EXPERTISE AT UGENT

SUSTAINABLE CHEMISTRY IN GHENT

FOR (SPECIALTY) CHEMICAL AND MATERIAL INDUSTRIES

UNIVERSITEIT GENT

OUR OFFER

This brochure gives the reader a concise overview of sustainable or green chemistry expertise in the Ghent region. The definition used for sustainable chemistry is the one of the *Organisation for Economic Cooperation and Development* (OECD). Sustainable chemistry is basically doing more with less: reducing the environmental impact of products and processes, optimising or rather completely avoiding the use of limited raw materials and minimising waste.

The R&D agenda in Flanders is based closely on what is happening at the European level. SusChem, the *European Technology Platform for Sustainable Chemistry*, has taken a leading role in this area and has defined 3 *Enabling Technologies*:

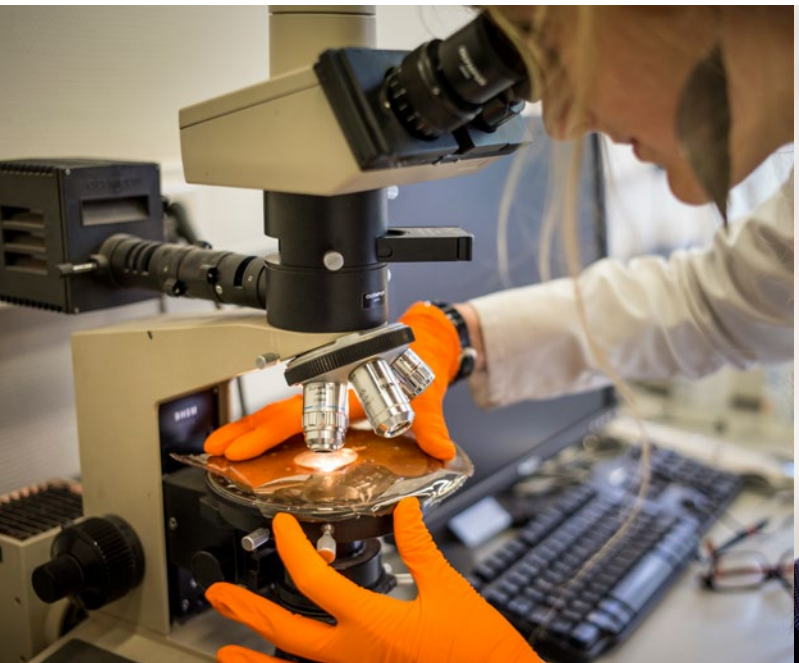
- **Industrial Biotechnology –** making use of biological innovations to improve industrial processes and products;
- **Materials Technology –** making use of nanotechnologies and advanced materials sciences to create new materials with unique properties;
- **Reaction & Process Design –** efforts aimed at ensuring that industrial processes operate in an integrated, efficient and environmentally-friendly manner.

In this overview, the expertise present in our region is presented according to SusChem's 3 *Enabling Technologies*. Research at Ghent University in these 3 Enabling Technologies is carried out by 27 independent academic staff (ZAP) leaders and 250 researchers (postdoctoral fellows and doctoral students), with further support from 40 technicians.

Our chemical expertise is engaged to tackle concrete challenges facing our society. These challenges are materialized as 5 R&D pipelines, grouped into 2 *Societal Challenge Innovation Programs*:

- **Resource Recovery –** recovering value from common waste flows where the waste flow is viewed as a raw material.
- **Chemicals from Renewable Resources –** making (fine) chemicals as well as polymeric materials from renewable resources, with focus on molecules that cannot be easily produced petrochemically.

The Ghent region provides a unique industrial pilot infrastructure. The 2 principal pilots are the **Bio Base Europe pilot plant** and the **Ghent University pilot for (steam) cracking**. Further to that, a particularly wide range of unique analytical and other instruments and expertise is available for industrial collaborations and services.



