

International Research Training Group (IRTG)

***Weiche Materie:
Von molekularen Kräften zu neuen Materialien***
***Soft Matter Science:
Concepts for the Design of Functional Materials***

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Günter Reiter**

**Université de Strasbourg and
Institut Charles Sadron, France
Jörg Baschnagel**

Funding Period: 1 Oct 2010 to 31 March 2015



UDS	Université de Strasbourg
ICS	Institut Charles Sadron

UF	Universität Freiburg
FMF	Freiburger Materialforschungszentrum
FRIAS	Freiburg Institute for Advanced Studies
IMTEK	Institut für Mikrosystemtechnik
MC	Makromolekulare Chemie
PC	Physikalisches Chemie
PI	Physikalisches Institut

IS2M	Institut de Sciences des Matériaux de Mulhouse
UB	Universität Basel

Theme A: Controlling and directing assembly processes in soft matter systems

A1	Transient self-assembled networks	Friedrich / Wittmer	1	1
A2	Dynamic nanostructures in self-assembled lipid bilayers	Schiller / Marques / Meier (Basel)	1	1+1
A3	Self-assembled nanoribbons and nanotubes of aromatic diamideesters	Reiter / Mésini	1	
A4	Self-assembled donor-acceptor amphiphilic polymers	Ludwigs / Giuseppone		1
A5	Controlled nucleation and growth of conjugated polymers	Ludwigs / Brinkmann	1	

Theme B: Designing and improving multi-component soft matter systems

B1	Macromolecular nanohybrid molecules	Mülhaupt / Lutz	1	
B2	Polymer multilayers at solid substrates	Rühe / Decher	1	+1
B3	Influence of nanofillers on the properties of polymer latex films	Bartsch / Meyer	1	1
B4	Colloidal stabilization by unattached homo- and copolymers	Bartsch / Semenov	1	1

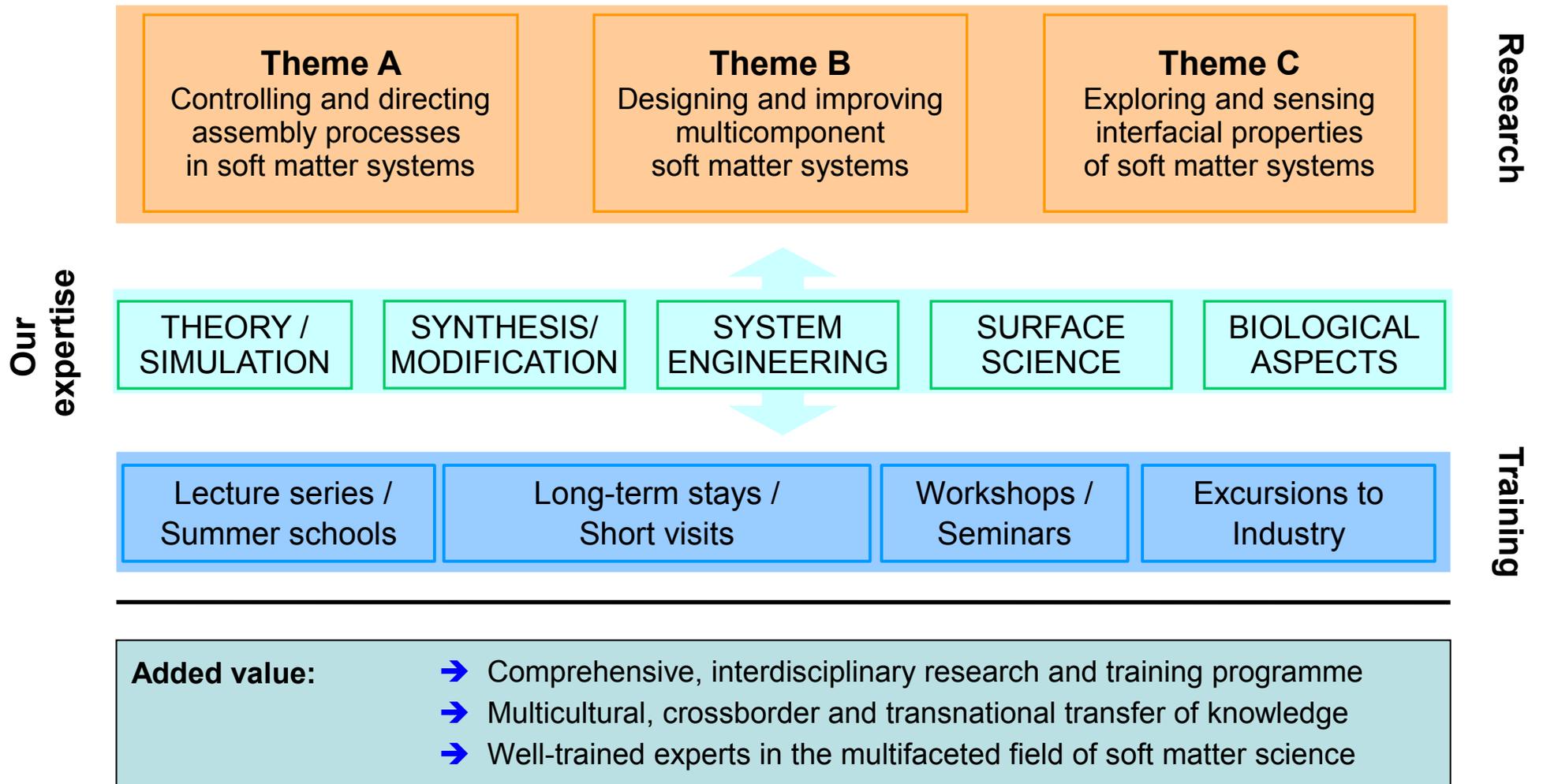
Theme C: Exploring and sensing interfacial properties of soft matter systems

