Universität Basel

Research Project

Nanostructured Polymers

Third-party funded project

Project title Nanostructured Polymers
Principal Investigator(s) Meier, Wolfgang P. ;
Project Members John, Christoph Marcel ; Necula, Danut ; Wehr, Riccardo Pascal ;
Organisation / Research unit
Departement Chemie
Departement Chemie / Makromolekulare Chemie (Meier)
Department
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The strategy to develop new materials and systems with emerging properties and functionality at the nano- or micro-scale is on focus in various domains, such as catalysis, medicine, technology and environmental sciences due to their ability to produce desired compounds/signals with precise location, to sensitively detect specific molecules or to generate active membranes and surfaces. Amphiphilic block-copolymers are particularly appealing to be used in such bottom-up approaches because they self-assemble in dilute solutions into various supramolecular assemblies with distinct architectures and properties, allowing their combination with active compounds, such as catalysts, metal complexes and biomolecules. The functionality of such new hybrid materials and systems is provided by the active compounds, while the supramolecular assemblies serve as templates/compartments/membranes bringing robustness and stability as key factors for translational applications.

In this project we plan to synthesize new amphiphilic diblock and triblock copolymers with hydrophilic and hydrophobic domains and properties (stimuli-responsiveness, flexibility, presence of functional end-groups) allowing encapsulation/insertion/attachment of biomolecules. The self-assembly of these amphiphilic copolymers will result in formation of supramolecular assemblies in solution (vesicles, micelles, nanoparticles) and hybrid membranes (lipid-polymer and polymer-polymer) on solid supports. The synthesis of different libraries of amphiphilic copolymers will allow a systematic investigation of the resulting supramolecular assemblies and membranes to favor specific interactions with biomolecules and develop complex hybrid systems with desired functionality. Of particular interest are the triblock copolymers with different hydrophilic domains because the resulting membranes will be intrinsically asymmetric and will favor directed insertion of biomolecules, for example of membrane proteins. In addition, the presence of hydrophilic domains with specific properties, as for example chirality, will enable control of the self-assembled architecture and even self-organization of such assemblies, while the presence of specific molecules exposed at the hydrophilic surface of the assemblies will support their interactions with biomolecules.

Nanostructured membranes will be developed by combinations of copolymers with lipids, or of copolymers with different properties in a variety of ratios and conditions to modulate their phase separation. Heterogeneity introduced at the surface level will support specific combinations with bioactive molecules to engineer “smart” complex surfaces. A second approach will target formation of copolymer membranes on pore-containing solid supports to develop confined cells. Insertion of membrane proteins inside the copolymer membranes spanning the pores, will allow a molecular flow through, which will support the reactions inside the confined cells. A complementary strategy will be used to generate compartments-in-compartment systems by encapsulation of synthetic nanoreactors within giant plasma membrane vesicles from donor cells: complex reactions in protected synthetic spaces will take place in a close-to-nature environment, as a key step for further applications.

Keywords amphiphilic copolymers; polymerisation; smart surfaces; supramolecular assemblies; nanoreactors; membranes; self-assembly; complex compartments
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