

Supervisor(s)	Period	Funding
Prof. dr. ir. Kevin Van Geem Prof. Dr. Frederic Lynen Dr. Robin John Varghese	4 years	PFAROS

Ph.D.: Comprehensive 2D Analysis of Halogenated and Oxygenated Contaminants in Complex Matrices

Aim

Develop and validate advanced analytical procedures for the identification, characterization, and quantification of organic contaminants, heteroatom-containing compounds, PFAS, and elemental impurities across oil, gas, and water matrices arising from plastic-recycling processes — drawing on a broad suite of separation and detection technologies including one- and two-dimensional liquid and gas chromatography (HPLC, LC×LC, GC, GC×GC), element selective detectors (AED, SCD, NCD), high-resolution mass spectrometry (TOF-MS, qMS), and elemental analysis — in support of circular-economy safety and quality objectives.

Justification

Recycled plastic feedstocks and their derived streams — pyrolysis oils, process gases, aqueous condensates, and solid residues — carry a chemically diverse burden of contaminants: residual monomers, additives, degradation products, process by-products, legacy pollutants, heteroatom-containing species (sulfur, nitrogen, halogen compounds), per- and polyfluoroalkyl substances (PFAS), and elemental impurities (heavy metals, metalloids). No single analytical technique can address this complexity across all matrices and contaminant classes. GC×GC combined with high-resolution MS detection provides the necessary separation power but requires purpose-built methods and validated workflows tailored to these matrices. Recycling streams could also contain heteroatom-containing species (sulfur, oxygen, nitrogen, and halogen compounds), per- and polyfluoroalkyl substances (PFAS), and elemental impurities (heavy metals and metalloids), all of which pose distinct regulatory and toxicological risks. The analytical knowledge generated will directly support regulatory compliance (REACH, EU Food Contact Materials, NIAS frameworks, PFAS restrictions under EU POPs regulation), feedstock quality control, and process optimization across the plastic-recycling value chain.

Program

The PhD research is structured around three interconnected work packages:

WP1 – Contaminant Landscape & Method Strategy. Conduct a systematic review of contaminant classes relevant to mechanical recycling (PET, PE, PP, PS), solvent-based recycling, and pyrolysis streams. Define priority analyte lists — spanning organic contaminants, PFAS, heteroatom-containing species, and elemental impurities across oil, gas, and water matrices — in consultation with industrial partners, and identify which analytical approach (chromatographic separation, selective detection, elemental analysis, or a combination) best addresses each contaminant class and matrix type.

WP2 – Analytical Method Development & Validation. Design and optimize analytical procedures for each contaminant class and matrix, drawing on one- and two-dimensional separations (HPLC, LC×LC, GC, GC×GC), the full selective-detector suite (AED, SCD, NCD), high-resolution MS (TOF-MS, qMS), and dedicated PFAS workflows. Element-selective detection in LC is less developed than in GC. Expanding and benchmarking available halogen-selective LC detection options is an ongoing challenge, but progress is possible. Develop matched sample preparation protocols (solvent extraction, thermal desorption, headspace, SPE, ashing/digestion for elemental fractions). Validate for LOD, LOQ, linearity, precision, accuracy, and matrix effects (ISO 17025 / ICH Q2). Translate validated procedures into SOPs transferable to industrial partners.

WP3 – Non-Target Screening, Data Analysis & Dissemination. Apply non-target and suspect-screening workflows to discover unexpected impurities in real recycling samples. Use chemometric approaches (PCA, clustering) using Python or R to fingerprint contaminant profiles across technologies and feedstock origins. Elemental contaminant profiles (ICP-MS/OES or ED-XRF data) will be integrated with GC×GC molecular fingerprints to build a comprehensive picture of recycling-stream quality and risk. Publish in high-impact journals and present at international conferences.

Candidate Profile

Requirements:

- Master's degree in Analytical Chemistry, Chemistry, Chemical Engineering, or relevant topics.
- Hands-on experience with at least one analytical separation technique (GC, HPLC, or equivalent); ability to develop and troubleshoot analytical procedures independently.
- Practical laboratory skills and scientific curiosity — the ability to design analytical procedures from first principles, not just operate established methods.
- Genuine background in mass spectrometric structure elucidation, confident interpretation of HRMS in complex matrices.
- Ability to design experiments, work independently, and critically engage the primary literature.
- Strong scientific writing and communication skills in English.

Preferred:

- Experience with two-dimensional chromatography (GC×GC, LC×LC), selective detectors (AED, SCD, NCD), or PFAS analytical workflows is a significant advantage.
- Coding ability in Python or R for data processing, chemometrics, or workflow automation.
- Complementary techniques: HPLC, LC-MS/MS, FTIR, or TGA.

How to Apply

Apply by emailing Mohammadhossein.Havaei@UGent.be. Your application should include:

1. Curriculum vitae, including an overview of courses followed and grades.
2. Motivation letter (max. 2 pages) addressing your fit for this specific project.
3. Academic transcripts for your Bachelor's and Master's degrees.
4. Contact details for two academic referees (letters may be requested at a later stage).

This PhD position is available as of 01/01/2027 and remains open until the vacancy is filled. Informal inquiries are warmly welcomed.

A PhD at UGent and the LCT

We offer a challenging, stimulating, and internationally diverse research environment where you contribute to solving real-world problems with clear societal and industrial relevance. The UGent doctoral school program provides access to a broad range of courses and training. We offer a competitive PhD scholarship (1+3 contract, with an evaluation after year 1) and the opportunity to obtain a PhD in Engineering. The position is embedded within the PFAROS project, providing access to a cutting-edge industrial consortium and collaborative network at the frontier of plastic-recycling analytics.

The Laboratory for Chemical Technology (LCT) at Ghent University is one of the few laboratories worldwide that span the full range of chemical engineering, from the molecular to the process scale. Over 100 researchers, under the supervision of 10 professors, collaborate on fundamental kinetics, advanced analytics, reactor hydrodynamics, and process modeling. The analytical platform includes state-of-the-art GC×GC instrumentation hyphenated to TOF-MS, qMS, AED, SCD, and NCD, complemented by elemental analysis capabilities and dedicated sample preparation facilities.