Monday 14th October 2013

OPTICALLY INVISIBLE PLASTICS:

A NEW TOOL TO DETECT WATER POLLUTANTS

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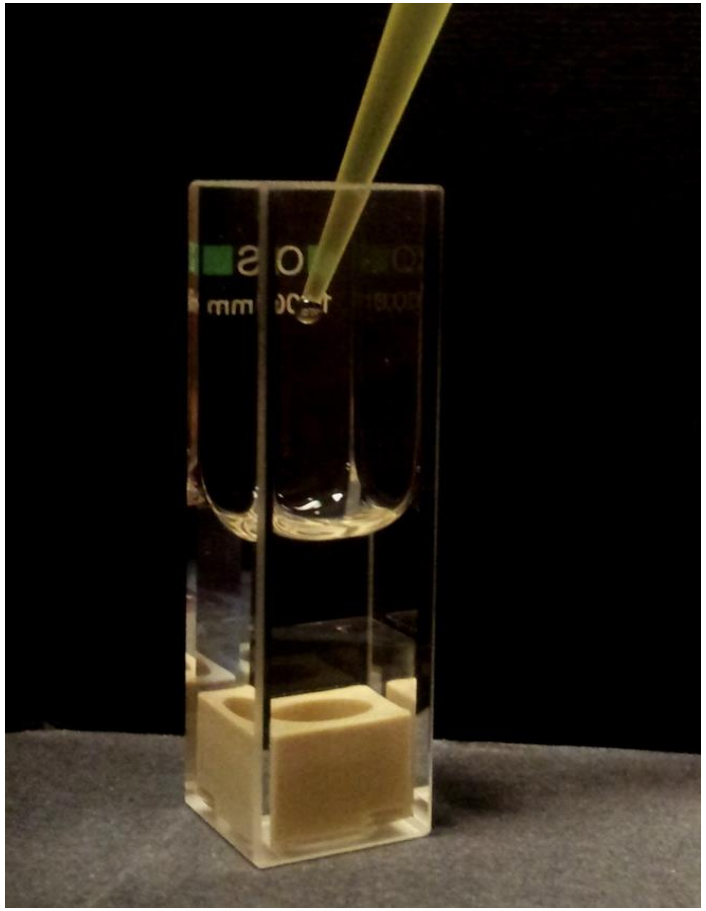
What does optically invisible mean?



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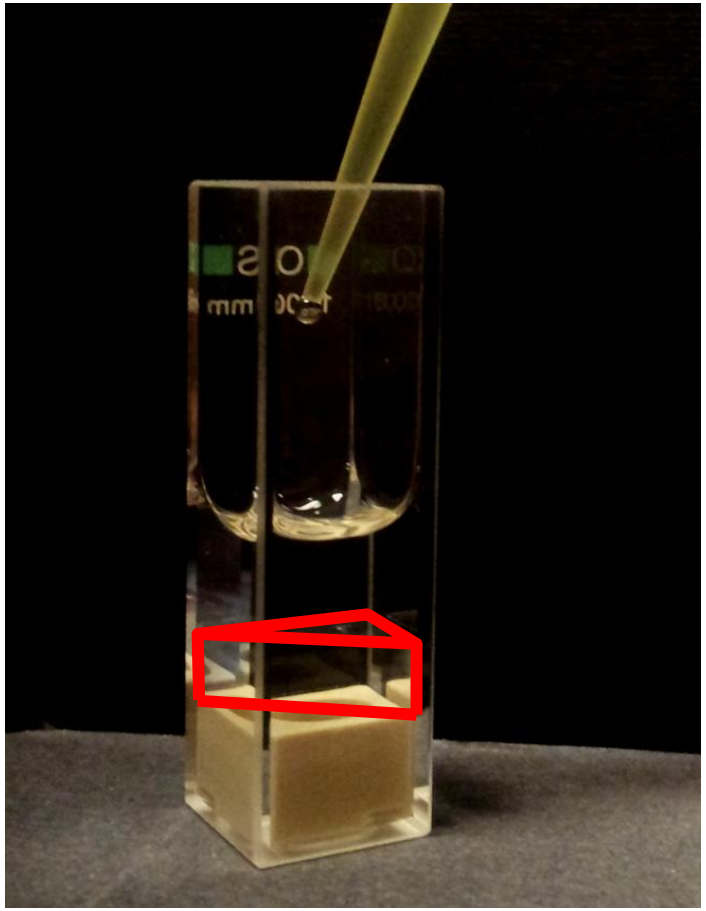