c1	Interactions between biological systems and patterned surfaces	Rühe / Krafft / Anselme (Mulhouse)	1	
c2	Development of mechanically responsive sensors	Schiller / Schaaf	1	1
c3	Modeling late stages of spin coating	Blumen / Baschnagel	1	
c4	Frictional and adhesive properties of polymer surfaces and films of controlled structure and function	Reiter / Le Houérou	1	
c5	Mechanics of surface recovery + reconstruction after deformation	Mülhaupt / Pelletier		1

Total number of PhD stipends :

12 7+2

SOFT MATTER SCIENCE: Concepts for the Design of Functional Materials



Qualification Programme

GOAL: Comprehensive interdisciplinary training

TRAINING PLATFORM

TEAM-WORK

INTERNATIONALITY

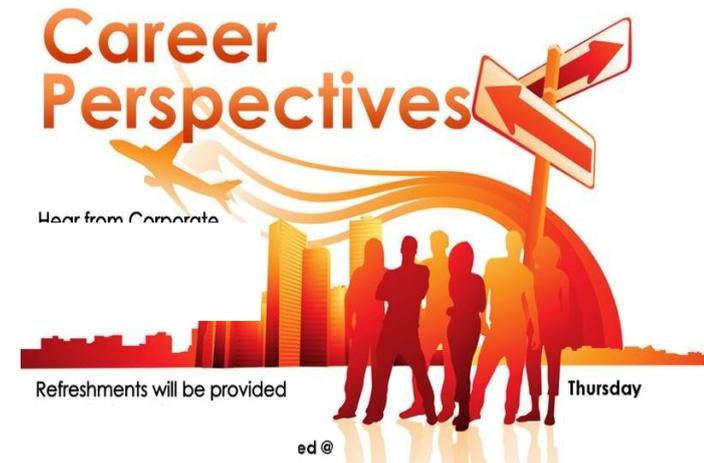
SKILLS

EXCHANGES

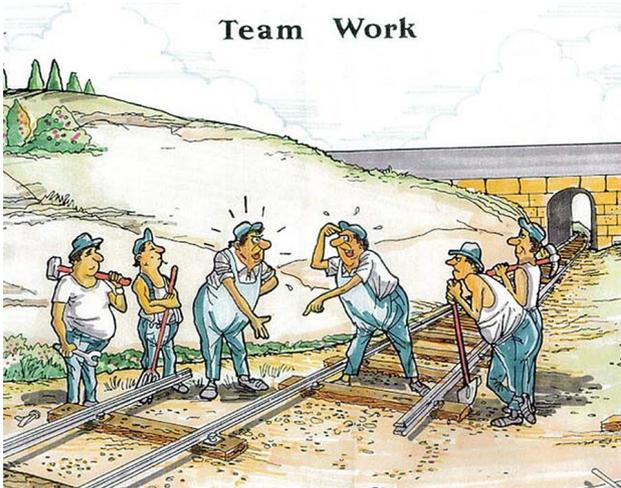
OUTREACH

IMPACT

CAREER PERSPECTIVES



Team Work



Qualification Programme

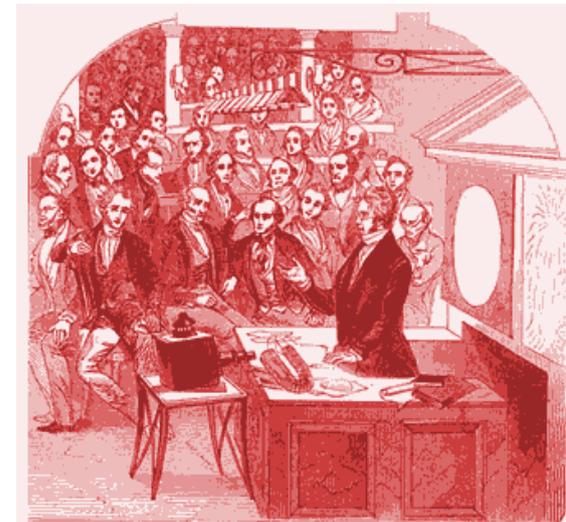
Courses

- Introductory and advanced courses (ca. 10 hours each)
- Annual, organized in the framework of schools (duration: 5 days)

Strong accent on multidisciplinary training

Workshops

- Annual (3 days), compulsory for all participants of the IRTG
- Organized by the doctoral researchers
- Complement: one-day “students-only” meetings (without the supervisors)



