OUR EXPERT TEAM

PROF RICHARD HOOGENBOOM

Supramolecular Chemistry Group (SC)

PROF PETER DUBRUEL

Polymer Chemistry and Biomaterials Group (PBM)

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The Organic and Biomimetic Chemistry Research Group

The Supramolecular Chemistry Group (SC)

The research of the Supramolecular Chemistry Group is inspired by the beauty of natural self-assembly processes. Nature exploits a limited number of building blocks in combination with non-covalent and hydrophobic interactions to build complex functional assemblies, such as proteins and cells. The research of this group aims to develop well-defined synthetic structures with controlled ordering and/or self-assembly resulting in functional systems. The use of synthetic building blocks allows a higher level of complexity when compared to the limited diversity in Nature. Moreover, the combination of well-defined 'smart' polymer structures with supramolecular interactions provides an ideal platform to develop functional systems for, e.g., sensors and diagnostics, drug delivery and responsive hydrogels. The research of the group can be subdivided in three main research directions:

- Supramolecular polymers
- 'Smart' responsive polymer structures
- Poly(2-oxazoline)s and next-generation polyethyleneimines

Application areas that are targeted include polymer therapeutics, diagnostics, drug delivery, biomedical devices, cosmetics, and personal care.

The Polymer Chemistry & Biomaterials Group (PBM)

The research of the Polymer Chemistry & Biomaterials Group (PBM) can be subdivided in the following research activities:

- Functional polymers for biomedical applications
- Biomaterials: e.g. biocompatible coatings
- Advanced drug/gene delivery systems
- Scaffolds for tissue engineering
- Organ-on chip development

Polymer synthesis facilities are available to perform various types of polymerizations and characterization of polymer bulk properties. In addition, state-of-the-art equipment is available for surface modification & characterization. Furthermore, rapid prototyping (Bioscaffolder, fused deposition modelling), inkjet printing and a (co-extrusion) electrospinning device are available for polymer processing.

The Organic and Biomimetic Chemistry Research Group

The Organic and Biomimetic Chemistry Research Group finds its inspiration in naturally occurring systems and biologically relevant processes. The major research interests are:

The design and synthesis of artificial hydrolases where both modified multipodal oligopeptides and modified oligonucleotide duplexes are used in order to mimic the desired catalytic site.

The construction of conformationally defined multipodal peptide architectures. Methods are being developed for the synthesis of both dipodal and tripodal peptides on solid phase. The synthesized compounds can possibly find applications as peptide vaccins, DNA-binding ligands and receptor mimics. More specifically the use of cholic acid based steroid derivatives has been explored for the conformational restriction and metabolic stabilization of appended peptide chains.

The development of new methods for crosslinking of biomacromolecules such as peptides, proteins and oligonucleotides. Through the use of a furan moiety with inducible reactivity a method is developed for the site-selective introduction of covalent bonds between two binding partners.

CONTACT INFORMATION

Your biomaterial partner for applied biomedical research

- drug delivery (injectables, tablets, ...)
- medical devices and implants
- coatings for diagnostic applications (biosensors)
- soft tissue and bone mimics for tissue engineering

This Biomaterials cluster is supported by the business unit ChemTech, that is the focal point for industrial collaborations between research groups dealing with chemistry and pharma, biotech and medtech companies that are looking for polymer expertise.

ChemTech Life Sciences facilitates and coordinates a set of industrial projects and manages a strategic IP portfolio and its licensing and spin-off opportunities.

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EXPERTISE AT UGENT

INNOVATIVE BIOMATERIALS & HYDROGELS

GHENT UNIVERSITY

OUR OFFER

Highly versatile poly(2-oxazoline) platform for advanced drug delivery, coatings and tissue engineering

