

Vrstvy Langmuirovy-Blodgettové

Proč LB vrstvy

- Využití v molekulární elektronice
- Snadná příprava – tedy principiálně
- Používáno cca od roku 1930

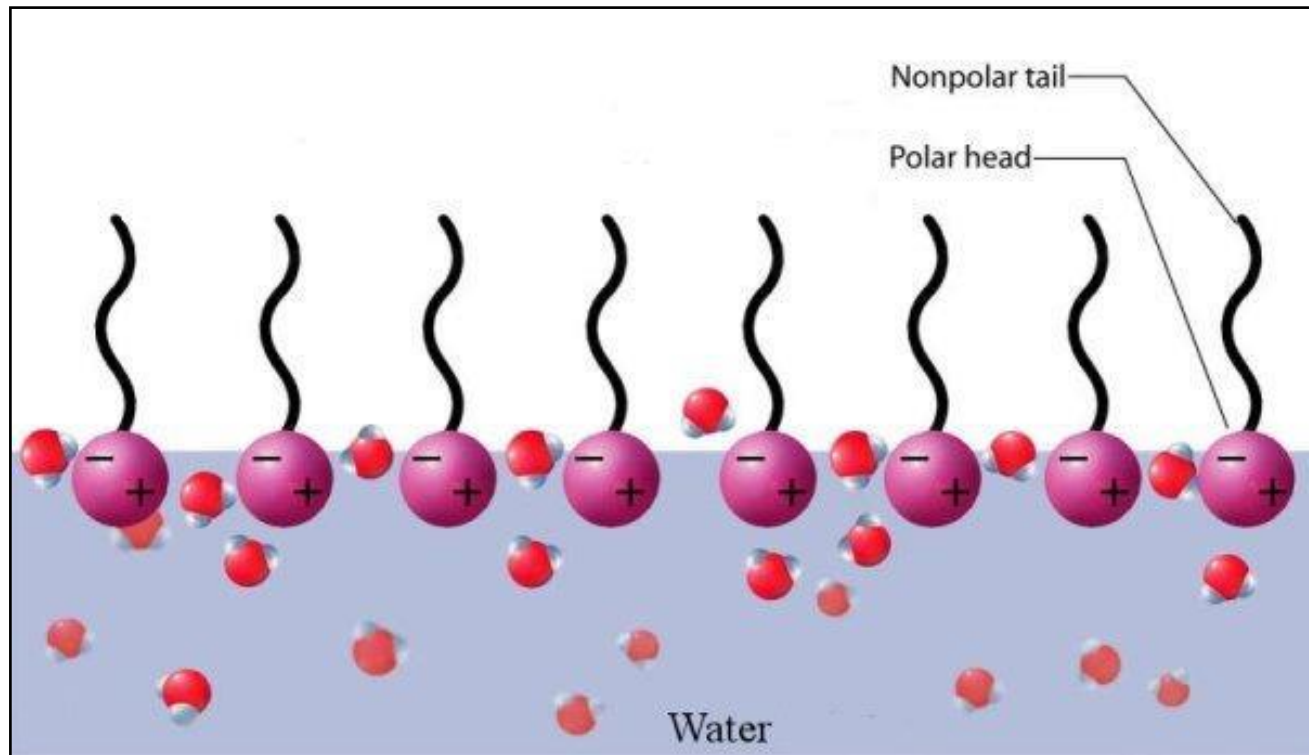
Vrstvy Langmuirovy-Blodgettové

- Vrstvy Langmuirovy-Blodgettové jsou tvořeny vrstvou molekul [surfaktantu](#) na tuhém podkladu, vytvořená přenesením nerozpustného monomolekulárního filmu ([povrchový film nerozpustné látky na kapalině](#)) z hladiny kapaliny na tuhou podložku.
- Monomolekulární film je adsorbován homogenně při každém ponoření a vynoření podložky, takže tloušťky vrstev jsou přesně udány.

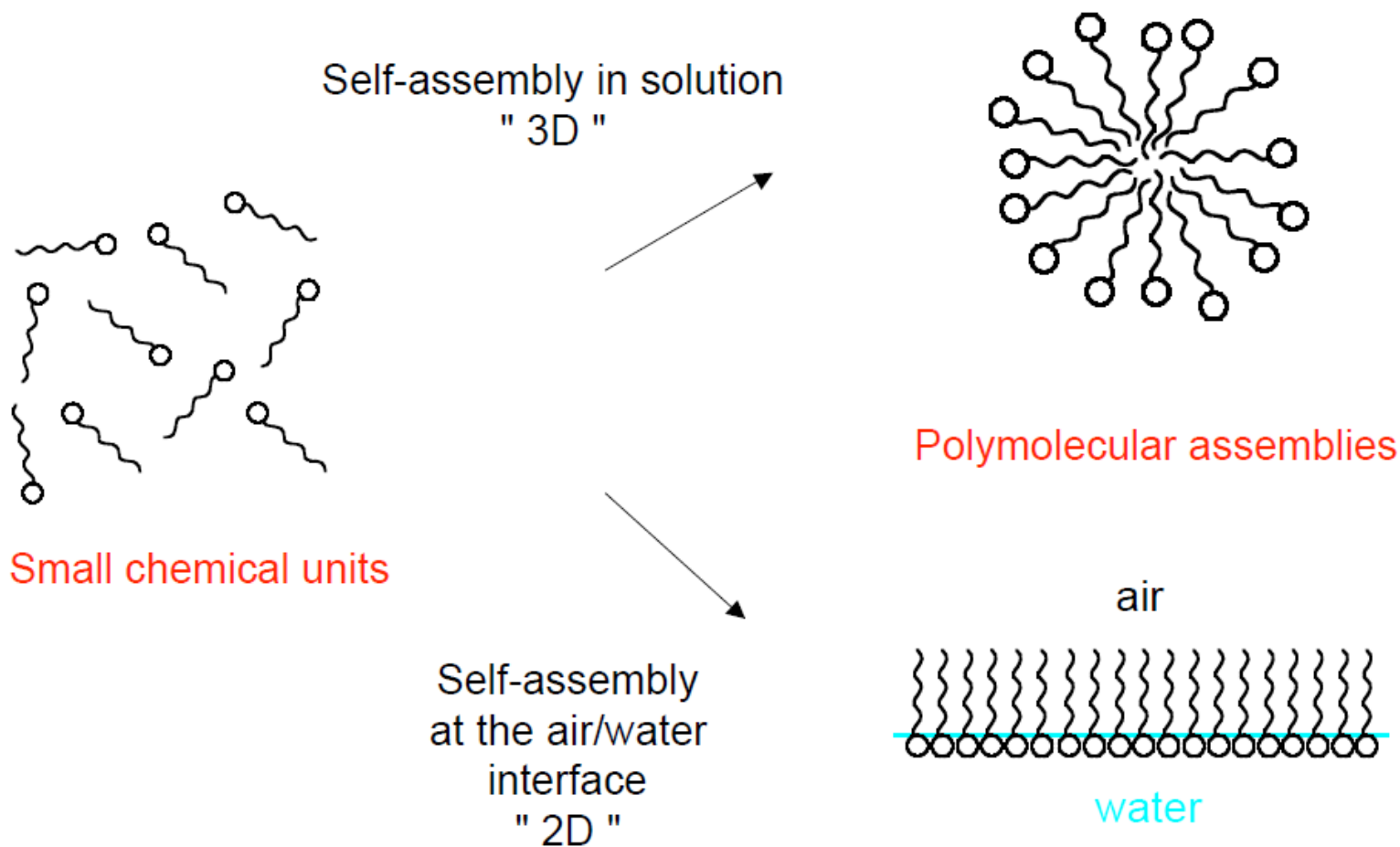
Vrstvy Langmuirovy-Blodgettové

- Tloušťka je přesná protože tloušťka každé monovrstvy je známa a celková tloušťka je součtem tlouštěk dílčích vrstev. Vrstvy jsou uspořádány vertikálně a jsou obvykle tvořeny amfifilními molekulami s hydrofilní hlavou a hydrofobním „ocáskem“.
- Vrstvy Langmuirovy-Blodgettové jsou zařazovány mezi vrstvy vykazující samouspořádání.

Princip

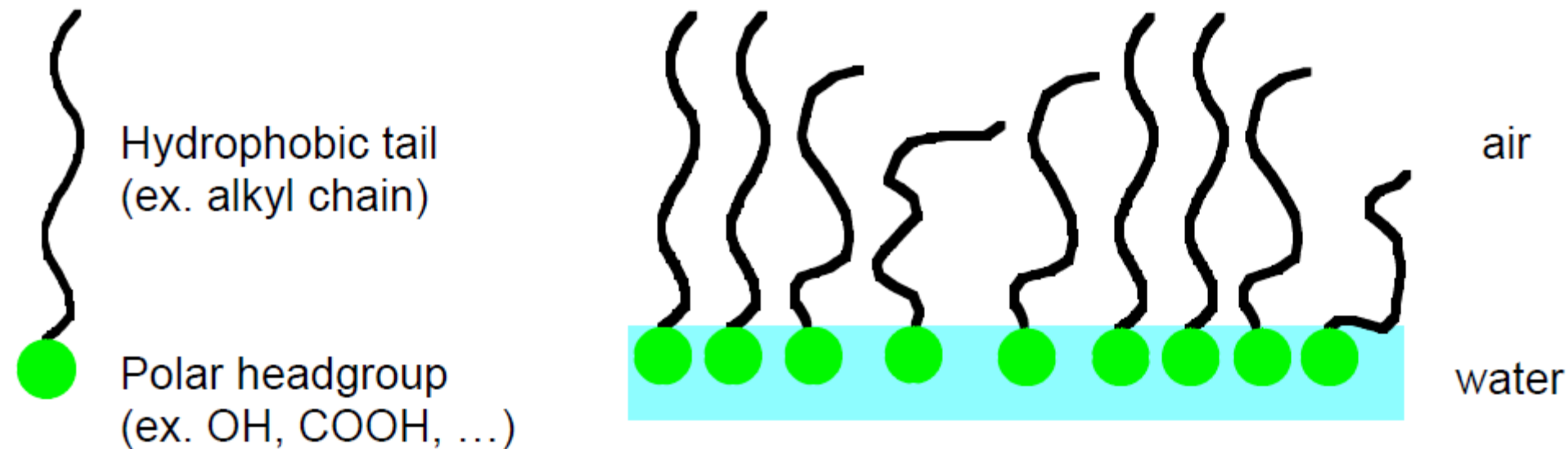


Příprava

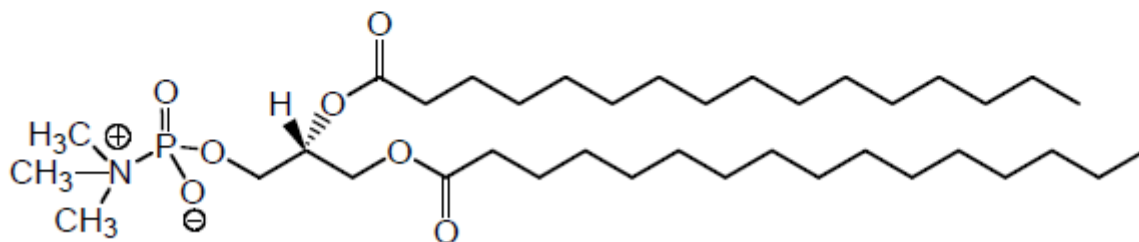
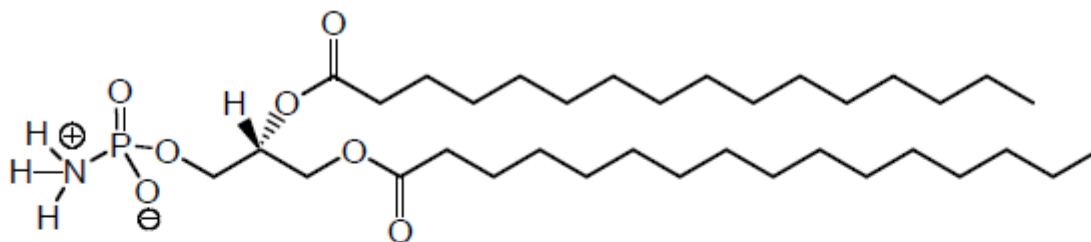
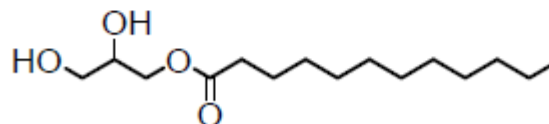
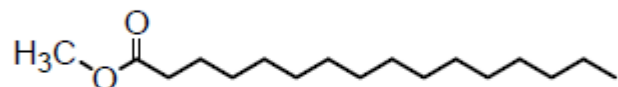
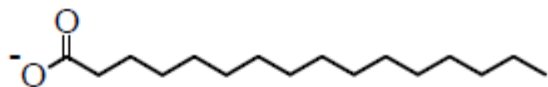