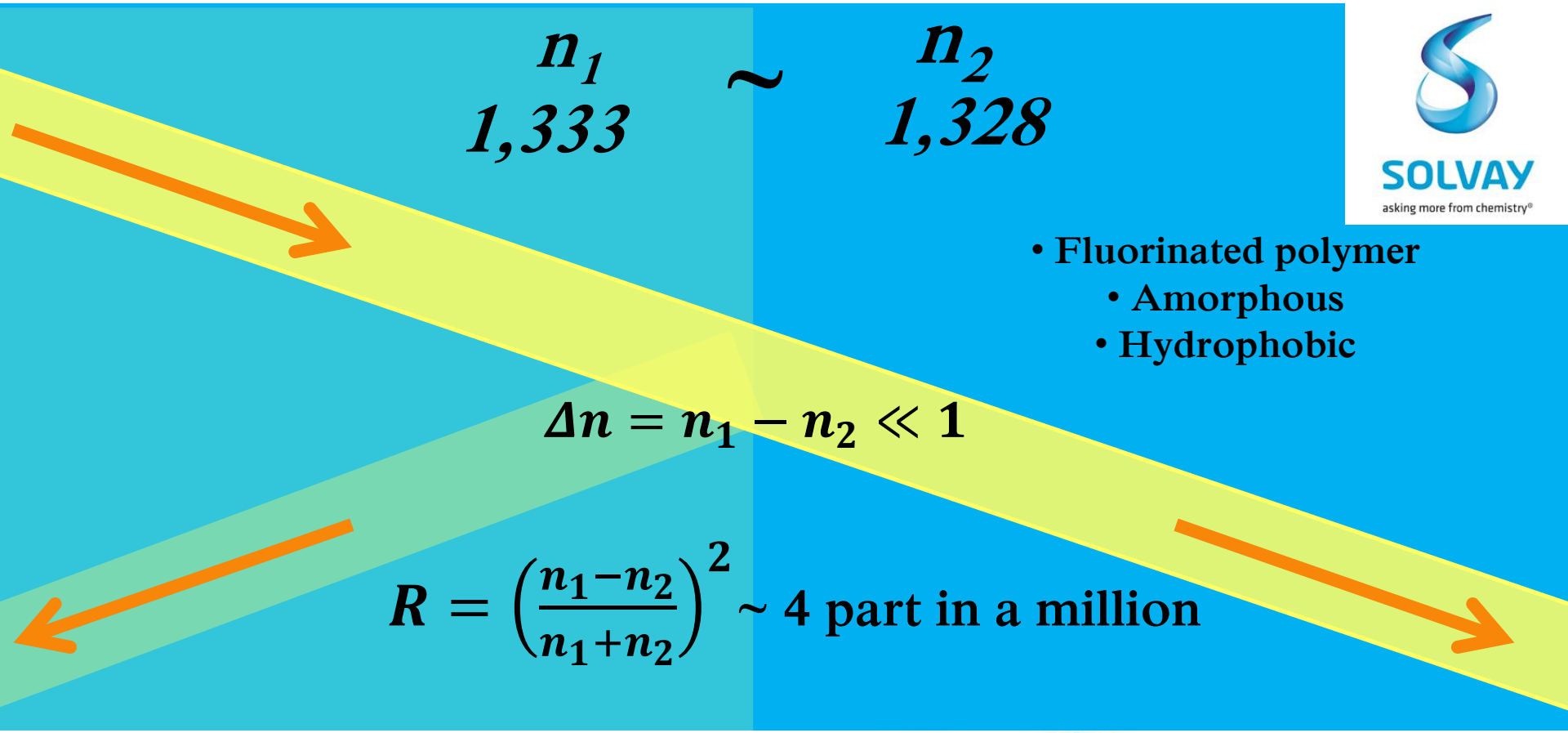
Basic Principle & Material

Light passing through two media having nearly **equal refractive indices**

water ***Hyflon AD ®***

n_1 ~ n_2

1,333 ~ 1,328



SOLVAY

asking more from chemistry®

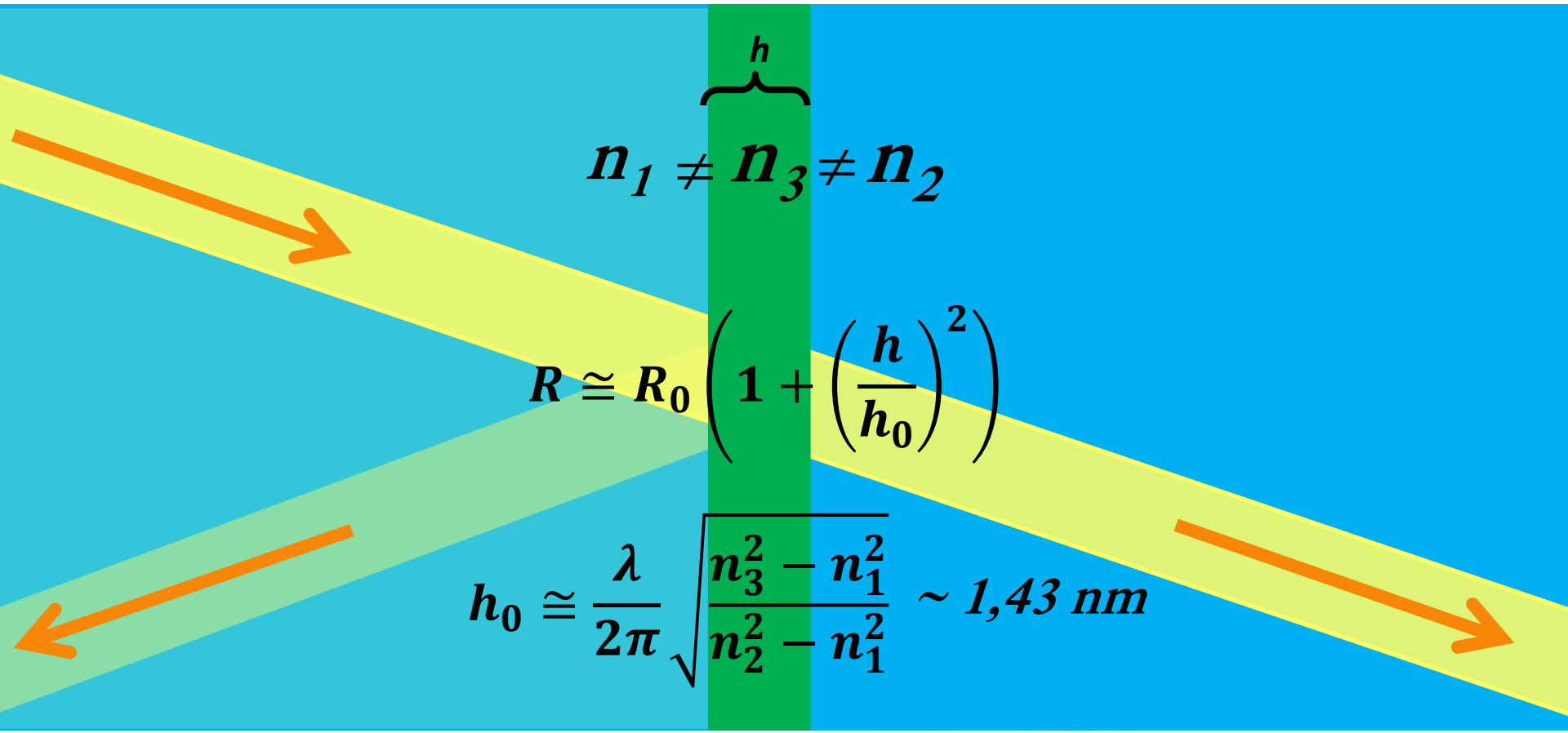
- **Fluorinated polymer**
- **Amorphous**
- **Hydrophobic**

$$\Delta n = n_1 - n_2 \ll 1$$

$$R = \left(\frac{n_1 - n_2}{n_1 + n_2}\right)^2 \sim 4 \text{ part in a million}$$

Basic Principle

If there is **a thin film** between the two media a small fraction is reflected



With a plastic materials we can create several different substrates!

Colloidal particles

With a plastic materials we can create several different substrates!

Close-packing structure

Colloidal particles

Thin films

With a plastic materials we can create several different substrates!

Flat surfaces

Close-packing structure

Colloidal particles

Random porous media

Thin films

With a plastic materials we can create several different substrates!

Flat surfaces

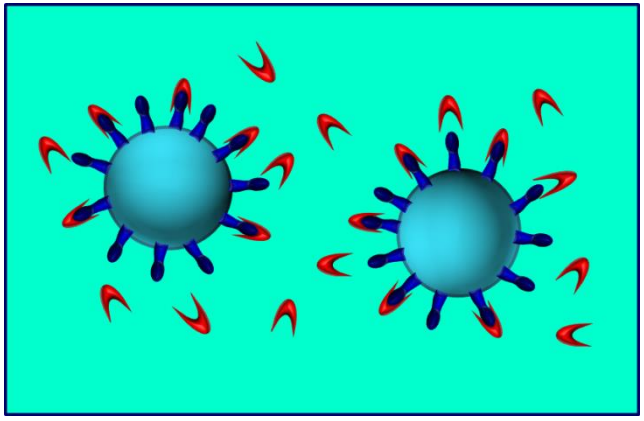
Close-packing structure

Regular lattice structure

Past years: functionalized surfaces

Phantom Nano Particles
to probe molecular interactions [1]