“Training camps”

- Training on the use of instrumentation or theoretical approaches
- Exchange of experience
- Collaborative practical work



Qualification Programme

Visiting researcher programme

Exposure: broad, worldwide, novel concepts and ideas in soft matter science

Domestic and international **experts**

Their **contributions** involve

- long-term visits of distinguished researcher
- multi-day visits for a block seminar and extensive discussions
- one-day visits for a lecture

e-learning (web-seminars, video-conferences, etc.) will be implemented as far as possible



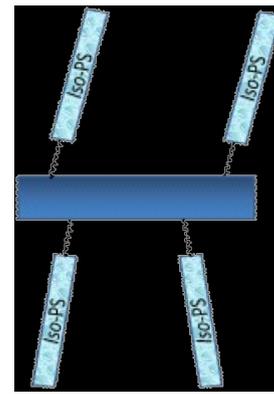
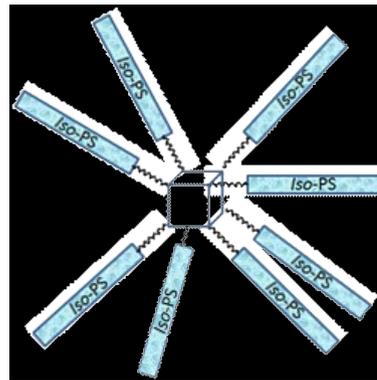
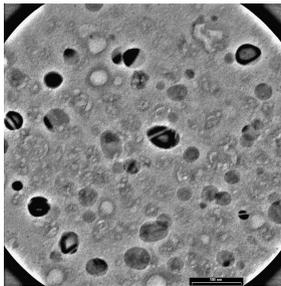
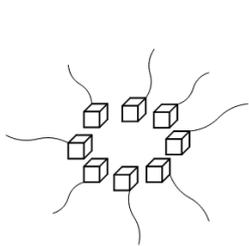
Qualification Programme

Additional qualification measures

- **Co-supervision** by scientist from contributing sites
- **Extensive exchange** of PhD students:
long-term stays coupled with short visits
- **Participation** in national and international conferences
- **Excursions** to Industry
- Participation in the “**French-German Forum**”
- Possibility of the “**Cotutelle de thèse**”
- Application for admission to the **European Doctoral College**