Základní stavební prvek

- surfaktanty nebo omfifile - jeden konec hydrofobní a druhý hydrofilní - zajistí orientaci molekuly na rozhraní voda - vzduch
- musí být vodou nerozpustné

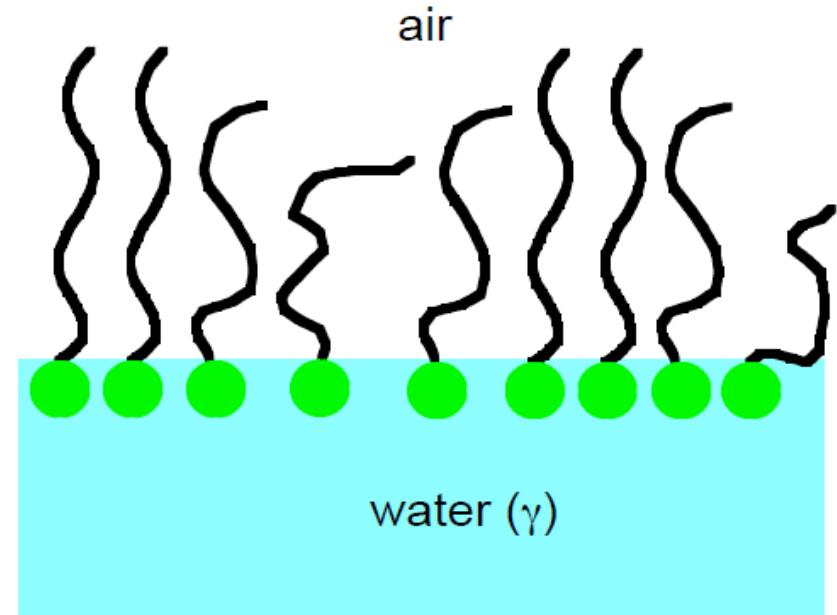
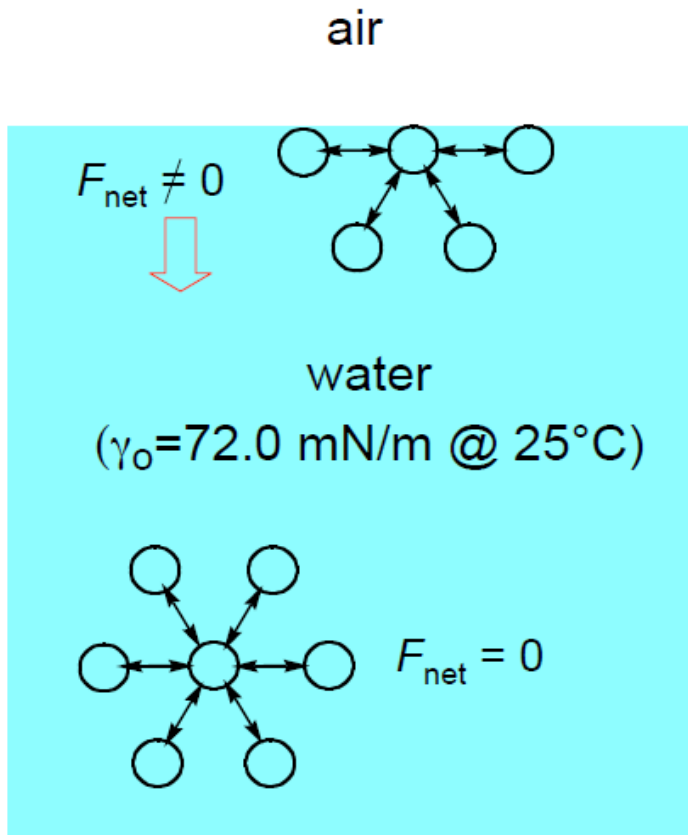


Příklady



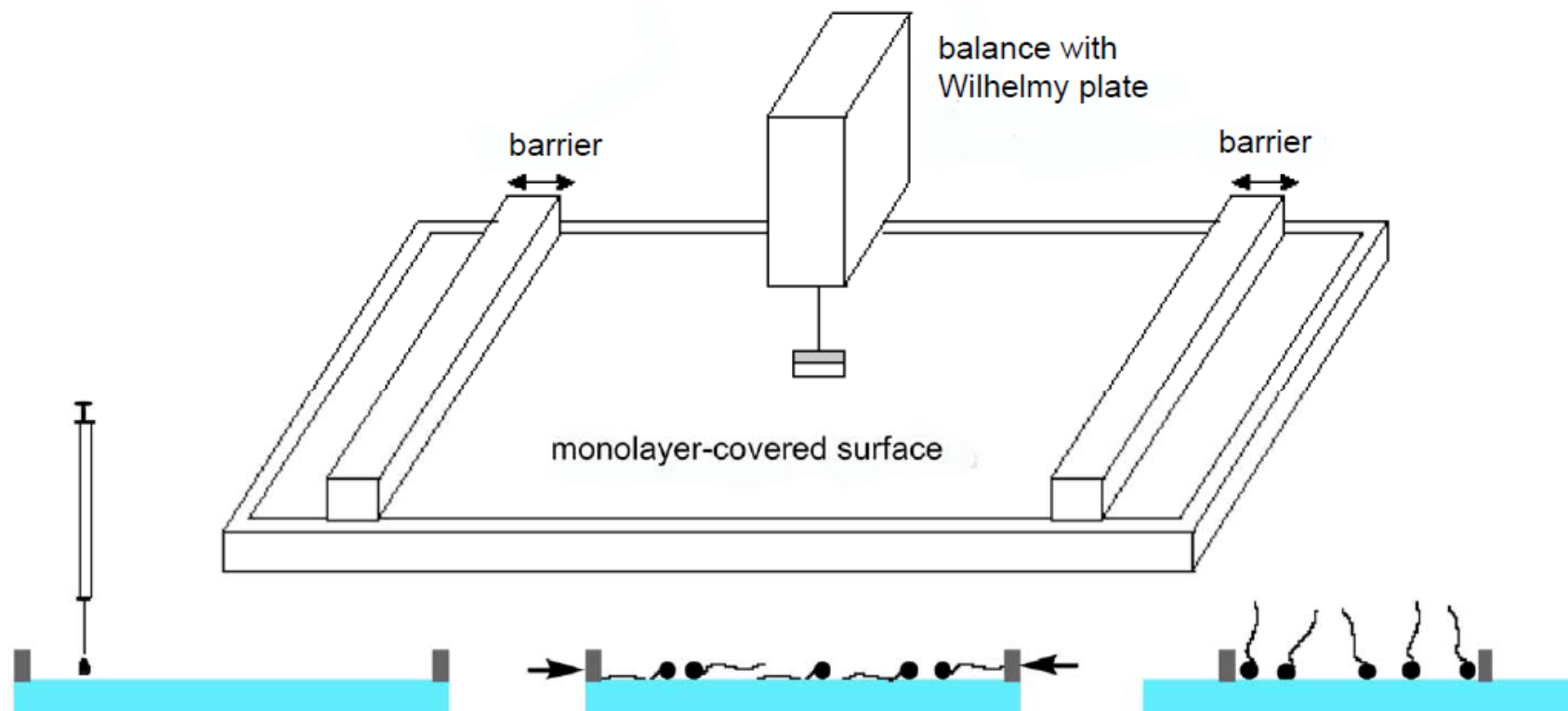
Funkce povrchového napětí

- díky nerovnováze sil na rozhraní vzniká povrchové napětí



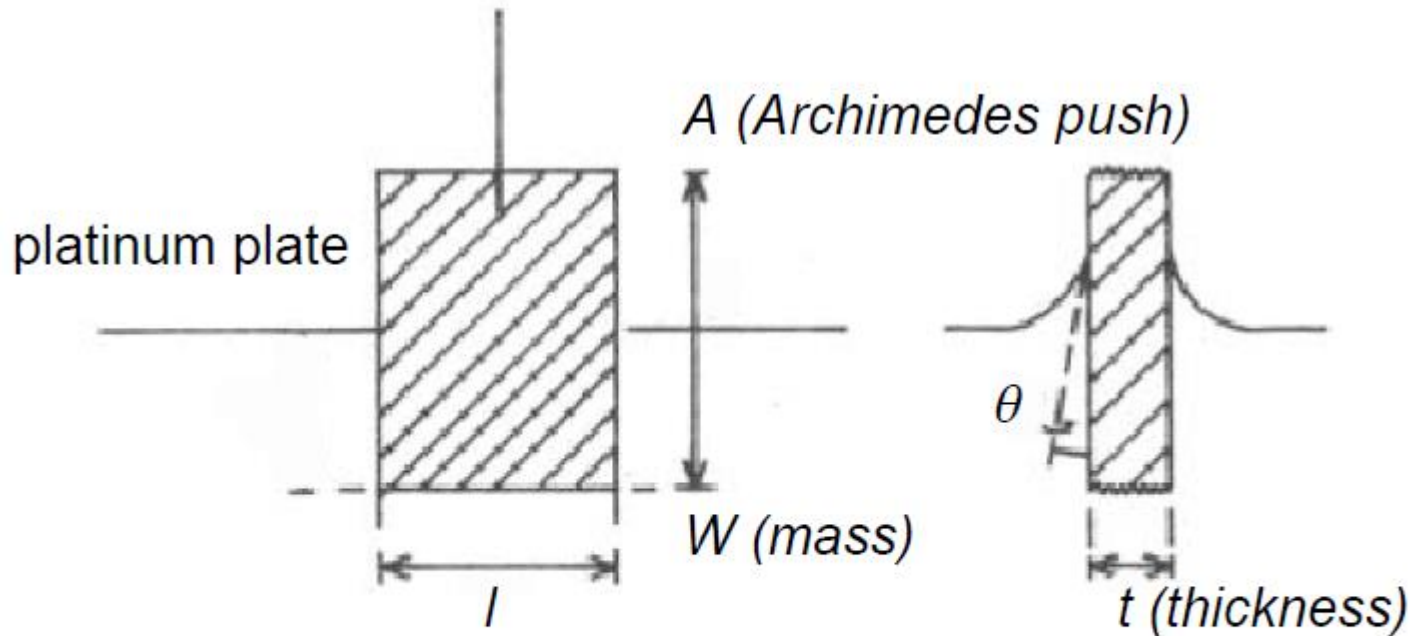
$$\text{Surface pressure } (\pi) = \gamma_o - \gamma$$

Převod plynu na pevnou látku



W. balance - měří povrchovou energii na rozhraní -
měříme během komprese

Jak funguje měření pomocí W.b.



$$F = W + 2\gamma(l + t)\cos\theta - A \quad \text{where } t \ll l$$

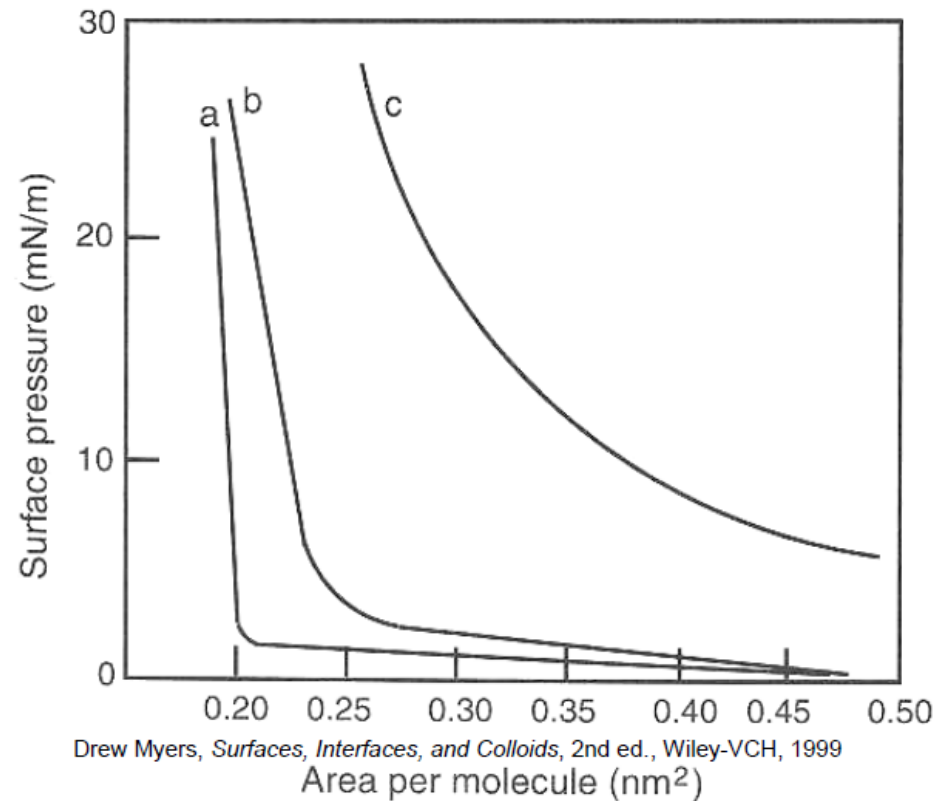
$$\text{If } \theta = 0, \cos\theta = 1 \text{ and } F = W + 2\gamma l - A$$

$$\Delta F = 2l(\gamma_{\text{solution}} - \gamma_{\text{water}}) = -2l\pi \quad \text{and} \quad \pi = -\Delta F/2l$$