Scattered light increase with bonded molecules



(1) D. Prosperi et al. small 2006, 2, No. 8-9, 1060 – 1067

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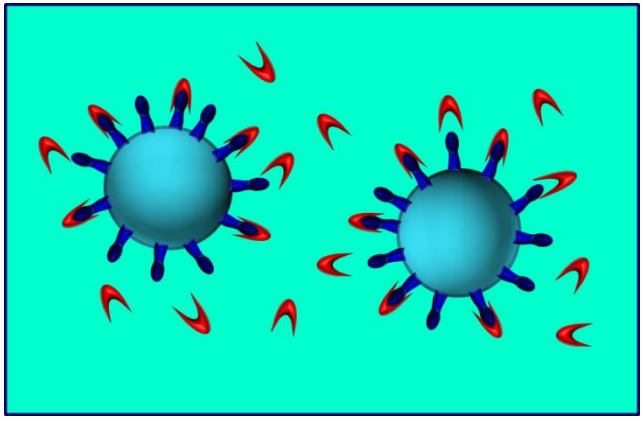
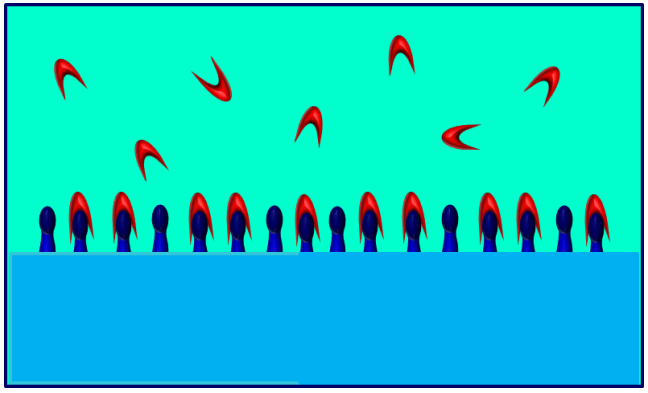


Reflective Phantom Interface

label-free biodetection [2]

Reflected light increase with bonded molecules

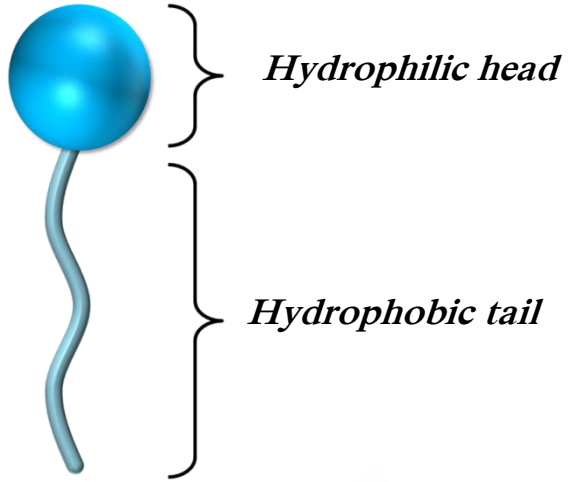


(1) D. Prosperi et al. small 2006, 2, No. 8-9, 1060 – 1067

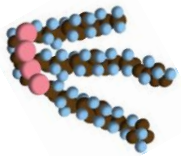
(2) F. Giavazzi et al. PNAS 2013 vol. 110 no. 23 9350-9355

Molecules *that spontaneously adsorb on the* ***bare surfaces***

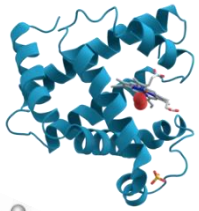
- Surfactants



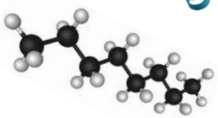
- Lipids (oils)



- Biomolecules (proteins)



- Paraffins (hexane)



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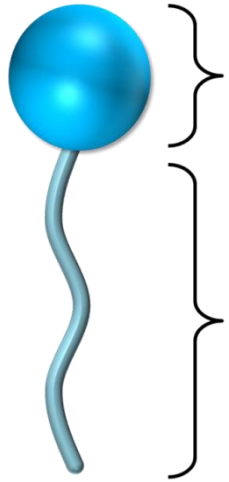

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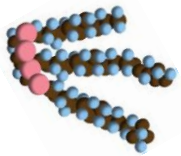

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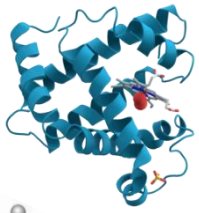

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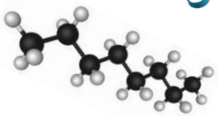
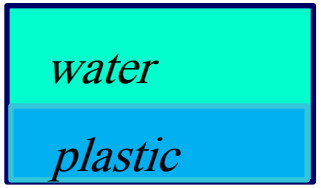
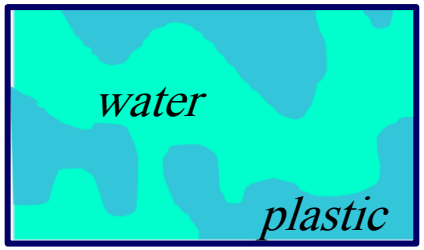