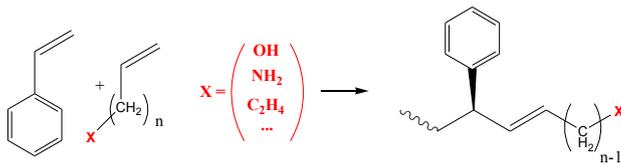
**Supramolecular and polymer chemistry :
Synthesis and self-assembly of branched macromolecular nanohybrids**



**Controlled crystallization
in confined environments**



novel micro
and nanostructured
materials



**Typical structures obtained by grafting
of iso-PS onto octafunctional
silsesquioxanes or onto graphene**

Applications : Engineering
plastics, thermoplastic
elastomers, coating

New strategies providing to access to iso-PS of controlled molecular weight and functionality, including macro-monomers were discovered. They will be combined via hydrosilylation to design new nano-hybrid materials and to study their crystallization

Freiburg, Mülhaupt: *Synthesis of functional iso-PS*

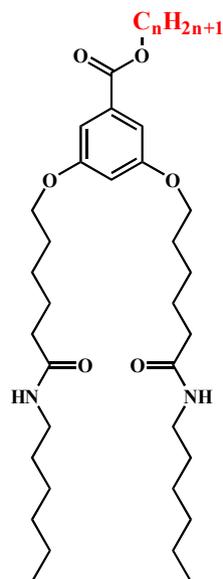
Freiburg, Reiter: *Crystallization*

Strasbourg, Lutz: *Synthesis of hybrid branched topologies*

A long term stay of the German PhD student in Strasbourg is envisaged

Coll. : R. Mülhaupt, P. J Lutz et al, Langmuir (1999) Macromolecules (2000)

**Supramolecular, polymer chemistry and organogelators :
Self-assembled nanoribbons and nanotubes**



BHPB

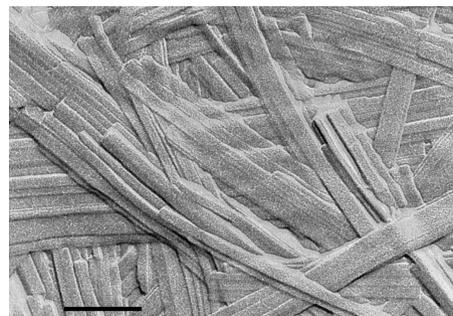
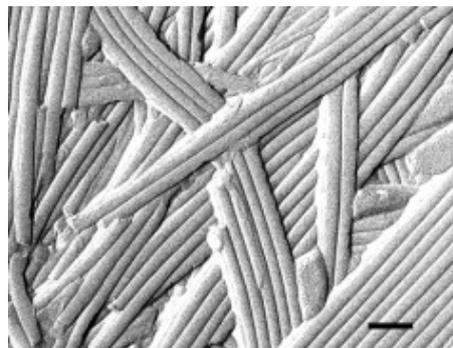
$n =$ ester chain length

Self-assembly

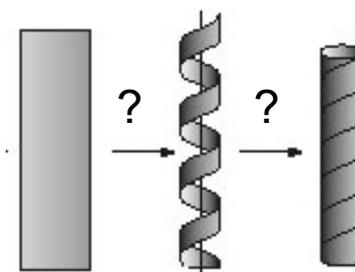
π -stacking
H bonds

$8 \leq n \leq 12$
➔ tubes

$n \leq 7$ or $n \geq 13$
➔ flat ribbons



Unclear dynamics
of formation



Compounds BHPB self-assemble to form nanotubes or flat ribbons.