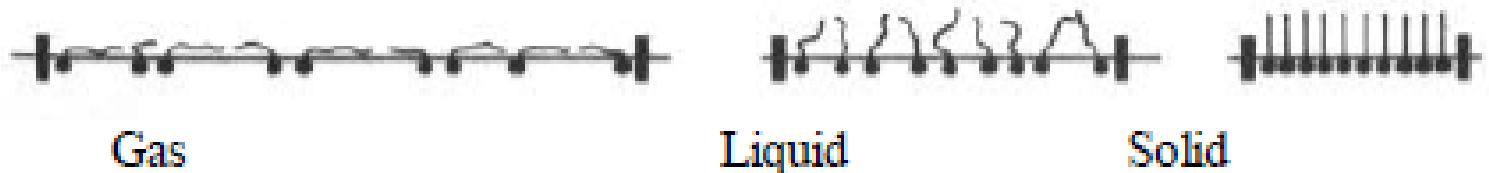
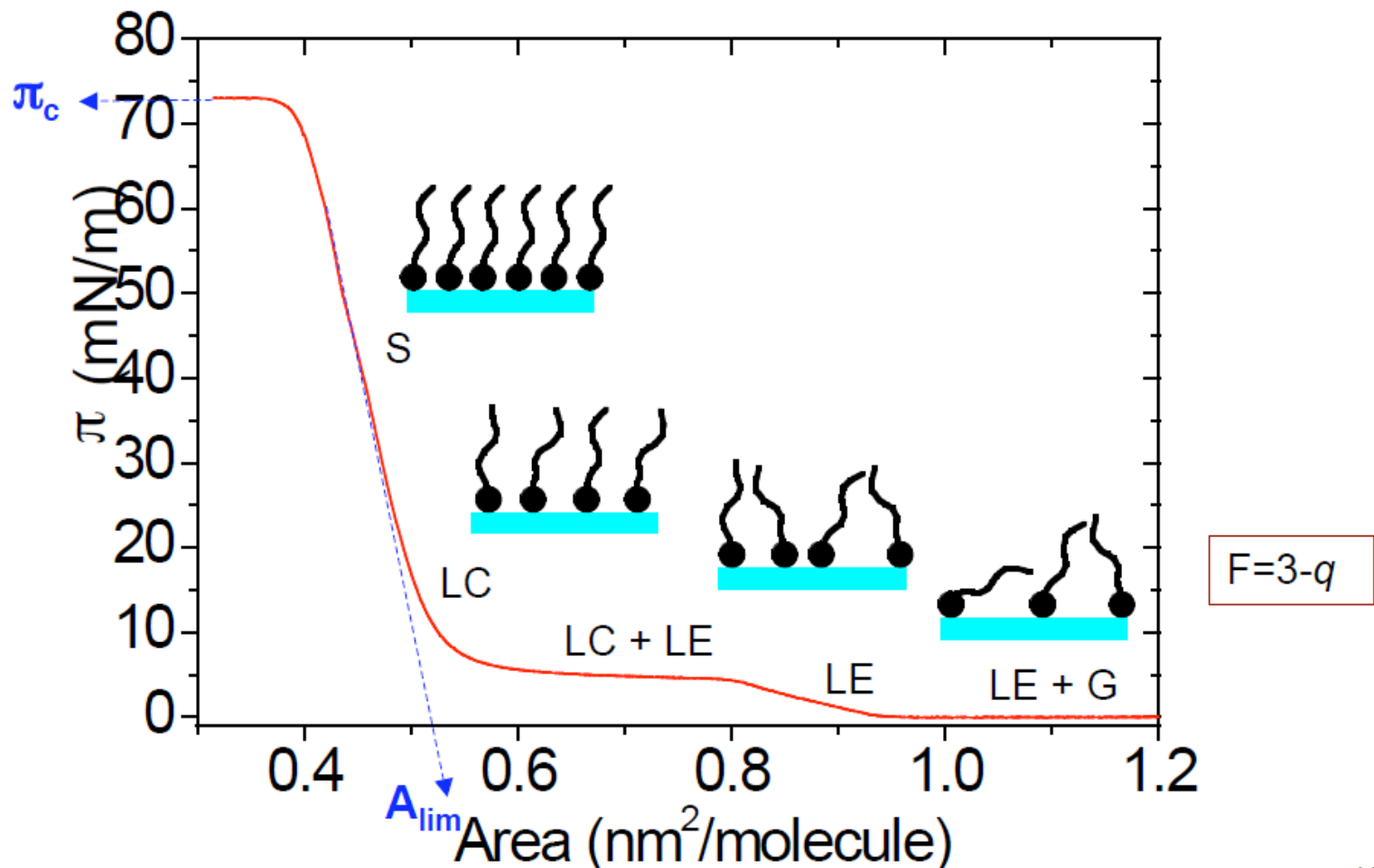
místo tenkého plátku platiny může být použito sklo, slída, atd.

Fyzikální chování

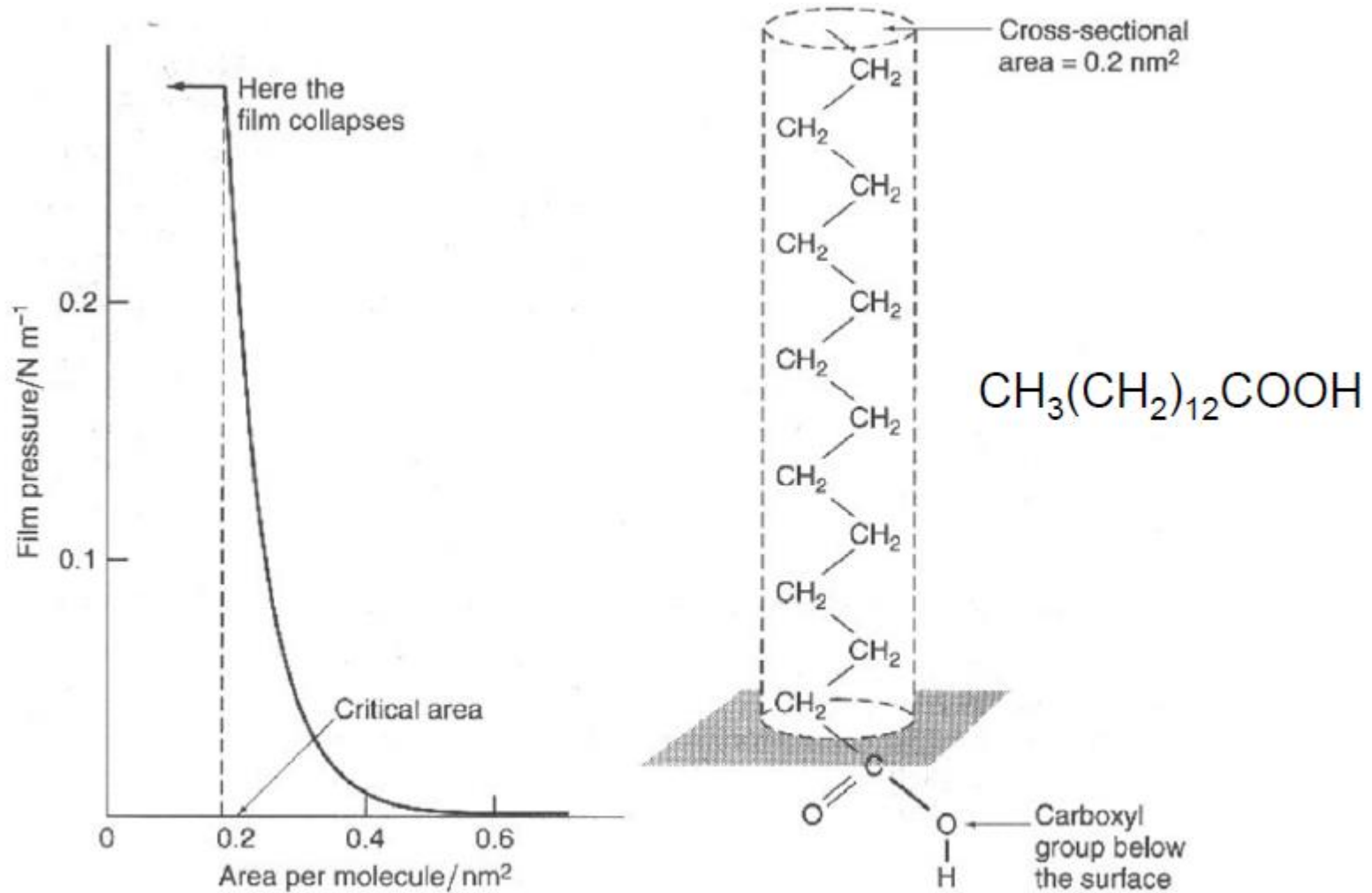
- - nestlačitelná vrstva
- b - částečně stlačitelná
- c - „porézní“ snadno stlačitelná