- *Flat surfaces:*

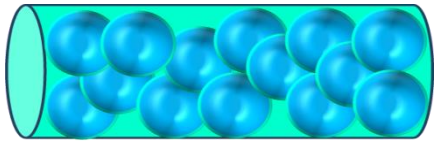
RPI approach



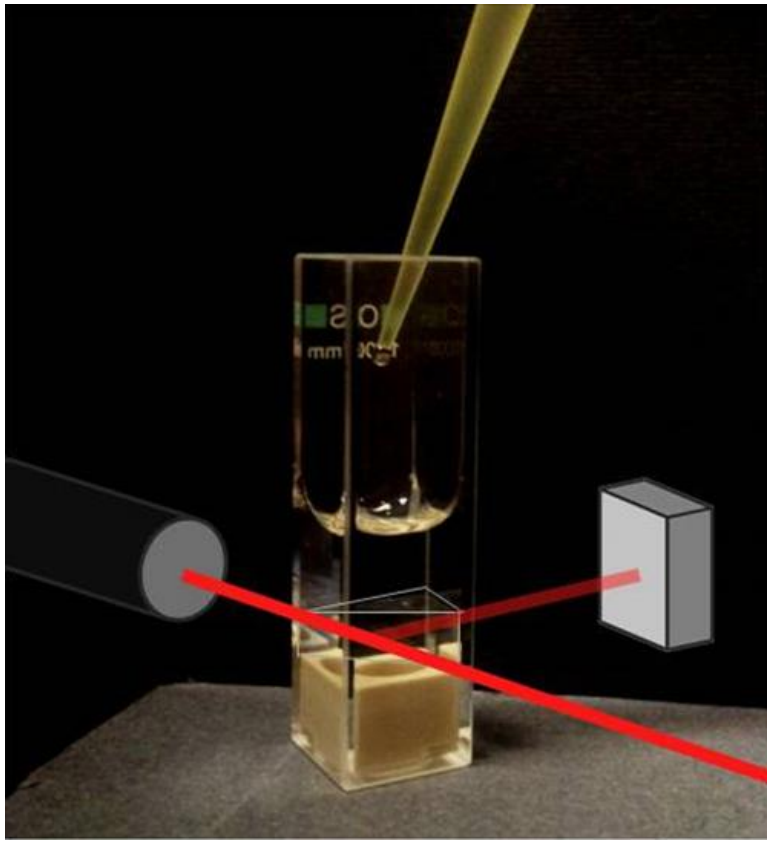
- *Micro-porous membranes*



-Chromatography columns



How Reflective Phantom Interface works



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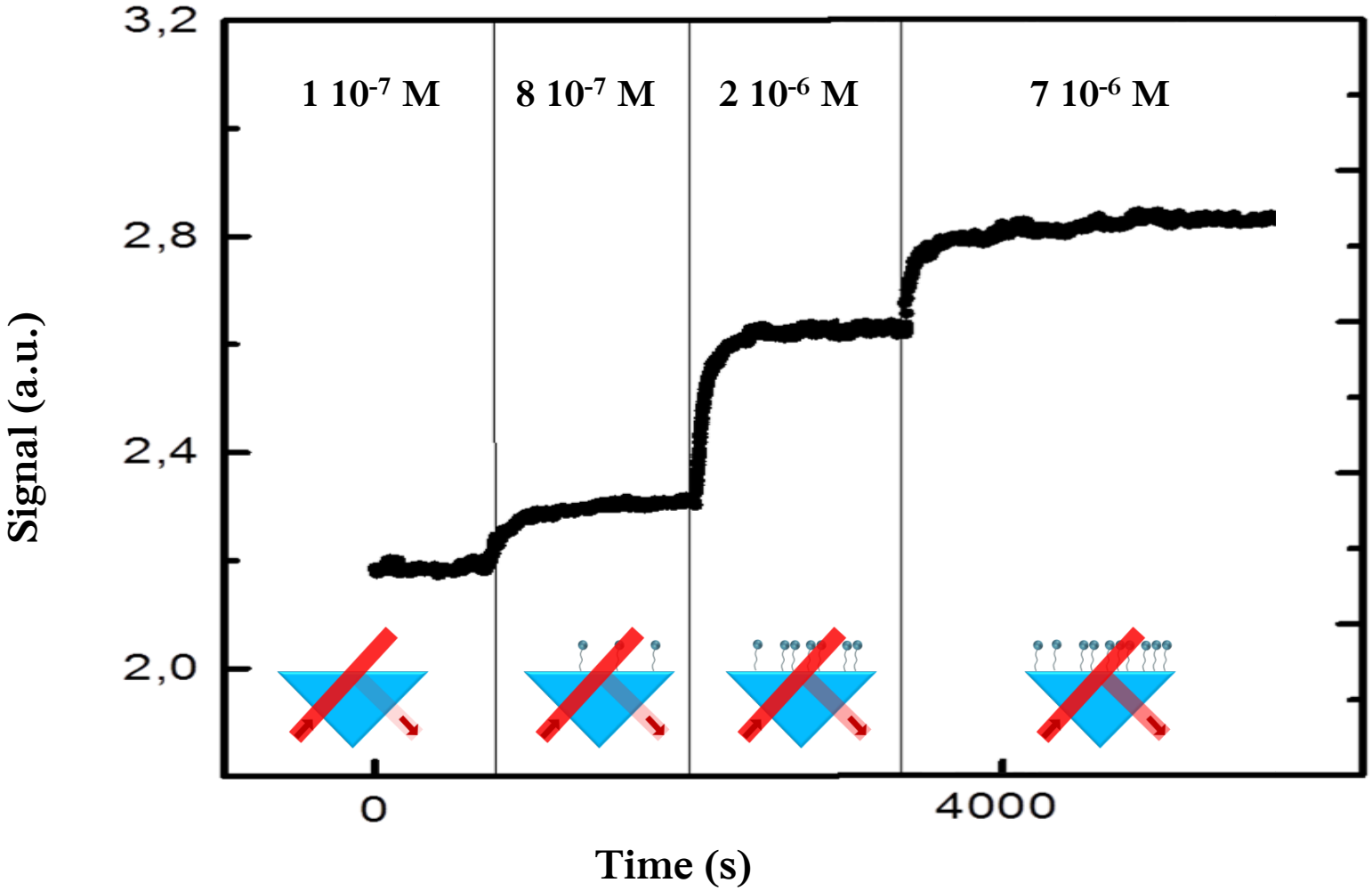
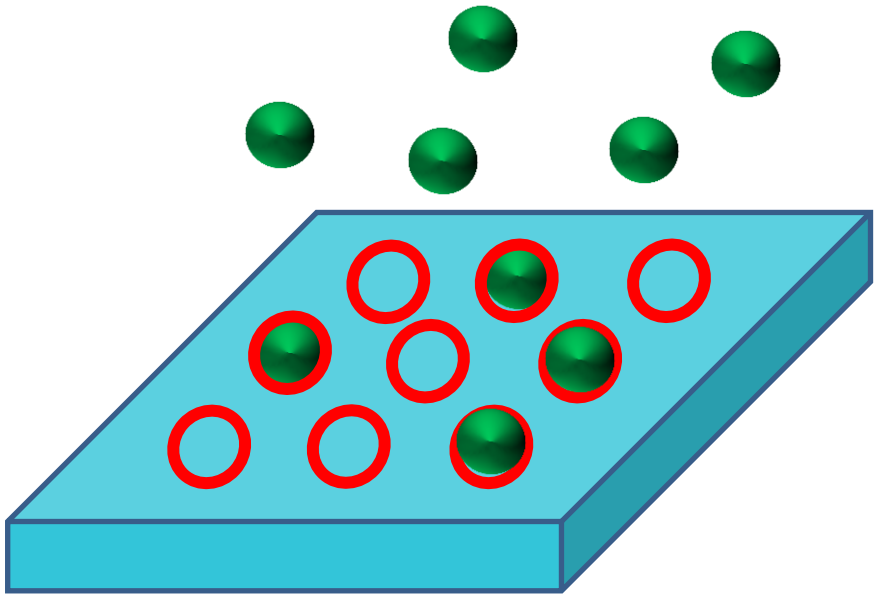


Adsorption process



solution

k_{on} x [●] x [○] ⇓ ⇑ k_{off} x [●]

surface

$$\frac{d\phi}{dt} = k_{on}c(1-\phi) - k_{off}\phi$$

is constant

Affinity constant $K_d = \frac{k_{off}}{k_{on}}$

Adsorption is easy and follows ideal-Langmuir behavior

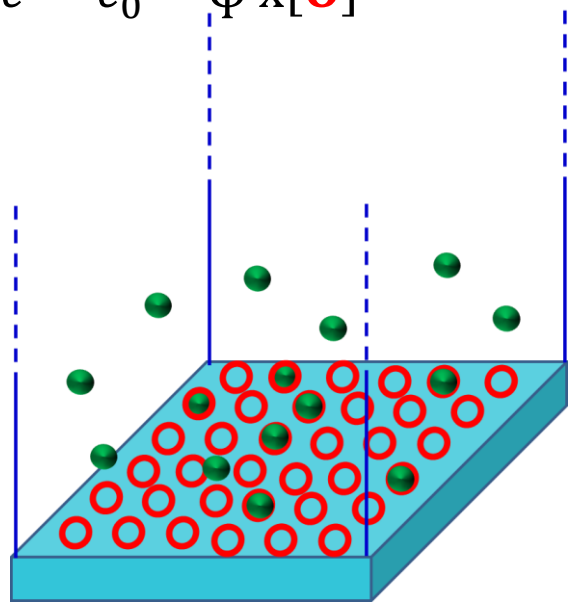
Some complications…

$$\frac{d\phi}{dt} = k_{on}c(1-\phi) - k_{off}\phi$$

Concentration could changes because of:

High number of binding sites

$c = c_0 - \phi$ x[**O**]



