Raman & SEM Group (PD Dr. N. P. Ivleva)

Institute of Water Chemistry
Chair of Analytical Chemistry and Water Chemistry
TUM School of Natural Sciences, Department of Chemistry
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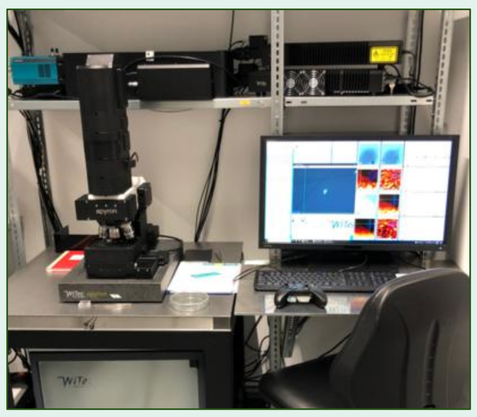
Analytical Methods

Raman Microspectroscopy

Combination of Raman Spectroscopy with Optical Microscopy



- Non-contact & non-destructive
- Vibrational fingerprint spectra
- Spatial resolution in µm-range: single-cells/-particles
- Chemical 2D & 3D imaging
- No interference of water

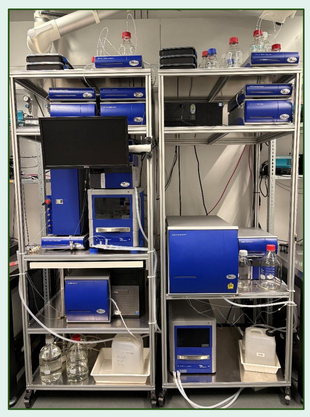
Scanning Electron Microscopy

Field emission SEM with Variable Pressure and Cryo Options

- Spatial resolution in nm-range
- Elemental composition based on characteristic X-rays (EDX)
- Analysis of non-conducting, water-containing and sensitive samples

Field Flow Fractionation

Flow-based Fractionation of nm-sized Particles

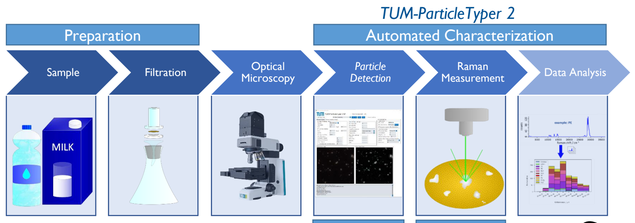


- Size fractionation based on separation force fields and diffusion properties of particles
- Asymmetrical Flow Field Flow Fractionation (AF4)
- Centrifugal Field Flow Fractionation (CF3)

Research Topics

Analysis of Plastic Particles in Water and Food

- Motivation: Missing of established methods for the quantification and identification of small plastic particles in real samples to assess health risks
- Aim: Analysis of water and milk samples down to 0.5 µm with *TUM-ParticleTyper 2 Software*. Analysis of nanoplastic particles in real matrices with online coupling of Field Flow Fractionation and Raman Microspectroscopy.



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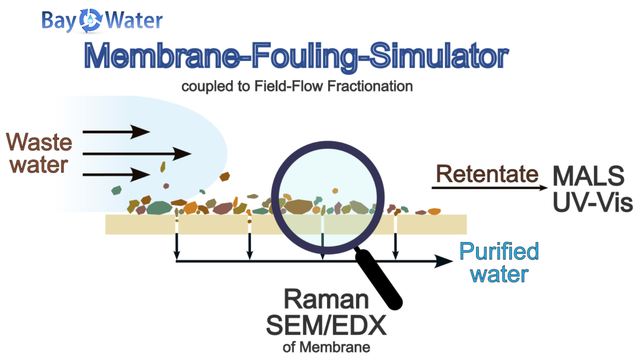
Characterization of Membrane (Bio-)Fouling

- Motivation: Deposition of particles or solutes on the reverse osmosis membrane - called (bio-)fouling - hinders its energy-efficient use in continuous processes
- Aim: Development and establishment of an advanced analytical method for the comprehensive physico-chemical characterization of membrane (bio-)fouling



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Microplastic Particles in Alpine Region