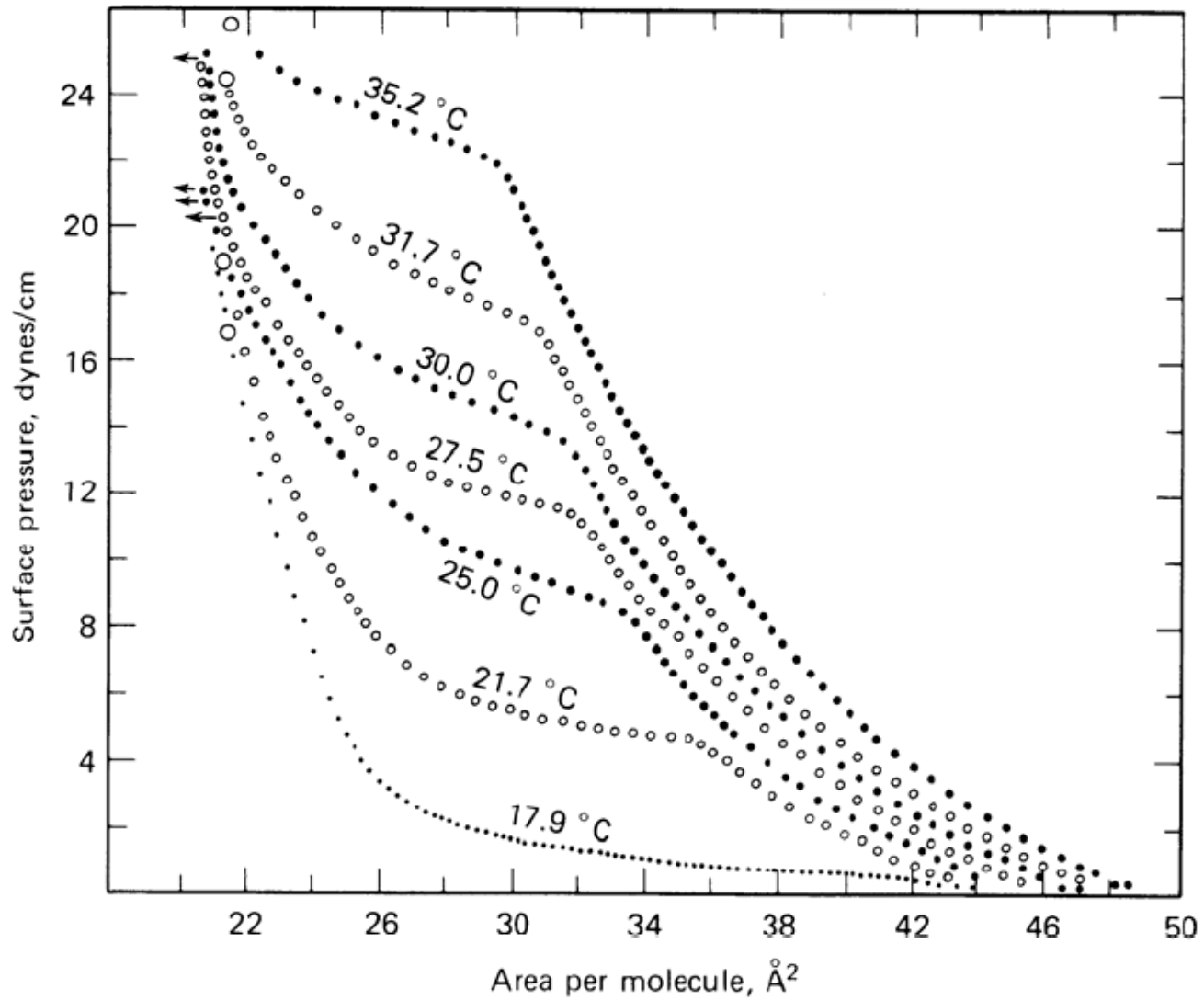
Izoterma - povrchové n./plocha



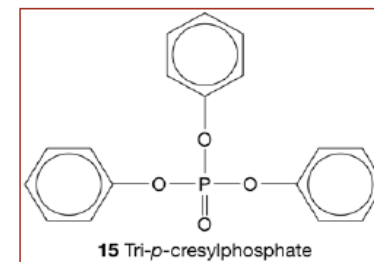
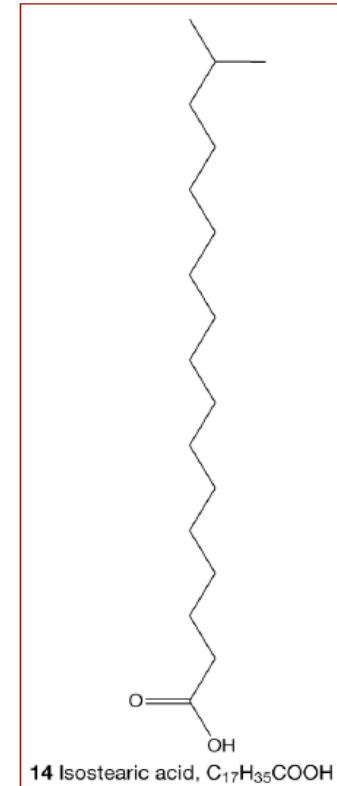
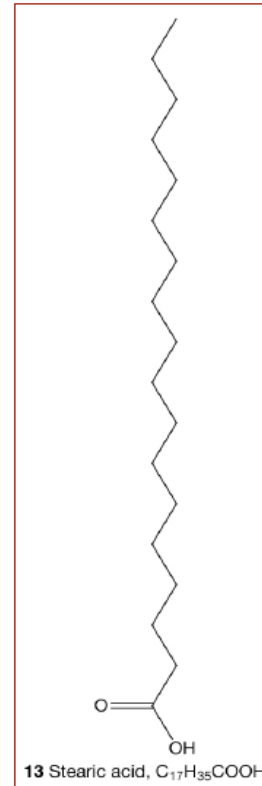
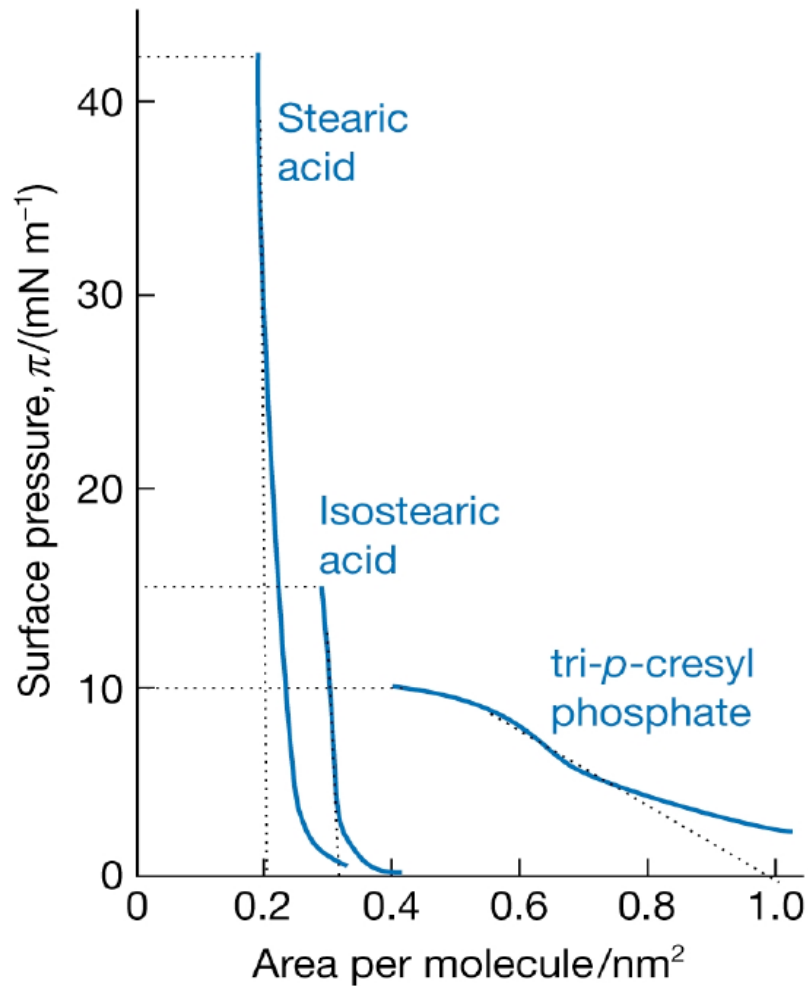
Příklad izotermy



Vliv teploty

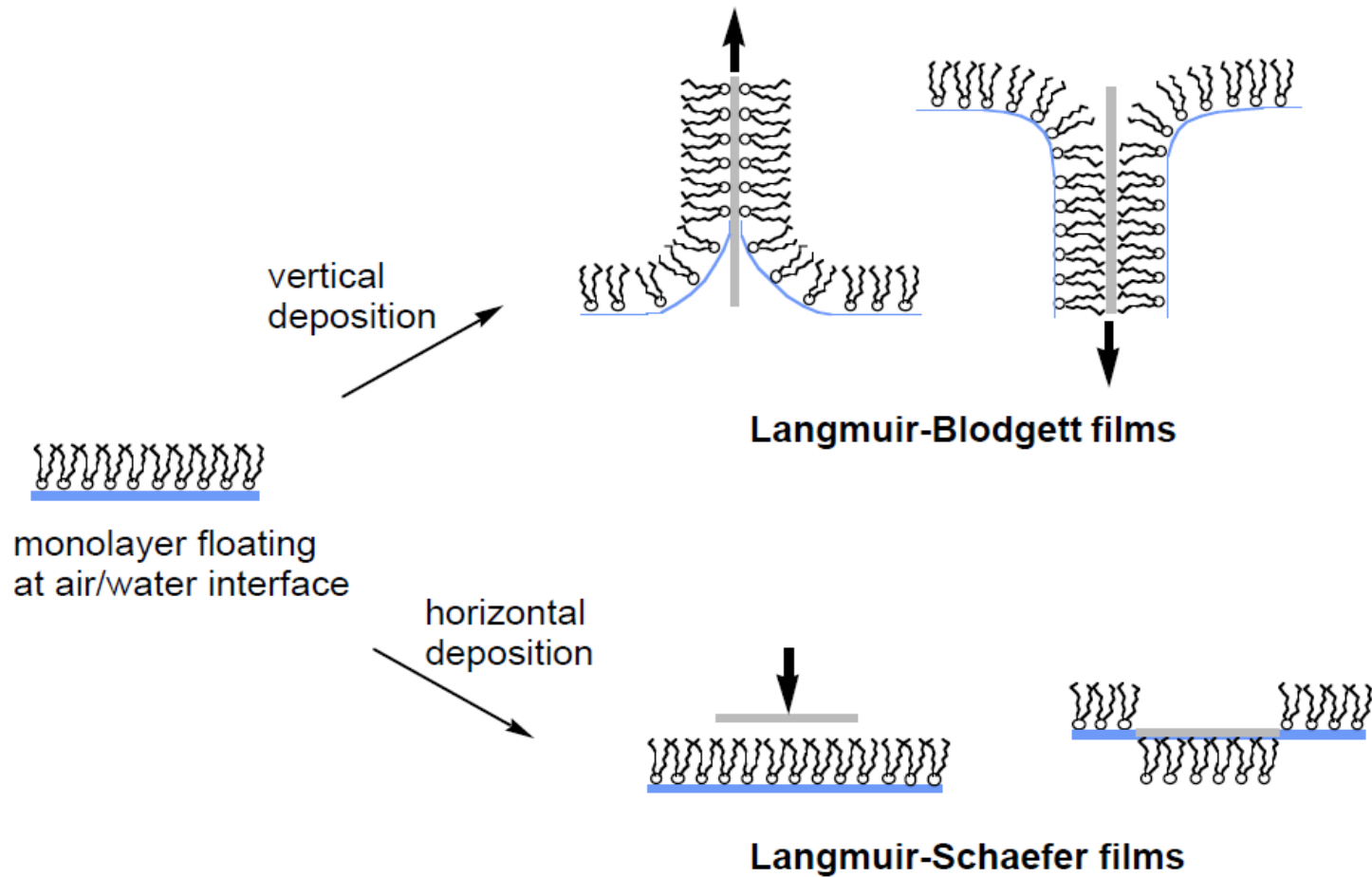


Pro různé surfaktanty



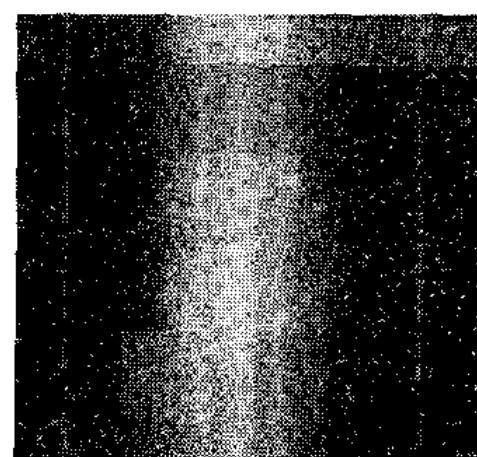
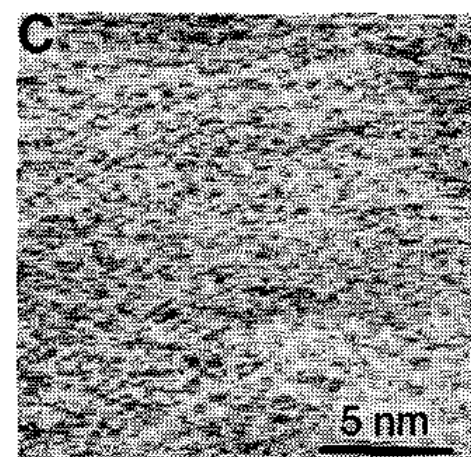
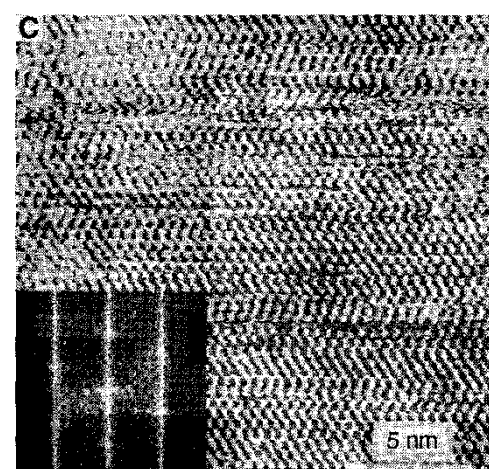
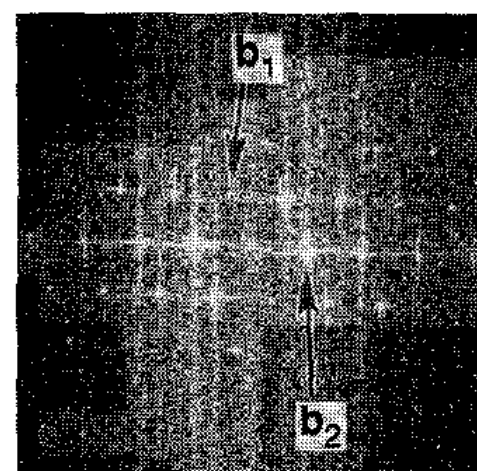
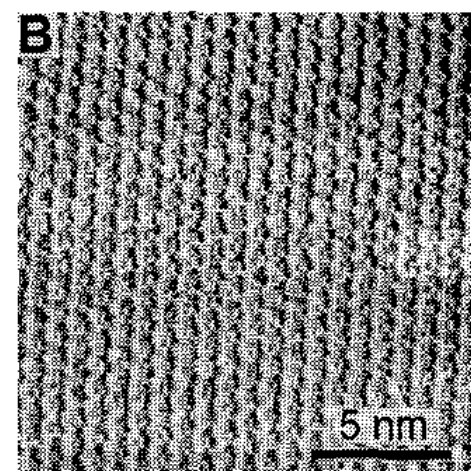
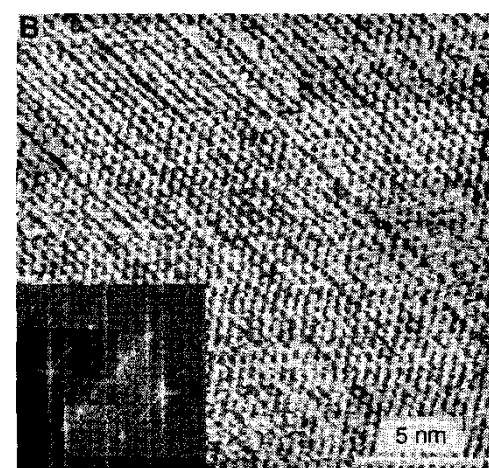
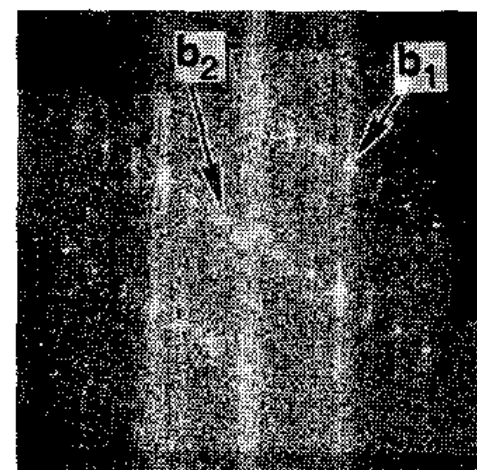
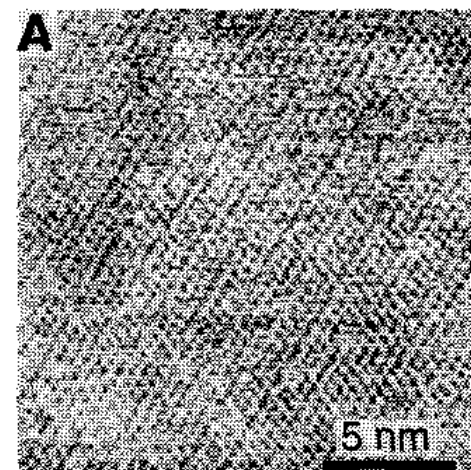
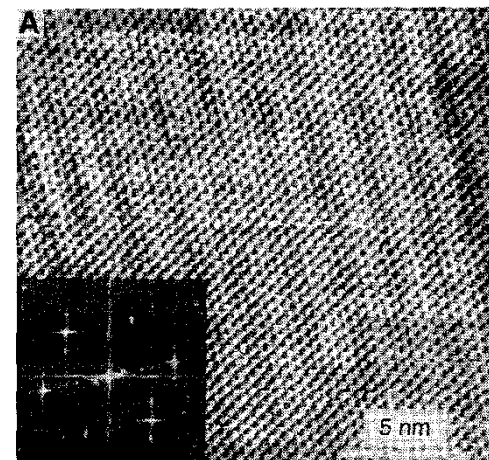
Jak přenést vrstvu