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KEY ENABLING TECHNOLOGIES

- REACTION AND PROCESS DESIGN
- INDUSTRIAL BIOTECH
- ADVANCED MATERIALS

SOCIETAL CHALLENGE INNOVATION PROGRAMS

- RESOURCE RECOVERY
- CHEMICALS FROM RENEWABLE RESOURCES

KEY ENABLING TECHNOLOGIES

REACTION AND PROCESS DESIGN

Existing production processes need to be continuously optimised and new production processes must be intelligently designed. The keywords here are sustainability, energy and raw material efficiency, productivity and flexibility. Ghent University's world-renowned expertise in the following highly intertwined technology platforms makes it an authority in this area.

- **Technology platform 1: Advanced Reactor Technology –** optimising existing technologies, development and scaling up of new (reactor) technologies.
- **Technology platform 2: Kinetic Modelling –** provide understanding of the reaction mechanism of chemical processes. Specific expertise present includes the kinetic modelling of reactions in complex mixtures consisting of hundreds of types of molecules.
- **Technology platform 3: Computational Fluid Dynamics (CFD) –** study the hydrodynamics of single- and/or multiple-phase flows, allows visualisation of previously unknown, complex transport phenomena leading to an improved reactor/process design
- **Technology platform 4: Catalyst Design –** integration of kinetic and pulse-response experiments, modelling and characterisation allowing a rational catalyst design.
- **Technology platform 5: Sustainability Assessment –** holistic approach which uses exergy analyses to focus on raw material consumption on the one hand and the efficiency of production and consumption chains on the other.

INDUSTRIAL BIOTECH

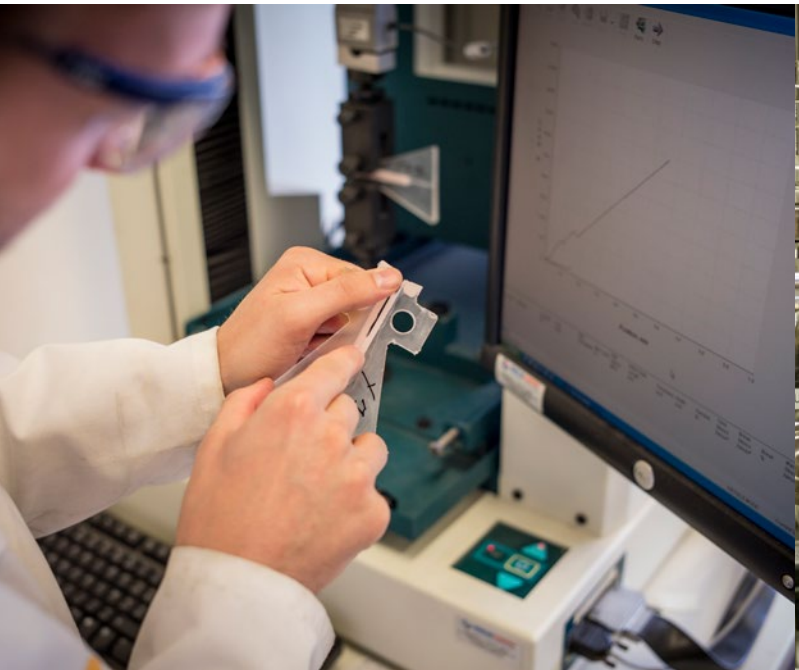
The Ghent region is particularly strong in the areas of enzyme engineering, biocatalysis, metabolic engineering and synthetic biology, bio-process engineering, fermentation, downstream processing (DSP), and chemical modification of bio-based chemicals. This expertise has been bundled into 5 technology platforms.

