# TurbidEye: Instrument development for automated water-sampling and microplastics composition analysis

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## Aim of the development

- To achieve automated water sampling and chemical analysis of synthetic polymer particles in water samples
- To allow implementation of unmanned and low-cost monitoring of microplastic contamination in waterbodies

## Technical Design

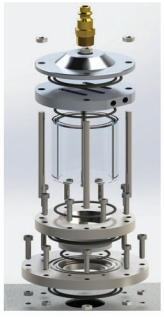
**Pre-filtering**

Water samples are collected driven by negative pressure generated by a pump system. Debris larger than 1 mm will be blocked away from entering the following processes.

**Fine filtering**

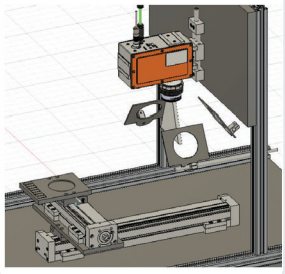
Fine particles (< 100 µm) will be able to pass through the fine filter and be entrapped on a porous water-permeable specimen carrier.

**Desiccation**



Solid samples gathered on the specimen carrier (made of quartz frits) will be dried with pressured airflow.

**Photo shooting**



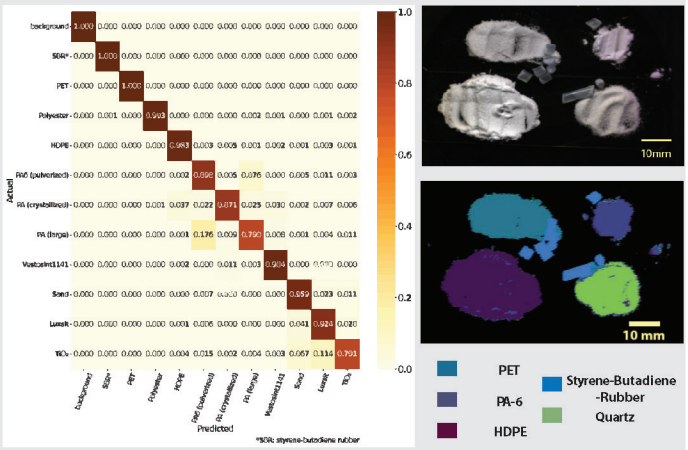
The particles of interest will be scanned with a near infrared camera mounted with a high-magnifying telecentric lens, reaching to an image resolution higher than 5 µm/pixel.

**Characterization**

Hyperspectral images will then be analyzed with embedded machine learning algorithms and particles will be chemically classified based on absorption/reflection spectra.

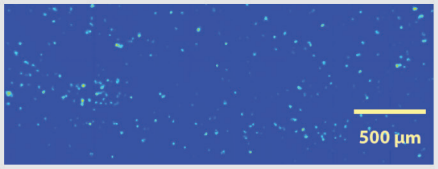
## First Results

- Supervised learning algorithms for microplastic classification exhibited high accuracy (>93% for over 10 different classes) in chemically characterizing samples with hyperspectral images of lower resolution (200 µm/pixel).




(Left) Confusion matrix of the machine learning model trained with the random decision forest algorithm. (Right) An image taken by the near infrared camera and the classification outcomes evaluated based on the trained machine learning model.

- With the help of precisely maneuverable (500 nm precision) steering axes, series of hyperspectral images with high resolution (~ 4.7 µm/pixel) can be captured while focusing on specific objects of interest. By subsequently averaging the signals of multiple repeated captures, denoised spectra with high quality can be obtained for further evaluation with machine learning algorithms at high accuracy.




A hyperspectral image of polyamide-6 particles with diameters ranging from 5 to 50 µm.

## Future Outlook

- Next steps are expectable in
  - optimizing the sampling units and processes to ensure reproducibility and reliability
  - enhancing the accuracy of chemical characterization of environmental microplastic samples
  - providing interactive digital interface to enable an easier operation and deeper automatization
- Foreseeable application areas
  - monitoring microplastic emission in wastewater effluents
  - examining microplastic contamination in the water supply system, especially in developing countries with poor water service

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