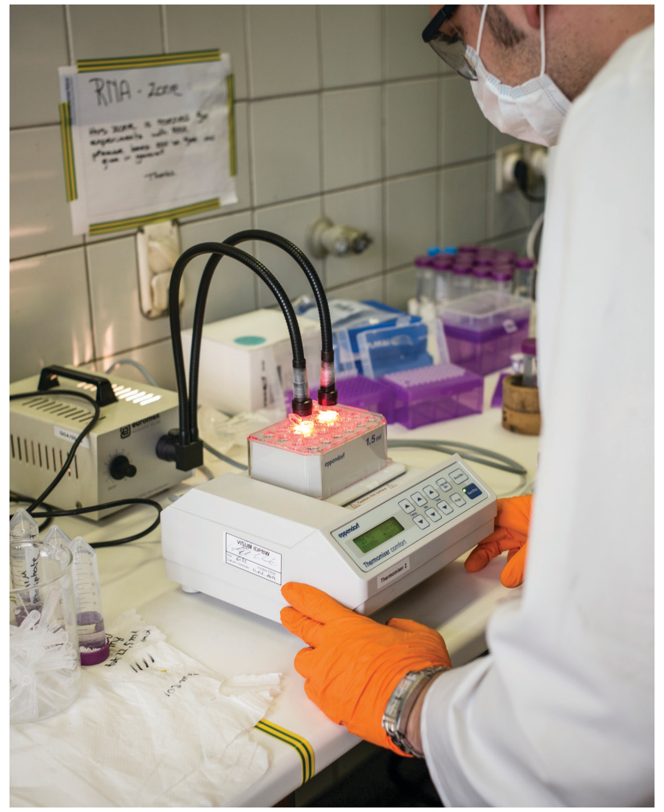
- Next Generation PEGylation
- Conjugates of poly(2-oxazoline) polymers for therapeutics, targeting and diagnostics
- Poly(2-oxazoline) & poly(2-oxazine) hydrogels (crosslinkable allylamido-polymers)
- Super hydrophilic poly(2-oxazoline)-(co)polymers biofilm resistant coatings
- PAOx-based polymer brushes for biosensor applications
- High molecular weight poly(2-oxazoline)s as excipient for drug formulations including solid dispersion tablets, nanofibers or 3D printed oral dosage forms
- 3D-printable thermally triggered PAOx-template scaffolds for tissue engineering

Next generation polyethyleneimines for RNA delivery

- Well-defined linear cationic polymers for gene therapy
- Non-viral vectors comprising polypropyleneimines

Easy-to-inject self-assembling peptide based hydrogels for controlled delivery

- Short self-assembling peptides for controlled delivery of small molecules, peptides, nanobodies, antibodies, cells
- Peptides consisting of natural amino acids, fully biodegradable and non-toxic
- thixotropic so injectable



Novel photo-curable nature derived biopolymers for fabrication of hydrogels

- 3D-printable gelatin-based bioinks to develop ECM-mimics and soft tissue
- Photo-curable hydrogels as wound dressings, coatings and drug delivery systems
- Scaffolds for regenerative medicine, including soft and hard scaffolds (e.g. bone-mimic)
- Injectable hydrogels for minimally invasive tissue engineering (e.g. breast reconstruction, skin regeneration)

Novel biocompatible polymeric platform to obtain unique bioresorbable soft tissues and bone mimics

- Platform of acrylate-endcapped urethane-based polymers (AUPs) serving the biomedical field with unique properties of being able to crosslink in the solid state
- Biodegradable and bioresorbable photo-curable poly-ε-caprolactone (PCL) or poly(lactic acid) (PLA)-based polymers
- Gelatin, Alginate- or Poly(ethylene glycol) (PEG)-based hydrogel precursors suitable for 3D(bio)printing and electrospinning
- Highly reactive biocompatible (biodegradable) polymers for high resolution laser-based 3D(bio)printing (micro-scaffolds for tissue engineering and organ-on-chip applications)
- Functionalised (bio)polymers to stimulate or to prevent cell adhesion
- Cell-interactive PET-like polyesters : biocompatible poly(alkylene therephtalates)
- Shape memory precursors and crosslinkable polyesters

OUR OFFER

BIOCOMPATIBLE & CELL-INTERACTIVE MATERIALS	PHOTO-CURABLE POLYMERS & HYDROGELS	BIORESORBABLE MATERIALS & SCAFFOLDS
HIGHLY FUNCTIONALISED POLYMERS	WELL-DEFINED CATIONIC POLYMERS	SUPER HYDROPHILIC POLYMERS
INJECTABLE HYDROGELS AND POLYMERS FOR DELIVERY	SELF ASSEMBLING PEPTIDE-HYDROGELS	STIMULI-RESPONSIVE AND SHAPE-MEMORY POLYMERS

PATENTED

OUR TOOLBOX

Chemical synthesis toolbox

Organic Synthesis

Our teams have expertise in synthesizing novel monomers and initiators as well as in the chemical modification of available building blocks. We offer extensive organic synthesis and characterization facilities.

