



Functionalized Polyrotaxanes Using Amphiphilic Cyclodextrins: Sliding Tethered Ligands



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SlidTetherLig Project

Cell adhesion, liposome drug targeting, colloids for immunoassays ...

Self-assembly, nano-patterning, biorecognition

Impact of polymer tether length on multiple ligand-receptor bond formation
Science, 293, 465-468, 2001

Sliding Grafted Polymer Layers
Macromolecules, 38, 1434-1441, 2005

C. Jeppesen, J.Y. Wong, T.L. Kohl, J.N. Israelachvili, N. Mullah, S. Zalipsky and C.M. Marques

Monolayers of modified cyclodextrins

Isotherms

- Formation of stable monolayers
- Pseudo-phase transition

Neutron reflectivity

X-ray reflectivity

Water content of CD layer

Change of conformation at pseudo-phase transition:

- Conformation at **low II**: CD-axis perpendicular to surface
- Conformation at **high II**: CD-axis parallel to surface

Synthesis of polyrotaxanes based on poly(ethylene-glycol) and α -cyclodextrin

Complexation

Capping

Purification

Methylation

Click Chemistry

¹H NMR spectra superposition

Complexation rate: 0.7 per α -CDN₁ polymer chain

Mixed CD/DPPC monolayers

Isotherms

- Stable mixed Langmuir monolayers
- No DPPC plateau for CD ratio >20%

Thermodynamical analysis of CD/DPPC mixture's miscibility

$\Delta G_{mix} = \Delta G_{mix}^0 - \Delta G_{mix}^{int} =$

$$\int_0^1 A d\Pi - 0.5 \left[x \int_0^1 A_{TASC} d\Pi + (1-x) \int_0^1 A_{DPPC} d\Pi \right]$$

→ TASC more miscible with DPPC than TBdSC

→ Miscibility increases with surface pressure (Error $\Delta G = \pm 80$ J/mol)

Brewster Angle Microscopy

TASC/DPPC 30/70

TBdSC/DPPC 30/70

Synthesis of permethylated monocholesteryl α -cyclodextrin TASC

Methylation

Reduction

Coupling

Atomic Force Microscopy

Langmuir-Blodgett on Silicon, tapping mode

Low Surface Pressure → Miscibility

High Surface Pressure → Phase segregation

Illustration

Low II

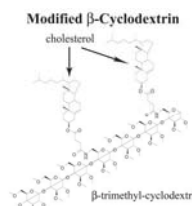
Phase transition

High II

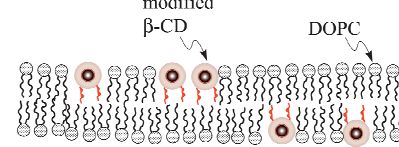
Modified β -Cyclodextrin in SUVs

(Small Unilamellar Vesicles)

Presence of CD does not increase bilayer thickness but the bilayer does appear "grainy."



Proposed arrangement of mod-CD in the bilayer modified



The attached cholesterol molecules prefer to be in the hydrophobic tail region, resulting in the CD ring being sunken below the level of the lipid headgroups.