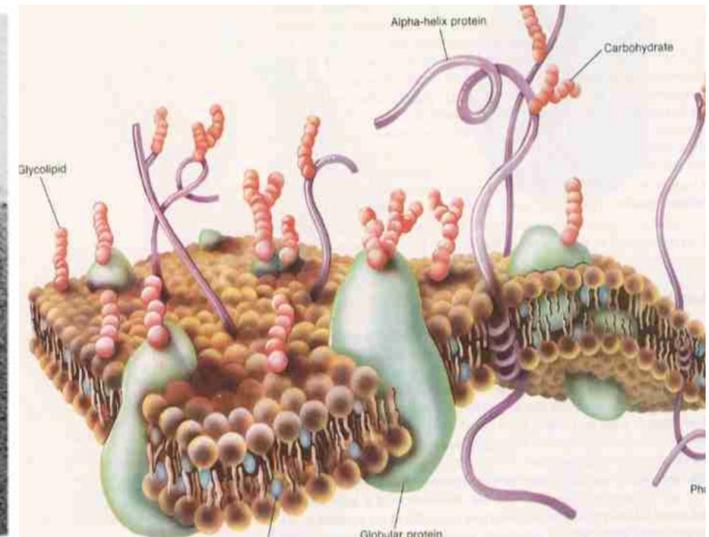
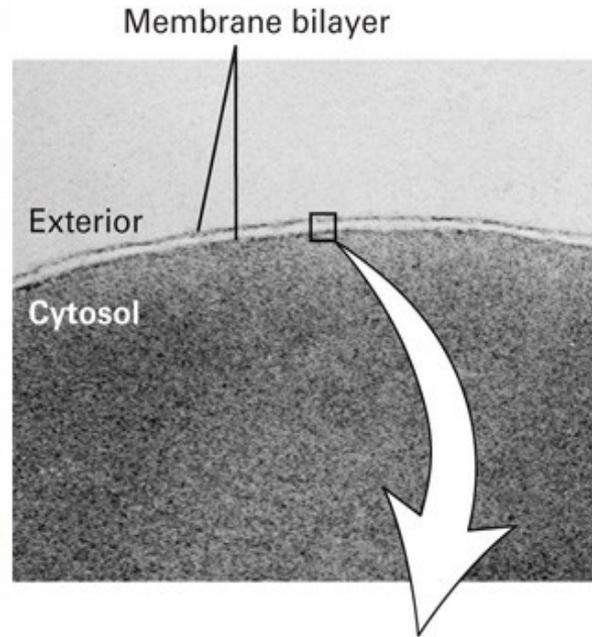
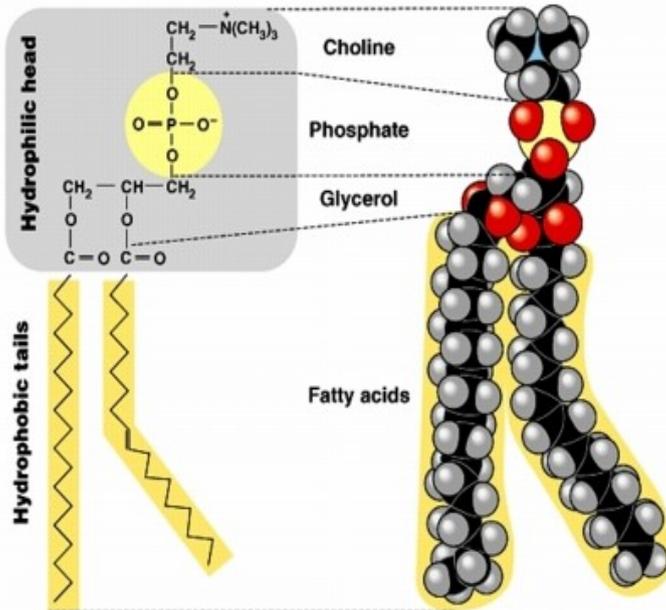
The projects aims at understanding the dynamics of the self-assembly and controlling their size and shape in 3D or in 2D (after adsorption on substrates) by variation of molecular parameters C , T or solvant composition.

Freiburg, Reiter: dynamics, structure in 2D (AFM and STEM)

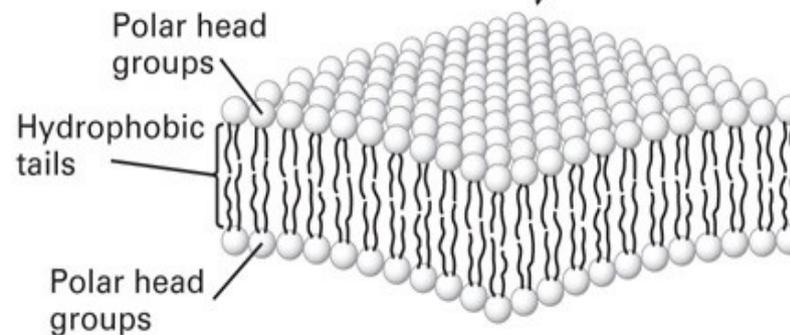
Strasbourg, Mesini, Brinkmann: synthesis, studies in 3D (TEM, SAXS)