- vhodné jsou sklo, slída, kovy, Si, ...



Metody přenosu

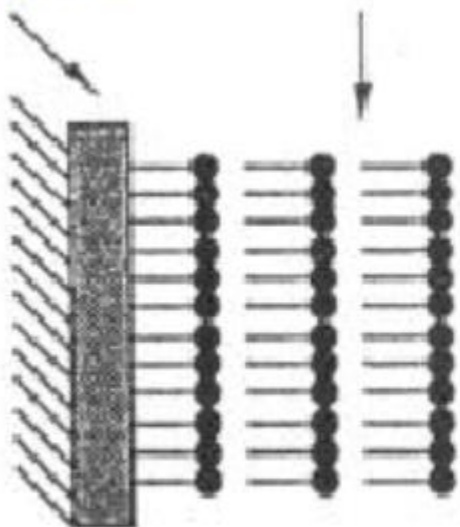
- kolmým vytažením destičky z tuhého materiálu z kapaliny pokryté filmem – metoda ponořovací; pochod může být opakován za vzniku dalších vrstev
- přenosem na vlhkou podložku dotýkající se jednou hranou kapaliny pod fázovým rozhráním (metoda dotyková),
- přenosem na hydrofilní podložku orientovanou paralelně k fázovému rozhraní (metoda vytahovací).



Více vrstev

solid
substrate

head-tail

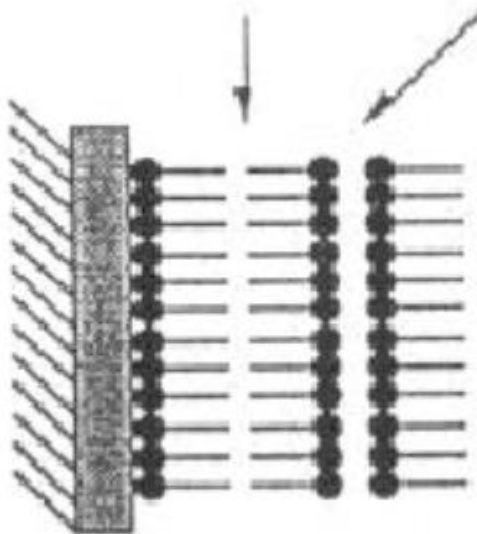


X type deposition onto
hydrophobic substrate

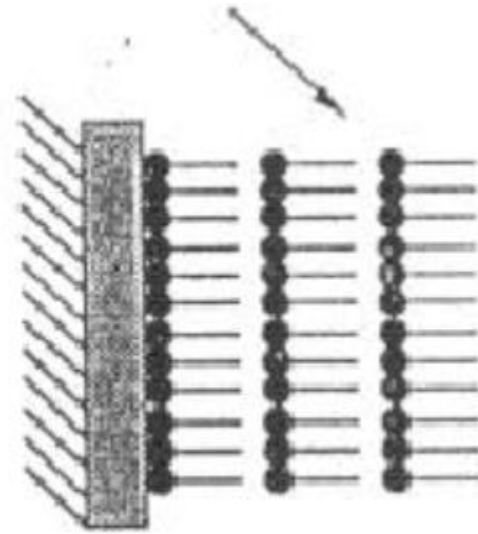
tail-tail

head-head

tail-head

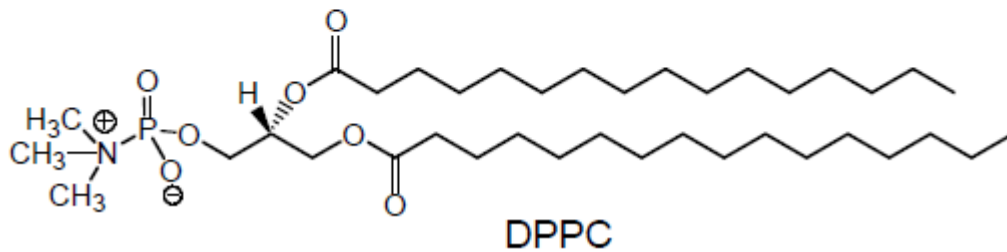
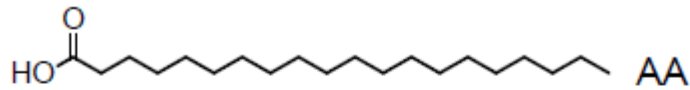


Y type deposition onto
hydrophilic substrate



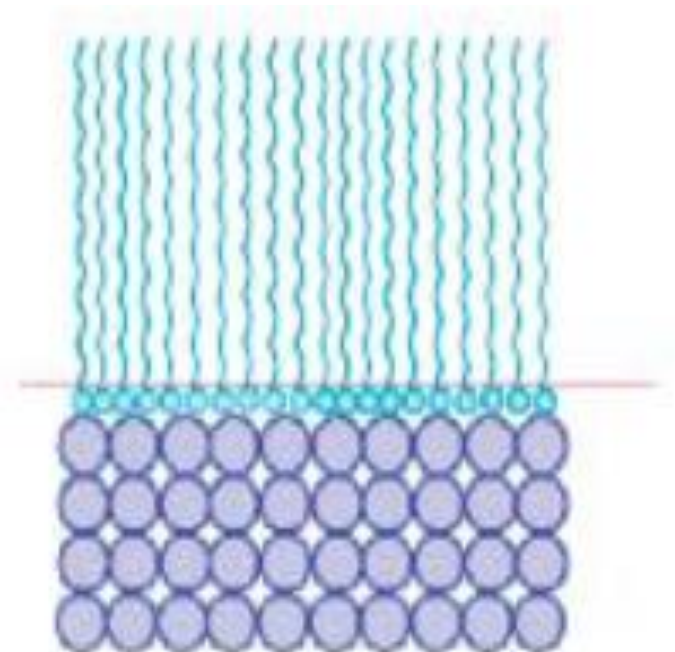
Z type deposition onto
hydrophilic substrate

2D krystaly



Crystallization of $\text{Ca}_3(\text{PO}_4)_2$ at Langmuir monolayers of dipalmitoylphosphatidylcholine (DPPC), arachidic acid (AA), and octadecylamine (ODA)

Langmuir **2004**, 20, 2243-2249



● crystalline calcium phosphate

Vlastnosti

- precizní kontrola na úrovni monovrstev
 - homogenní pokrytí na plochách až jednotky cm²
 - lze připravit multivrstvy (až stovky vrstev)
 - říditelné složení (dva surfaktanty)
 - použitelné na různé substrátů
-
- jen na „dokolale“ ploché a rovné a čisté povrchy
 - malá homogenní plocha
 - citlivé na vnější vlivy (teplota, pH, ...)

Analýza LB

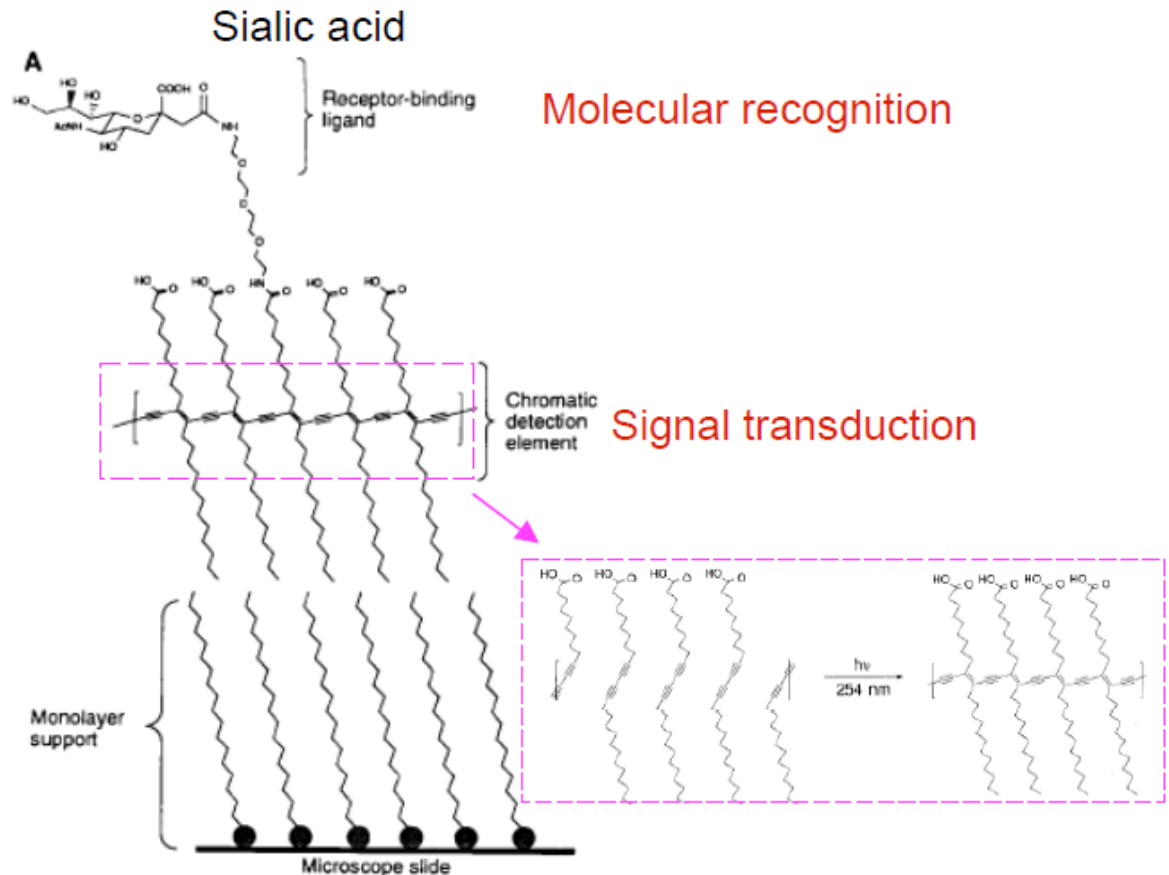
- na povrchu kapaliny
 - Kelvinova sonda
 - Epifluorescenční mikroskopie
 - Brewstova mikroskopie / ellipsometrie
 - XRD lépe grazing incidence
- na pevné látce
 - ellipsometrie
 - AFM

