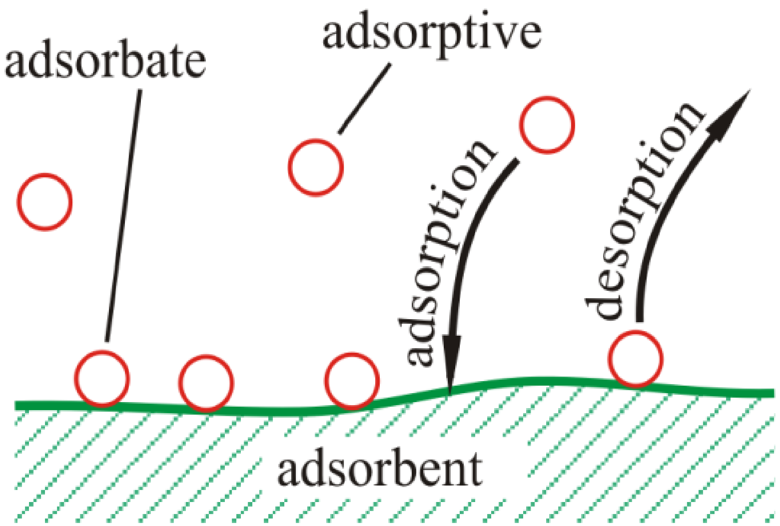
LIOPHILIC/HYDRPHOBIC   LIOPHOBICLIC/HYDRPHILLIC

BASED ON THE CHARGE OF THE HYDROPHOBIC PART

Anionic	$R\text{-}COO^- X^+$	Metal salts of carboxylic acids (soaps)
Kationic	$R\text{-}N^+(CH_3)_3 Y^-$	Quaterner ammonium salts
Nonionic	$R\text{-}Z\text{-}(CH_2\text{-}CH_2\text{-}O)_n H$	Z = O, S, NH, COO



(Ad)sorption



$$A + S \rightleftharpoons AS$$

Equilibrium process

$$\Delta G = \Delta H - T\Delta S$$