Several stays of the German PhD student in Strasbourg are envisaged

Dynamic Nanostructures in Self-Assembled Lipid Bilayers

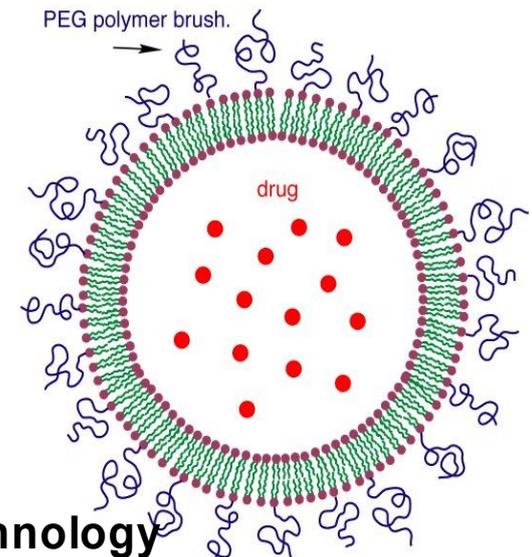


Phospholipids and other surfactants self-assemble in solution as micelles, bilayers, ...



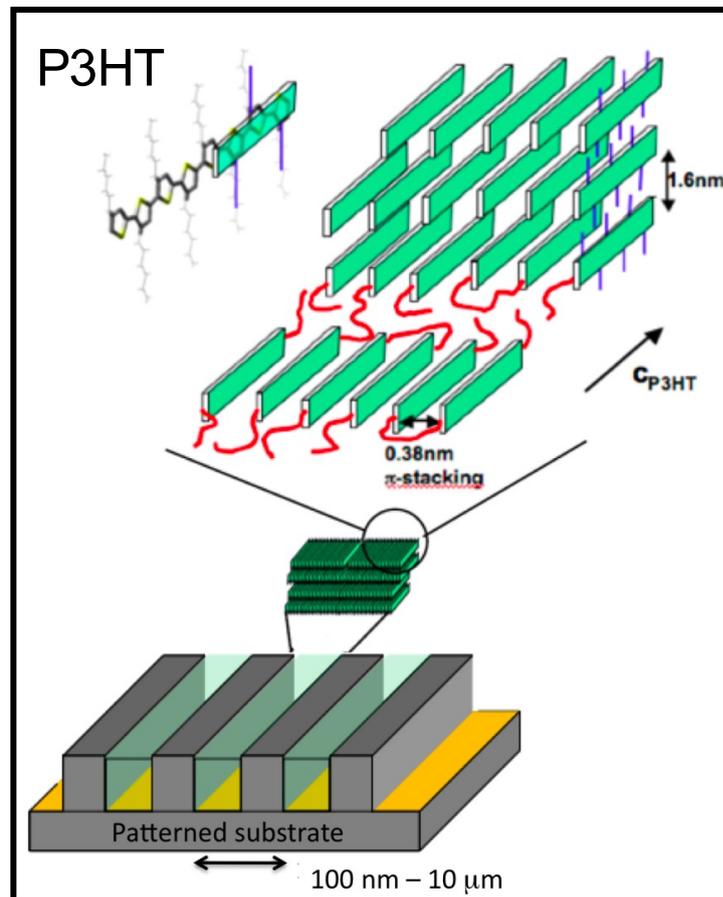
In the living realm: fluid phospholipid bilayers build the membrane of the cell and organelles.

*In the industry: 10¹⁰ \$US
Pharmaceuticals, Cosmetics.
Food industry.*



Stealth Technology

Optoelectronic applications based on semiconducting polymers require morphology control



Our approach:

Use of topographically & chemically patterned substrates to enforce oriented nucleation of a semiconducting polymer.
→ Interdisciplinary approach, 2 expertises

1. **Strasbourg:** Transmission Electron Microscopy, epitaxy, controlled crystallization
2. **Freiburg:** Synthesis, optoelectronic characterization, soft lithography

Expected results: Controlled nucleation & orientation of crystalline poly(3-alkylthiophene)s.
Improved charge transport characteristics.