- Motivation: Despite significant laboratory advancements, a gap remains in practical and commercial applications for analysis of micro/nanoplastics
- Aim: Establishing and advancing reliable analytical methods based on Raman Microspectroscopy and Field Flow Fractionation for precise measurement and surveillance of micro/nanoplastics in the environment
- Workflow: 1. Sample collection and preparation
  2. Laboratory analysis and data evaluation
  3. Knowledge transfer to local industry and authorities

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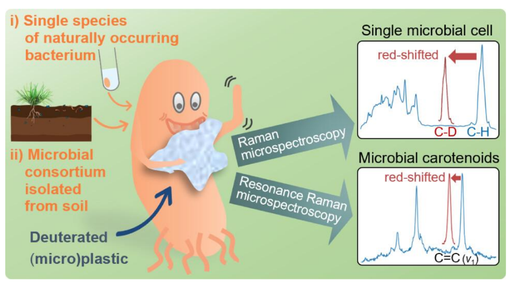
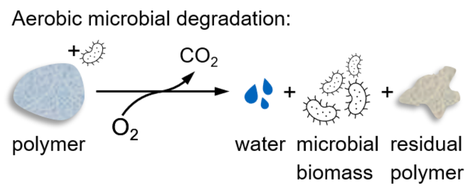
Biodegradability of Microplastic Particles

- Method development to monitor conversion of microplastics into final degradation products (CO_2, H_2O, and microbial biomass)
- Trace heavier stable isotopes from labelled polymer into microbial biomass with Stable Isotope Raman Microspectroscopy

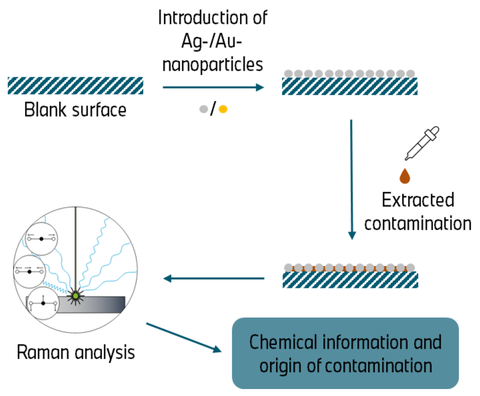




K. Müller, M. Elsner, A. E. Leung, H. Wacklin-Knecht, J. Allgaier, M. Heiling, N. P. Ivleva, Raman Microspectroscopy to Trace the Incorporation of Deuterium from Labeled (Micro)Plastics into Microbial Cells, *Analytical Chemistry* **2025**, doi.org/10.1021/acs.analchem.4c05827

SERS Analysis of Filmic Contaminations

- Motivation: Residue of organic substances, e.g. lubricants, on workpieces can interfere with the technical cleanliness by leading to the arise of weld spatter or reduced adhesion ability
- Aim: Establishment of an analytical method based on Surface-Enhanced Raman Spectroscopy (SERS) for the sensitive detection and identification of thin filmic contaminants



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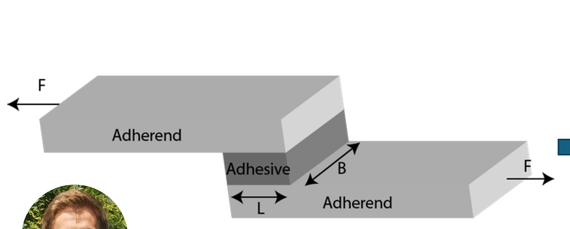
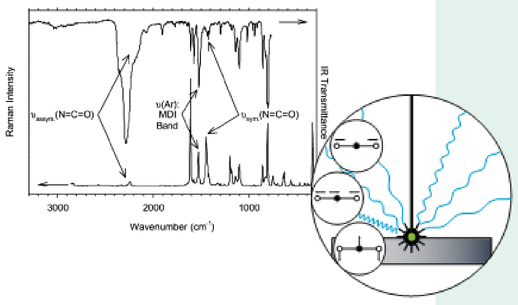
Nondestructive Analysis of Adhesives

Replacement of destructive lap-shear test due to high cost and low sustainability

- Tracking of polymerisation process via Raman and IR Spectroscopy under varying environmental conditions
- Combination of spectroscopic data with destructive analysis to develop prediction models for the strength of adhesives





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More information on our team, research topics, equipment, and publications at
https://www.ch.tum.de/hydrochemistry/raman-sem

Supported by:
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