Příklady použití

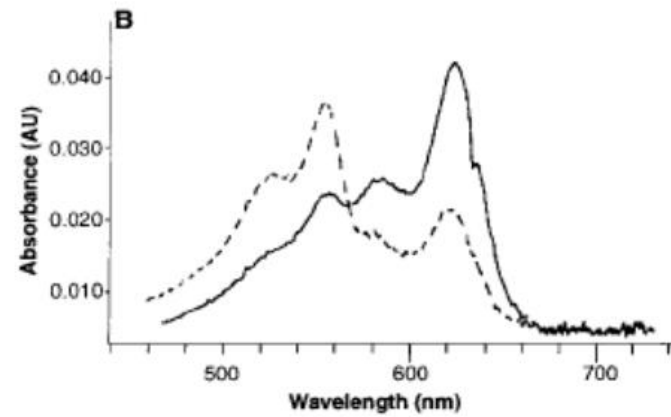
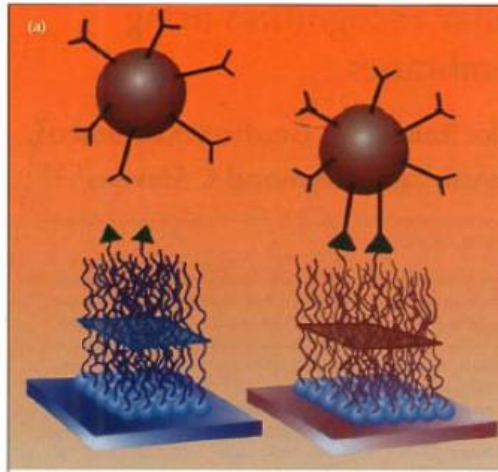
- Biosenzory
- fotodiody

Biosensor

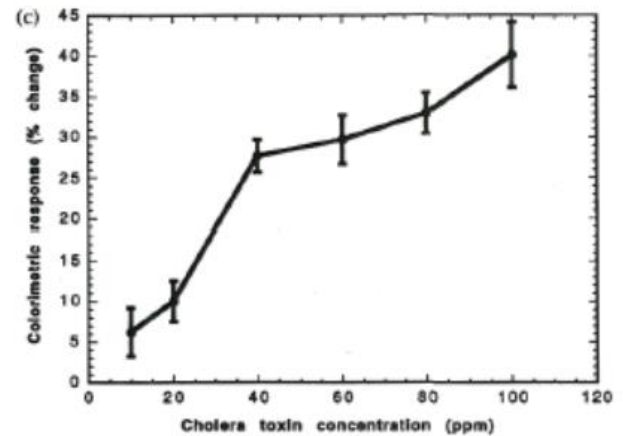
- ❖ Langmuir-Blodgett films mimicking cell membranes and incorporating polymers presenting optical properties can be prepared
- ❖ The binding of bacterial toxins or viruses on surface receptors trigger conformational and electronic shifts of the polydiacetylene assembly that result in a color transition.
- ❖ The color of the bioactive membrane shifts from blue to red following binding of the pathogenic agents.



Reakce na stimulant

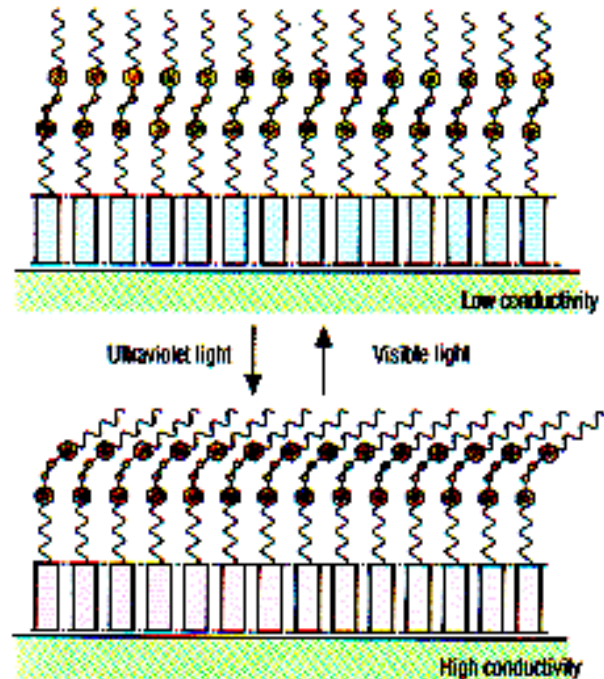


— Film before binding of virus
- - - Film after binding of virus



Fotodioda

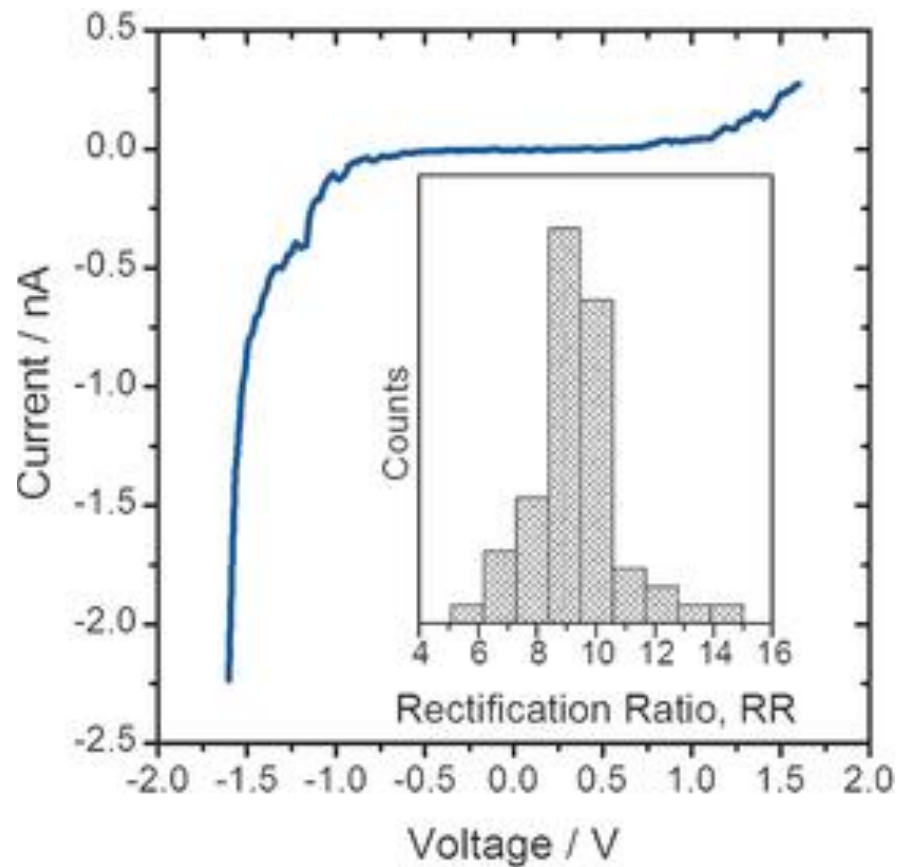
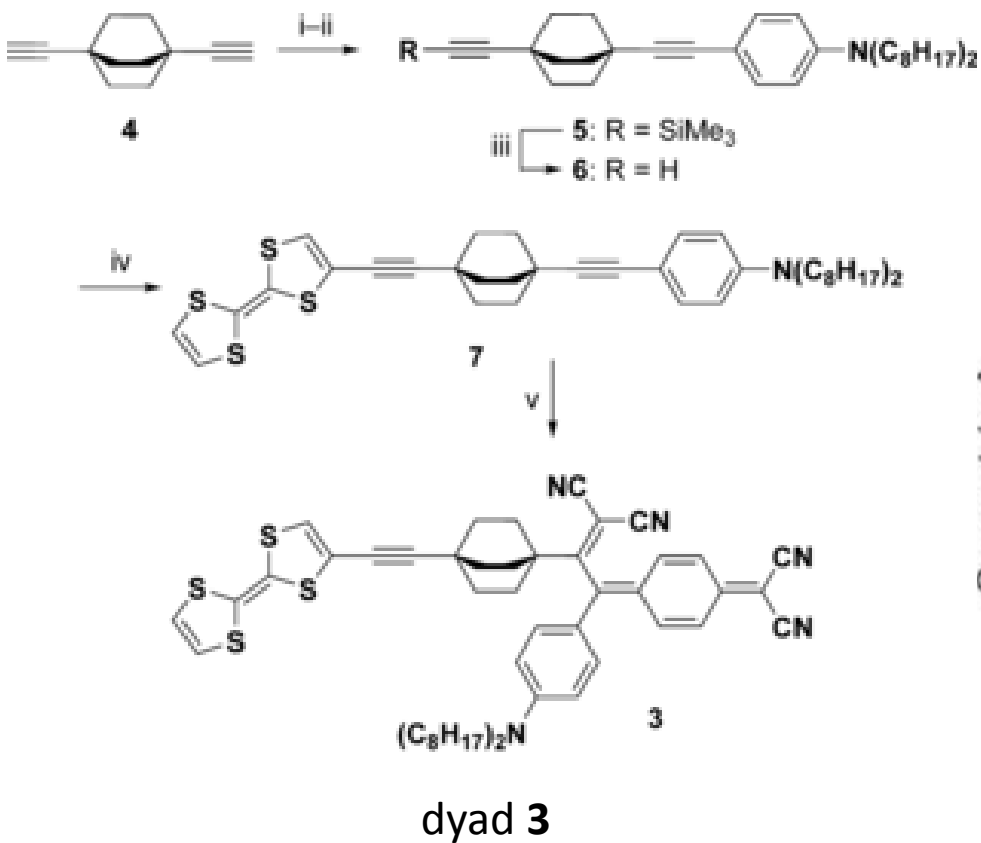
- Smíšením amfifilní látky a kyseliny arachové na vodní hladině a přenosem na kovovou podložku lze vytvořit fotodiodu.



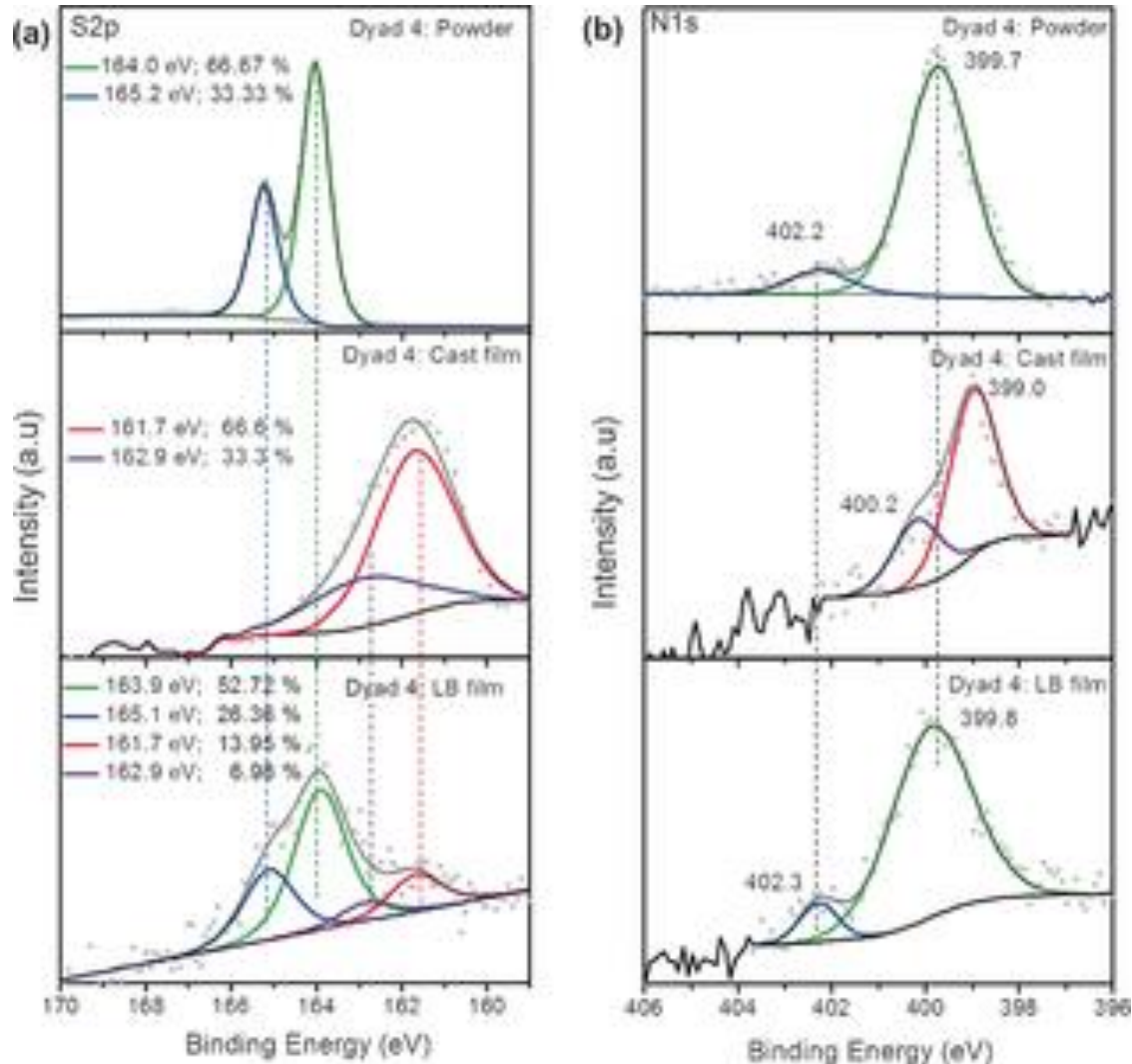
Dioda - usměrňovač

- Langmuir–Blodgett films were prepared and used in the fabrication and electrical studies of junction devices.
- One dyad showed the asymmetric current–voltage (I – V) curve characteristic for rectification,