- **Technology platform 1: Enzyme Engineering –** development of enzymes suitable for industrial applications. The efforts are aimed at improving existing biocatalysts and creating biocatalytic activity for new target molecules and end products.
- **Technology platform 2: Engineering of Microbial Production Organisms –** creation of microbial production strains for the industrial fermentative production of "value added" biochemicals.
- **Technology platform 3: Chemical Modification –** modification of small bio-based building blocks, biopolymers and fatty acid derivatives. Particular focus lies on fine chemicals and the production and/or modification of natural and "new-to-nature" bioactive substances.
- **Technology platform 4: Microbial Electrosynthesis –** use of CO_2 as the raw material for the biosynthesis of various molecules which then undergo chemical and/or biocatalytic processing to become valuable bio-based chemicals.
- **Technology platform 5: Bio-Process Engineering –** creating processes for the production of bio-based molecules with high added value that can be scaled up to (semi-)industrial scale.

ADVANCED MATERIALS

The challenges facing today's society often require advanced materials sciences and nanotechnologies to create new materials with unique properties. Ghent University's chemical expertise in the field of advanced materials has been bundled into 3 technology platforms.

- **Technology platform 1: Organic and Macromolecular Chemistry –** efficient synthesis, characterization and application of functional organic polymers, novel organic building blocks and derived materials. Our researchers develop new and more efficient synthesis strategies to create polymer materials.
- **Technology platform 2: Inorganic Chemistry –** synthesis and characterisation of ceramic coatings, nano particles and bulk materials; colloidal nano crystals and application of their physical properties; mesoporous materials.
- **Technology platform 3: Analytical Chemistry, structural determination and materials characterisation –** unique characterisation infrastructure in Flanders from a molecular, structural and materials standpoint.



SOCIETAL INNOVATION PROGRAMS

RESOURCE RECOVERY

This program integrates research efforts into research trains around specific issues involving researchers from different disciplines in the area of Resource Recovery (membrane technology, microbial technology, electrochemistry, chemical technology, material technology, modelling, analytical chemistry).
The current 3 pipelines in this program are thematic, (advanced) technology collaborations focusing on a common waste flow which is viewed as a raw material. The goal is to carry out fundamental research that can lead to short- to medium-term applications in the chemical industry or urban environments.

- **Pipeline 1: Resource Recovery from (Waste) Water -** produce "fit-for-use" water from available aqueous sidestreams whilst recovering as many residues as possible and transform the latter into high-value compounds.
- **Pipeline 2: CO_2 to Product -** CO_2 in gaseous form is transformed either directly or via an aqueous phase into valuable basic chemical molecules or product groups using captation and conversion technologies.
- **Pipeline 3: From Solid Plastic Waste to Chemicals -** analysing the quality and purity of solid plastic waste to determine whether the waste can be recycled directly or, where this is not possible, whether it can be pyrolysed or depolymerised to obtain the chemical building blocks. In parallel research is performed in the field of "design for recycling" so that solid plastic waste can be more easily recycled in the future.

CHEMICALS FROM RENEWABLE RESOURCES

Industry is looking for new chemical building blocks with special properties, and in particular for molecules that cannot be easily produced petrochemically.
There is also a clear need for robust (bio)synthesis methods, eventually combined with chemical modification, for biologically active molecules that are currently produced via extraction.

- **Pipeline 1: (Fine) Chemicals from Renewable Sources -** fine chemicals and the production and/or modification of natural and "new-to-nature" biologically active substances. The engineering of enzymes (biocatalysis) and of industrial microbial production strains (metabolic engineering, synthetic biology), bioprocess engineering and upscaling including downstream processing, and possible subsequent chemical modification of the fine chemicals produced in this manner are not only sustainable alternatives to classical chemistry, but allow for other additional benefits such as enantioselectivity, high purity and yield.
- **Pipeline 2: Polymers from Renewable Sources -** this pipeline focuses on the engineering plastics and more specifically on the synthesis of new monomers derived from natural building blocks, and polymerisation into polymers with special properties that stand out from those that are currently using monomers obtained from classical petrochemical routes.

CONTACT INFORMATION

Sustainable Chemistry in Ghent is supported by the business development units **CleanChem, SynBIOmiX** and **ChemTech** being the main contact points for industrial collaborations.

The business units facilitate and coordinate a set of **industrial projects** and manage a **strategic IP portfolio** and its licensing opportunities.

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