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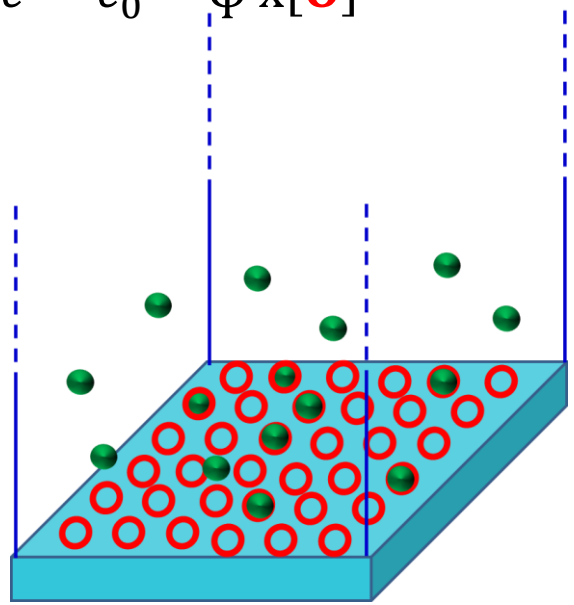
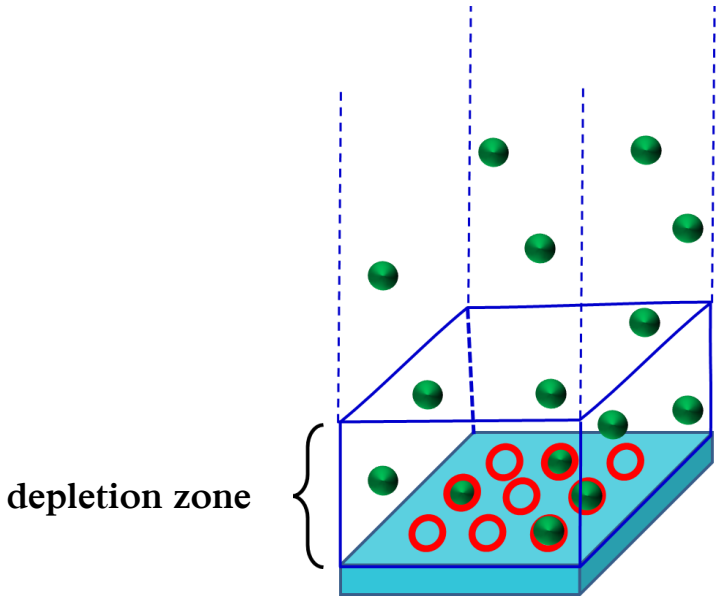
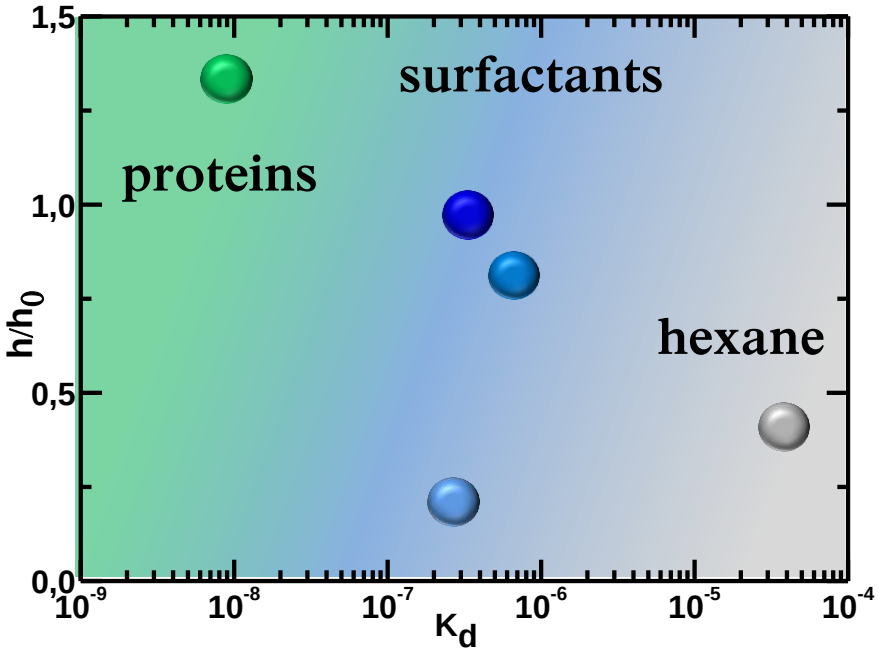


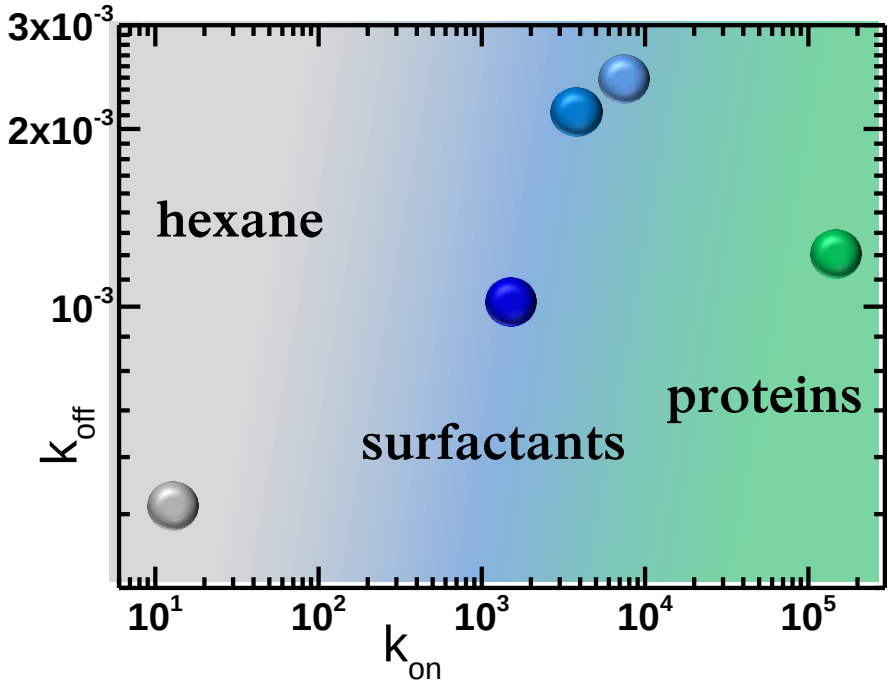
Formation of a depletion zone with different concentration



Equilibrium



Kinetics



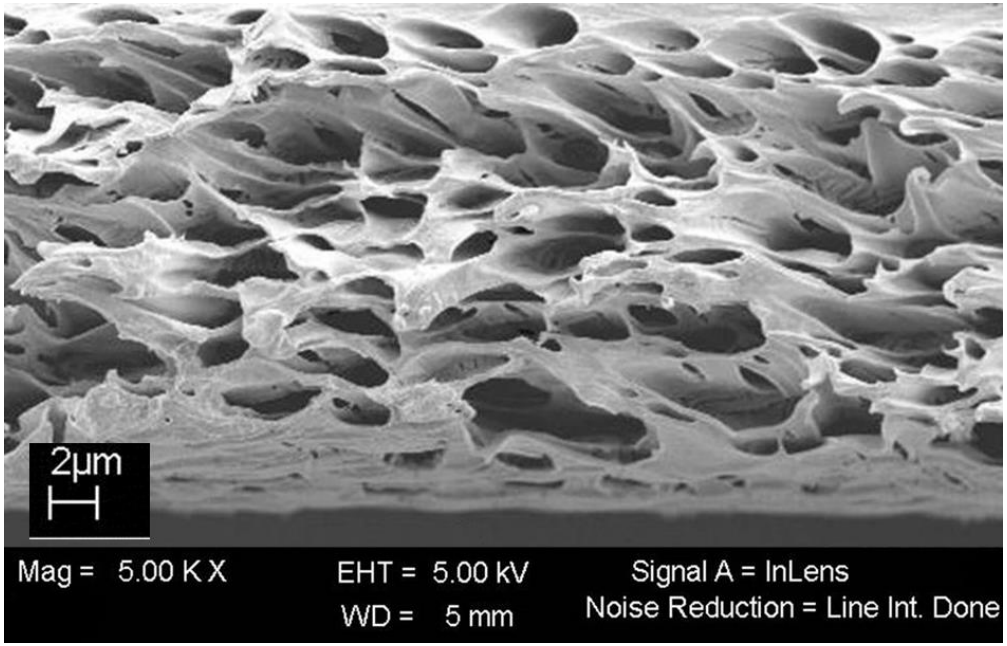
Different molecules have different kinetics and equilibrium behaviors