Extensive expertise in peptide and oligonucleotide synthesis as well as synthesis of conjugates. Novel linker technologies for conjugate construction. Novel site-selective protein modification methods are being developed and applied to different natural proteins as well as applied on recombinantly expressed nanobodies.

Polymer Synthesis

We are specialized in the preparation of well-defined polymers with narrow molar mass distribution and good end group fidelity by living cationic ring-opening polymerization and controlled radical polymerization (RAFT, ATRP, NMP and Cu(0)-mediated polymerization). Also, several types of polycondensations are used in a wide number of ongoing projects.

To derive structure-property correlations in polymeric materials, we synthesize libraries of (co)polymers via high-throughput polymer synthesis in order to predict and control the desired polymer properties. Both parallel conventionally heated and serial microwave heated synthesis robots are available as well as a range of high-throughput analytical techniques to optimize polymerization kinetics and to determine polymer properties.

These advanced synthesis tools also allow the development and optimization of fast and green synthetic protocols.

Polymer Functionalization

We functionalize polymers during polymerization as well as by post-polymerization modification, often by making use of 'click' chemistry platforms, as a function of the targeted applications. In addition, we have acquired expertise in the functionalization of synthetic polymers and biopolymers with crosslinkable moieties and/or low molecular weight compounds (e.g. peptides, aptamers, labels and drugs) depending on the envisaged application.

Characterization Toolbox

Our researchers have following advanced characterization infrastructure at their disposal:

- Molecular characterization: Structural elucidation using NMR, MALDI-TOF, on-line IR, ...
- Polymer structure characterization: Determination of molecular weights and molecular weight distributions by size-exclusion chromatography (range of eluents and detectors) and 2D LC/SEC. Characterization of crosslinked (hydrogel) networks using HR-MAS NMR and dynamic and static vapor sorption measurements, ...
- Polymer Solution behavior by turbidimetry, dynamic light scattering, particle size measurements, viscosimetry,...
- Surface visualization and characterization: Measurement of microscopic features and microstructures to nano-scale dimensions using optical microscopy, SEM, TEM, AFM, IR mapping, XRD, XPS, ... Surface wettability using static and dynamic contact angle measurements. Surface interactions through quartz crystal microbalance-coupled ellipsometry.
- Thermal and mechanical analysis: Thermal behavior can be studied with differential scanning calorimetry and thermogravimetry; the mechanical behavior by dynamic mechanical analysis, rheology and materials testing equipment.

Advanced processing toolbox

3D-printing

In addition to thermoplastics (e.g. PET, PCL, PLA, PCL), we process hydrogel building blocks (natural versus synthetic polymers) and cell suspensions using extrusion- and laser-based additive manufacturing through a CAD-CAM approach. In addition to digital light projection (DLP) and stereolithography (SLA), we also offer volumetric 3D-printing and high resolution two-photon polymerization (2PP). We also offer solutions for in situ curing of crosslinkable polymer precursors. We also have at our disposal fused deposition modelling (FDM) to process polymer filaments (PLA and PCL) into predetermined shapes. The 3D-printed architectures can be surface-functionalized (e.g. cell-interactive, hydrophilic) if required depending on the envisaged application. Finally, we offer combinations of inkjet printing together with tunable polymer technology for biomedical applications.

(Co-extrusion) electrospinning

We offer our expertise and knowhow to assist you from the material selection till the pilot scale. After careful selection of the materials (including the solvent system), fibers are electrospun using mono- and multinozzle lab equipment. In addition, core-shell fibers can be produced using our co-extrusion electrospinning setup. Depending on the application, subsequent functionalization of the electrospun fabric will be necessary. Finally, our pilot installation can be used to produce the desired quantities for application testing.