Dioda

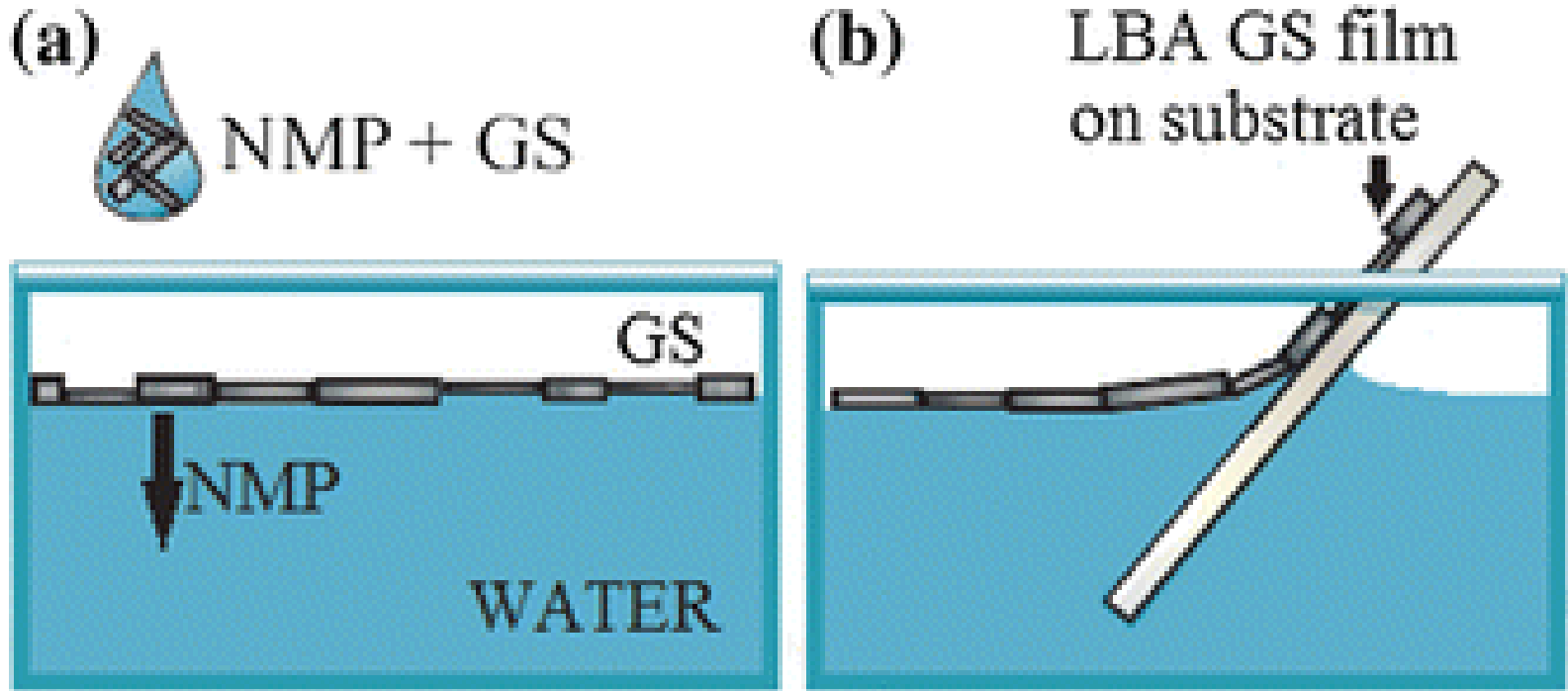


Vliv stavu



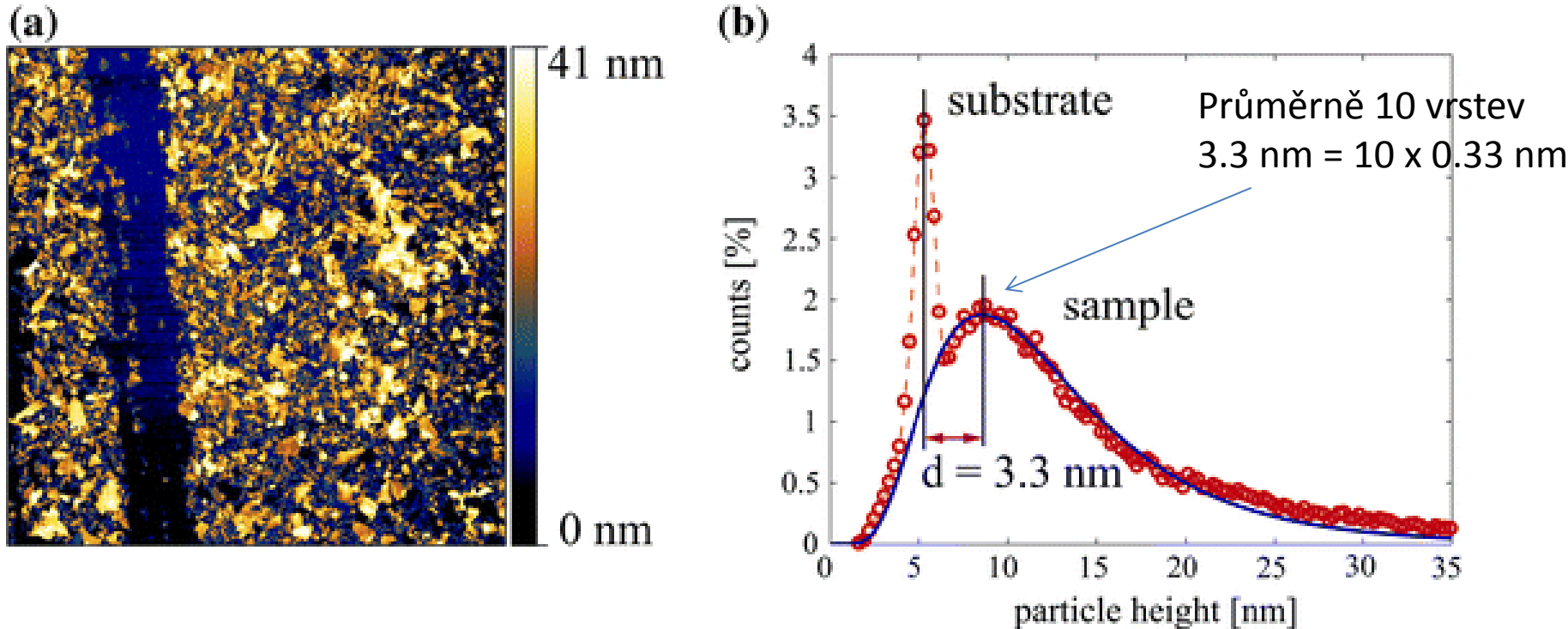
XPS spectra of a) S2p and b) N1s photoelectrons of dyad **3** in powder, in cast films, and in LB films transferred at 10 mN m^{-1} . In all cases the supporting substrate was gold.

Transparent and conductive films from liquid phase exfoliated graphene



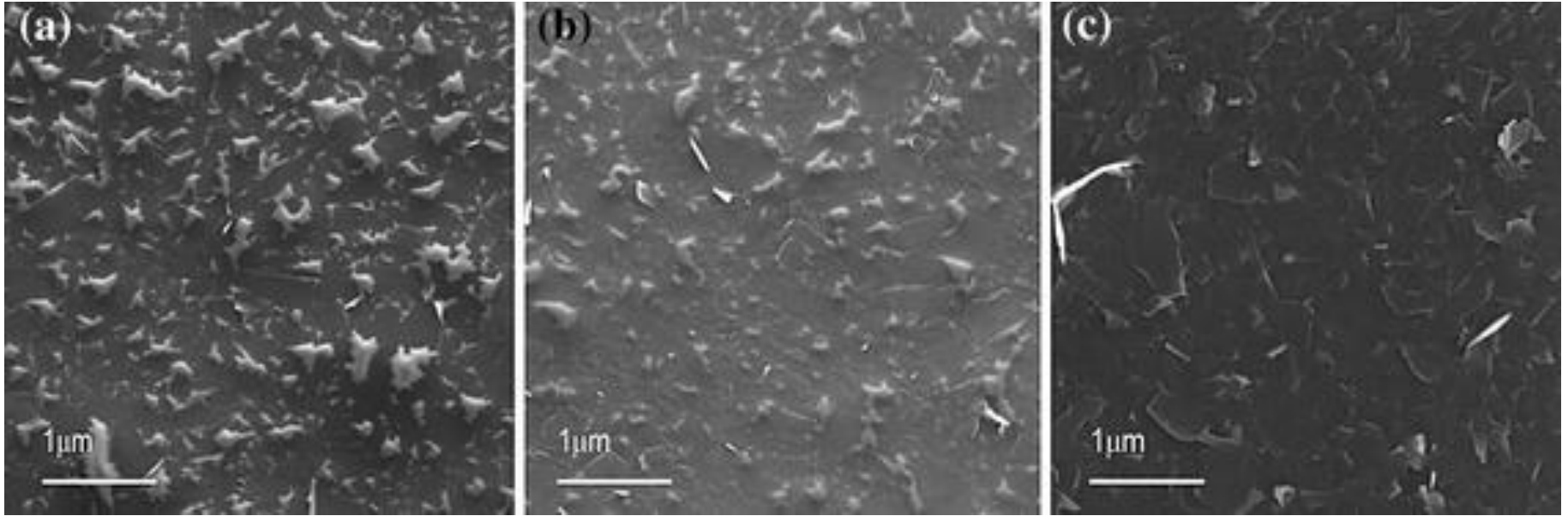
N-Methyl-2-pyrrolidone (NMP),

AFM na LB filmu



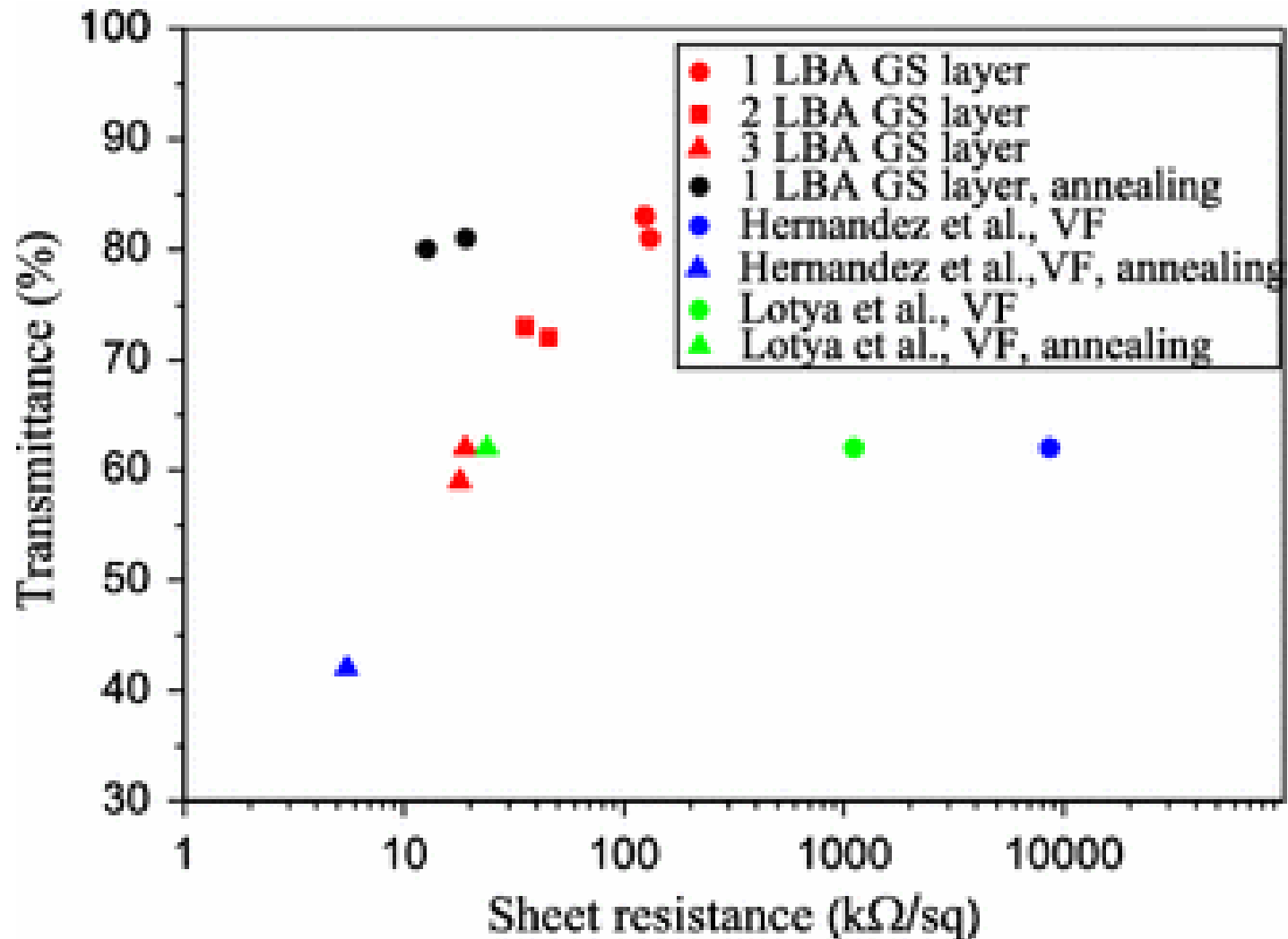
For GS films formed by evaporation of a high boiling point solvent, one of the biggest problems is that graphene flakes aggregate during evaporation
LB, which allows reliable and reproducible thickness control and prevents further agglomeration of graphene flakes during drying