SOLVAY

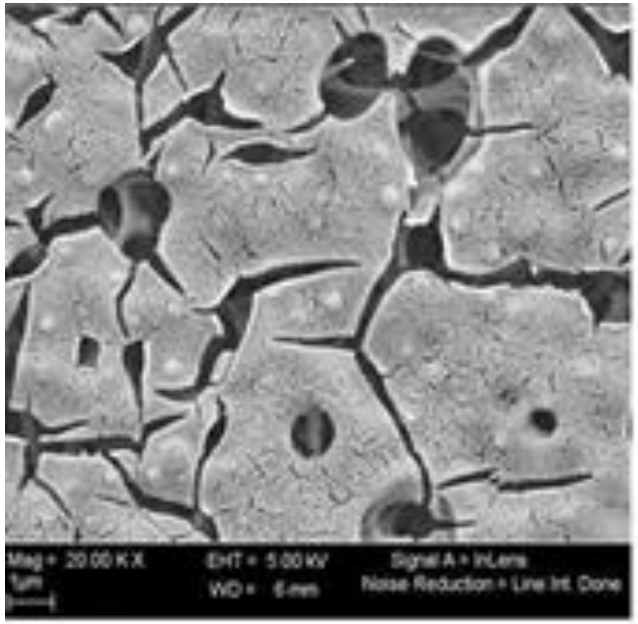
asking more from chemistry®

Micro-porous membranes

Section



Surface



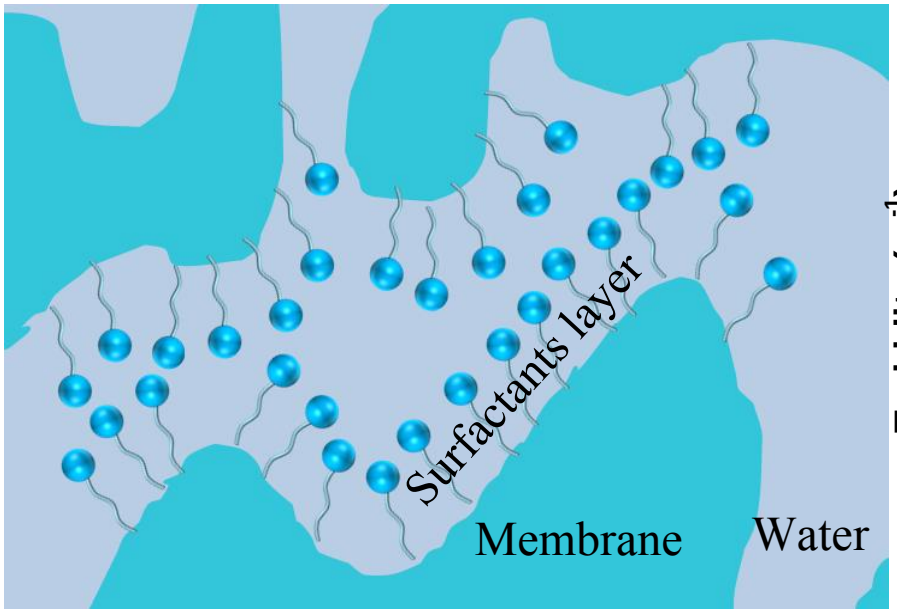
Optically invisible porous membrane

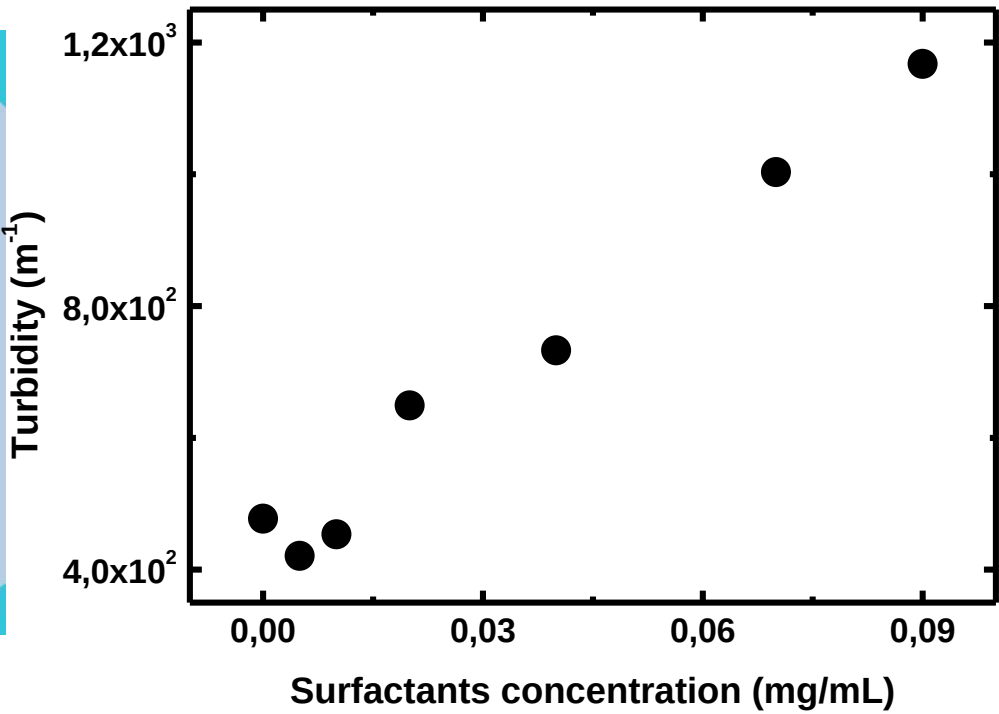
Dry

Wet

First tests for surfactants detection

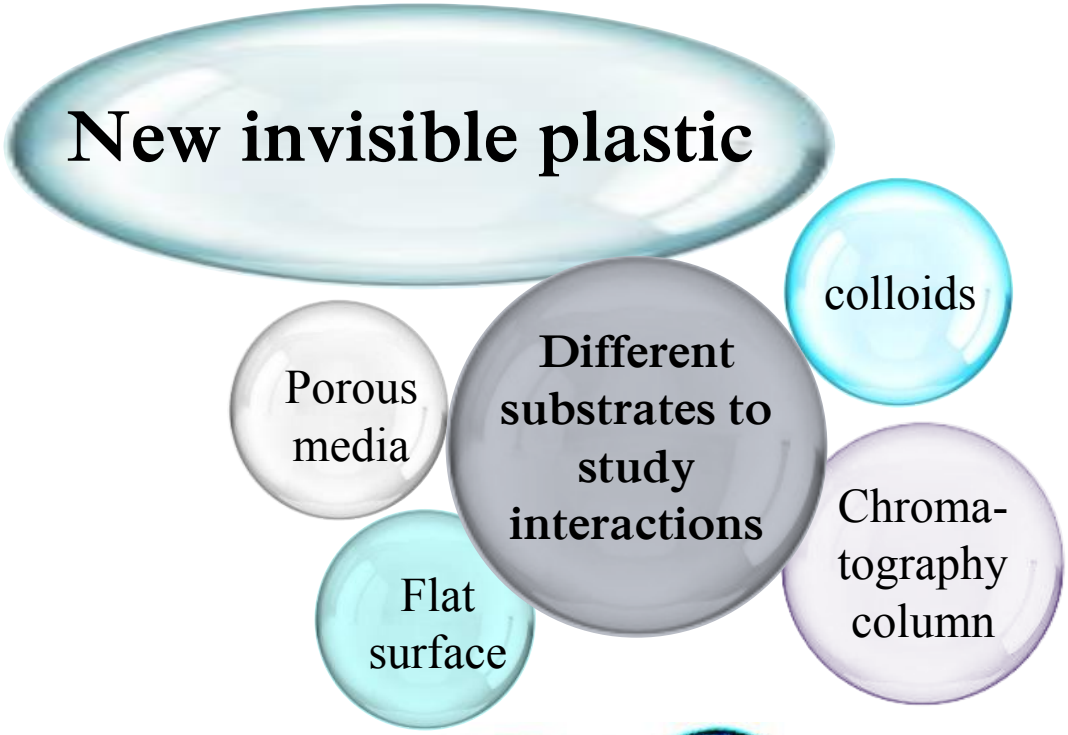
What happens inside the membrane



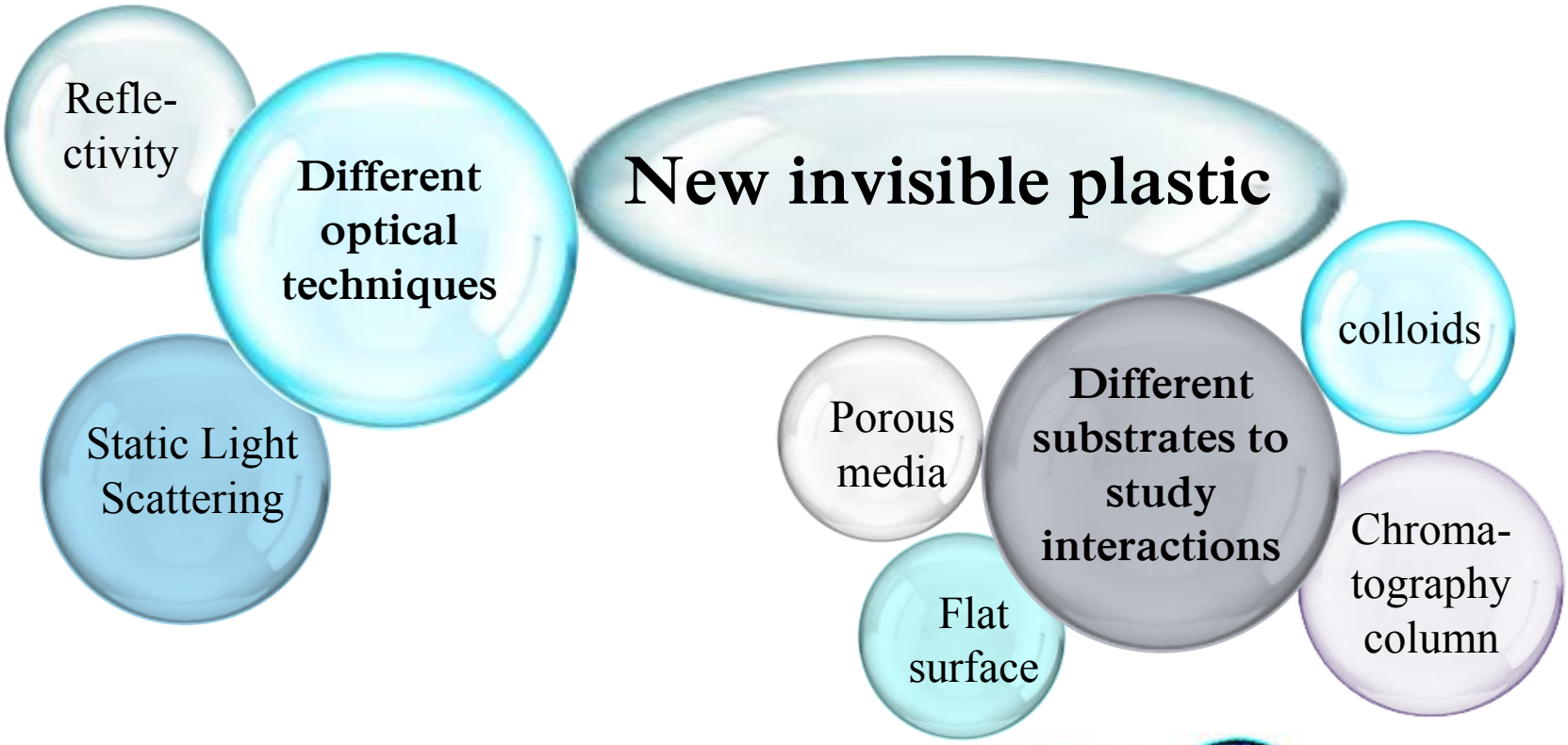


much work needs to be done

CONCLUSIONS



CONCLUSIONS



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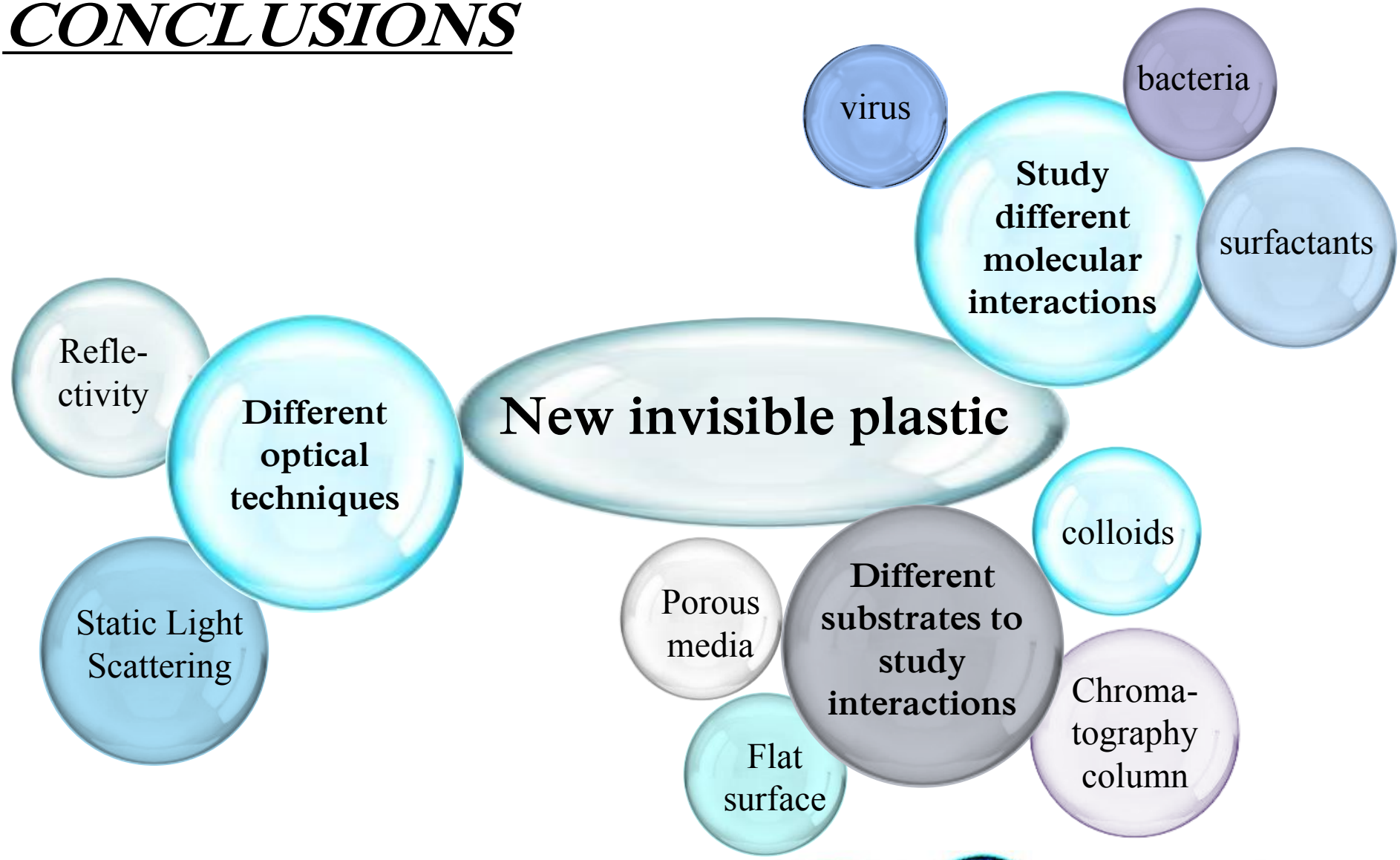
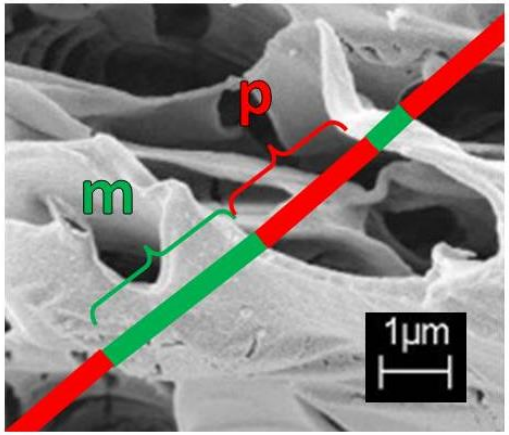
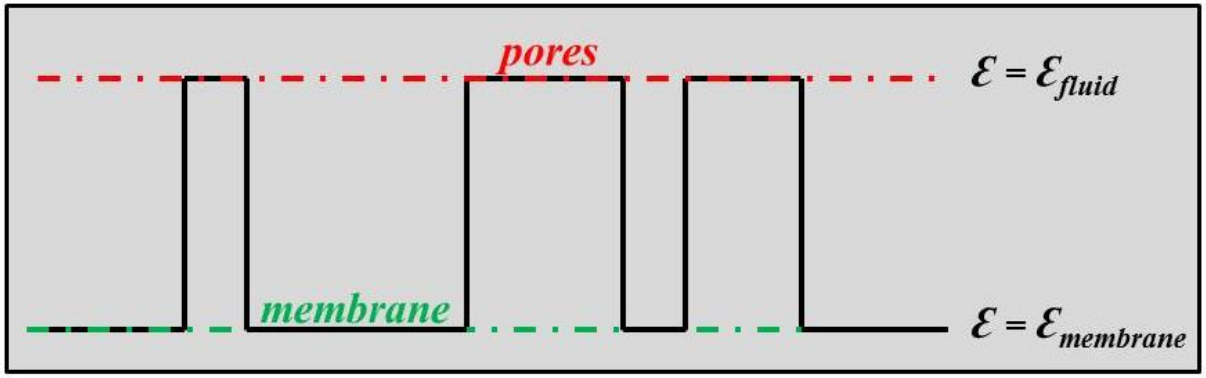



THANK YOU!

Theoretical model

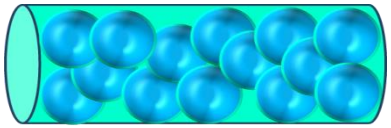
based on the fluctuation of the dielectric function inside the material



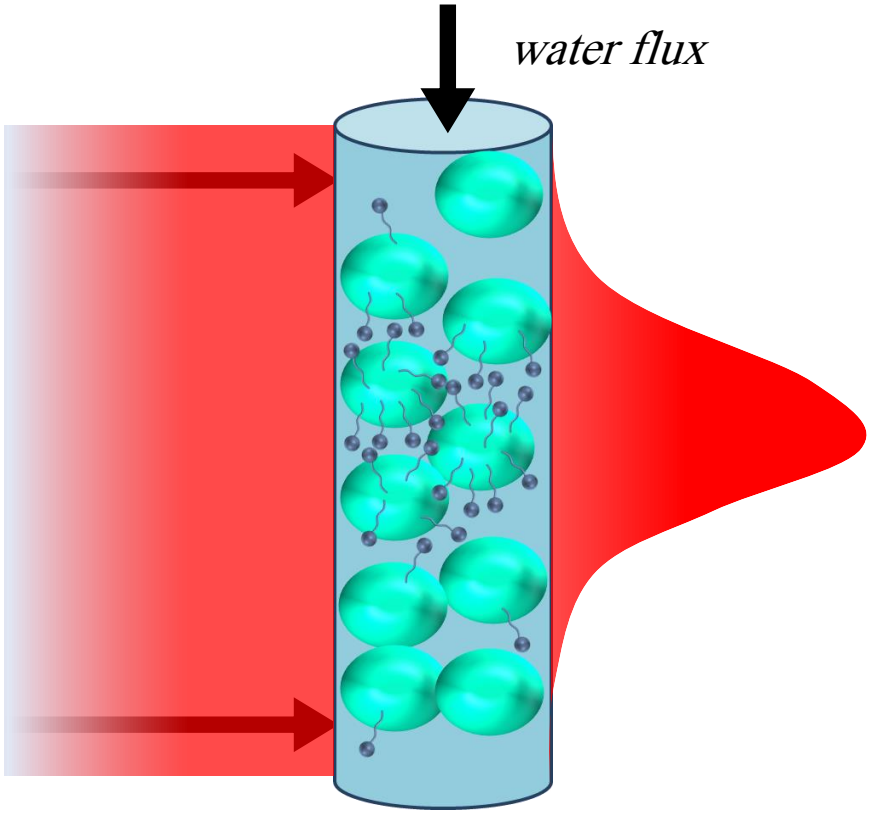


We are able to quantify membrane turbidity

$$T \propto \frac{m\,p}{(m+p)^2}\left(\varepsilon_m - \varepsilon_p\right)^2$$



Chromatography columns



Laminar light

as surfactants flow inside the column, the optical response will move

…yet to come…

Eindhoven University of Technologies

Institut Curie, Macromolecules and Microsystems in Biology and Medicine

Next Generation Biomimetic Analytical Platforms for Environmental Sensing