SEM

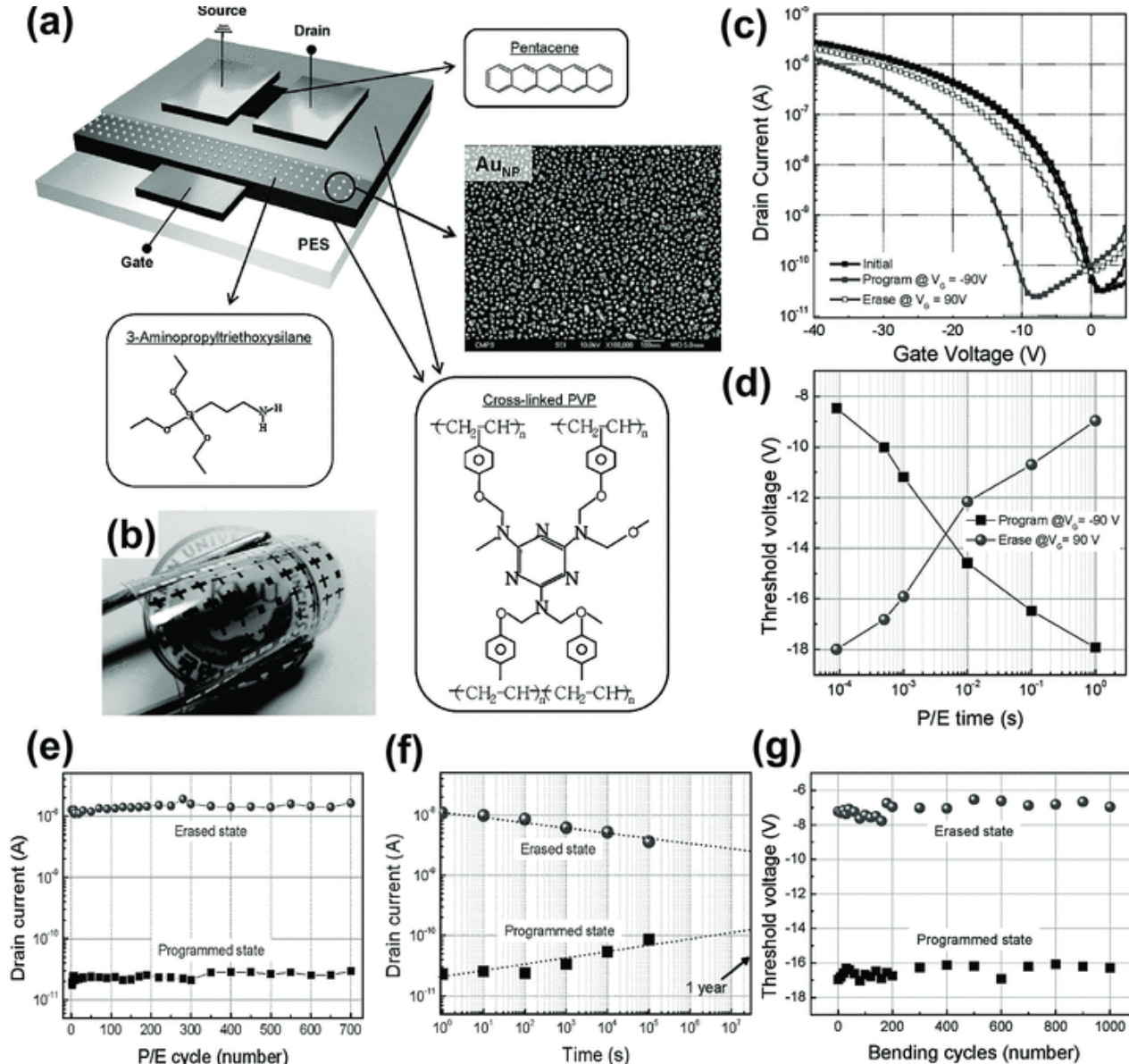


SEM images of: **a** singly deposited LB film on a glass substrate, **b** the same film after annealing, **c** two LB depositions with an annealing step in between

Průhlednost a odpor



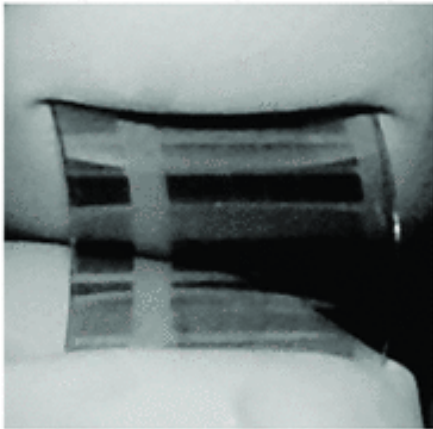
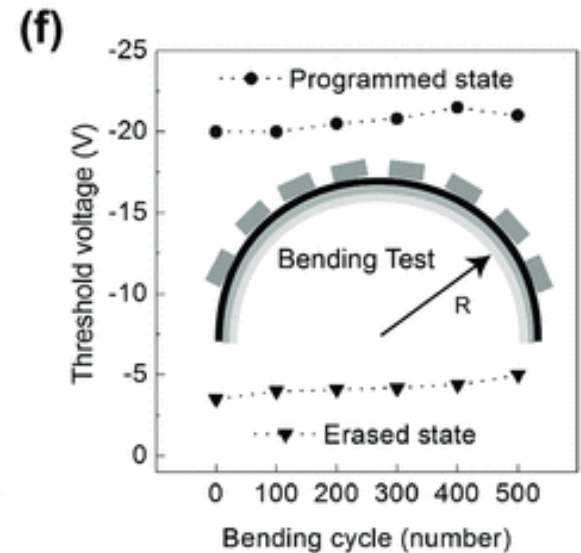
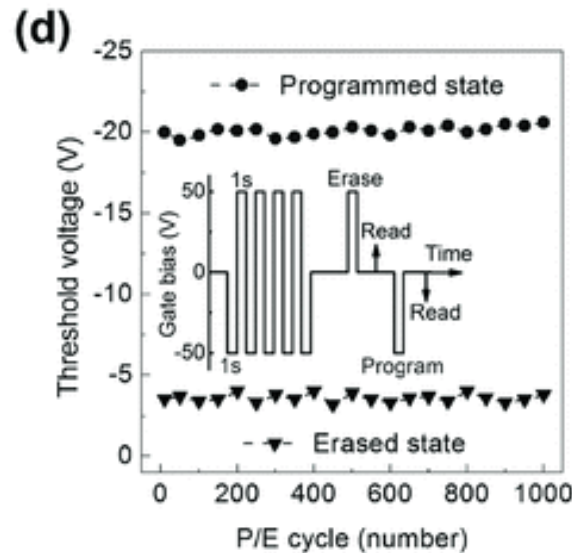
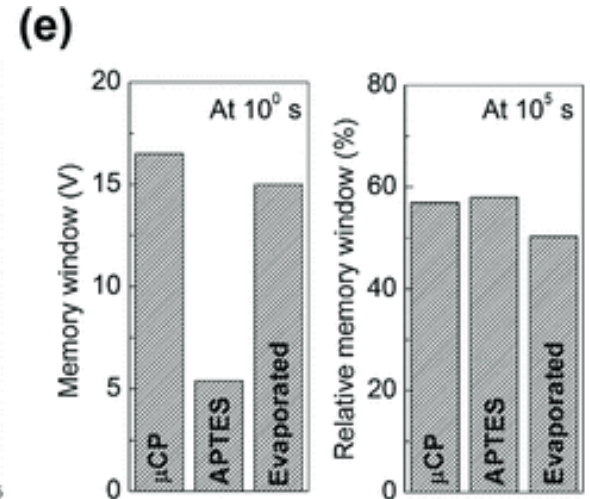
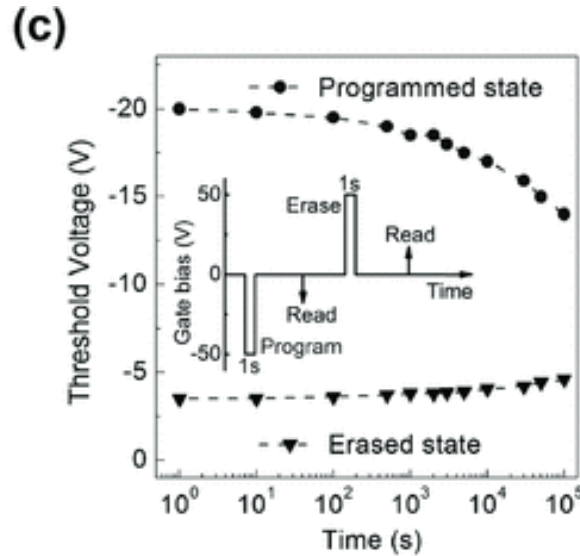
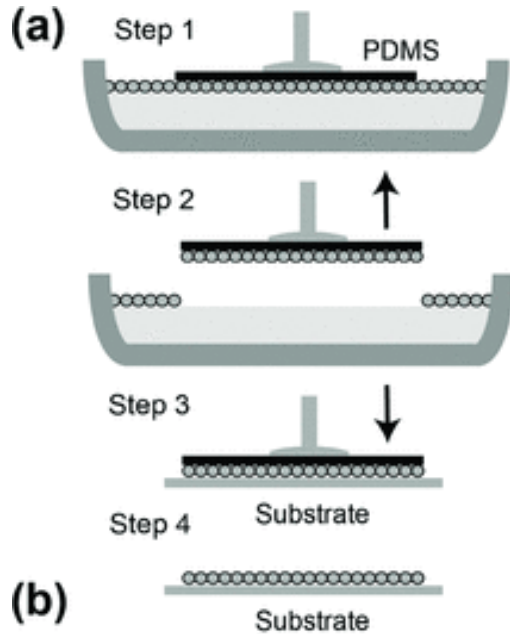
The memory device



Popis

- a) Three-dimensional schematic diagram of the memory device.
- b) Photograph of the fabricated flexible organic memory device with the device size $3 \times 3 \text{ cm}^2$.
- c) Transfer curve of the memory device at initial state, programmed state and erased state. The Program/erase operation is application of $-90\text{V}/+90 \text{ V}$ for 1 s.
- d) Program/erase speeds of the memory device.
- e) Endurance characteristics of flexible organic memory devices with respect to the number of program/erase operations.
- f) Data retention capability of the memory device.
- g) Mechanical stability test of the flexible organic memory device that was carried out by repeatedly bending the device with the bending radius of 20 mm.

S polem nanočastic (NP)



Popis

- a) Schematic illustration of the process for forming a NPs array: (Step 1) Softly contact the PDMS pad with a ***NPs monolayer floating on a water*** surface; (Step 2) Lift up the NPs array from water surface by PDMS; (Step 3) Bring the PDMS stamp pad into conformal contact with a flexible substrate for ~ 10 s; (Step 4) Au NPs array on the desire substrate.
- b) Optical photograph of fabricated flexible memory device.
- c) Data retention capability of μ CP device as function of elapsed time. The inset image is the test pulse sequence for the measurement.
- d) Endurance property of μ CP device with respect to the number of program/erase cycles. The inset image is the test pulse sequence for the measurement.
- e) Retention capabilities of three samples (at 10^0 s and 10^5 s).
- f) Mechanical stability test of the μ CP device that was carried out by repeatedly bending the memory devices with a bending radius of 10 mm. The programmed/erased V_{th} was measured after a certain number of bending cycles.

Plynové senzory

- Založené na SPR

