Identifying Microplastics in the North Sea: From Extraction to Detection

Claudia Lorenz, Lisa Roscher, Linn Speidel, Sebastian Primpke, Gunnar Gerdts

Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Biologische Anstalt Helgoland

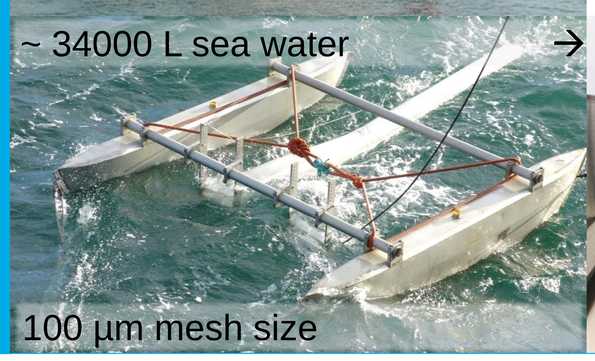
Microplastics (MPs, < 5 mm) have been identified as emerging topic of global concern. Therefore the detection of MP pollution has also been included in the European Marine Strategy Framework Directive (MSRL, descriptor 10.1.3) [1]. Although monitoring of MP pollution is demanded there are still knowledge gaps on how much MPs are out there, because the required analytics are challenging and no standard operating procedure (SOP) does exist so far. Environmental samples i.e. surface water samples contain next to MPs a high amount of natural organic material. The extraction of these MPs from the environmental matrix is crucial to enable a solid identification especially of small of MPs (11-500 µm) with state-of-the-art methods like micro Fourier transform infrared (µFTIR) spectroscopy.

In the framework of JPI Oceans BASEMAN project several innovative approaches were developed and processes optimized to gain insight into the extend of MP pollution in North Sea surface waters.

Sampling and Extraction

Heincke cruise 2014 (He430)

~ 34000 L sea water → 1 L sample



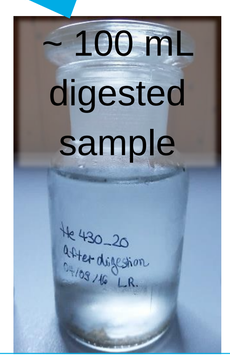
100 µm mesh size

Plankton sample containing a high amount of natural organic material

MP reactor [2]

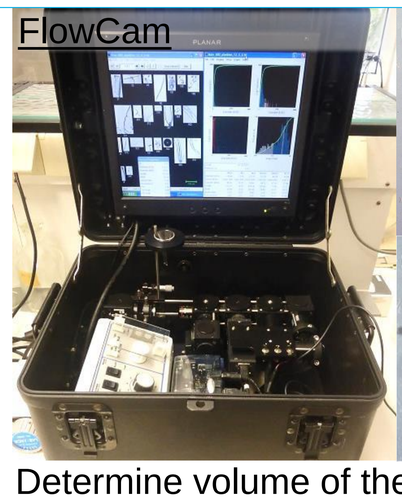
Enzymatic-oxidative treatment [3] for approx. 10 days

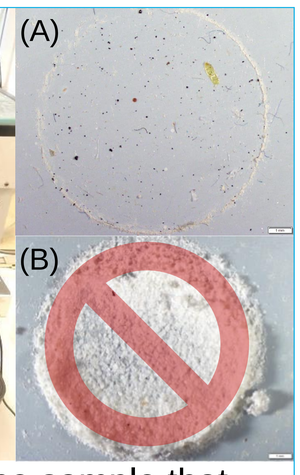
98.6 % reduction of natural organic material



~ 100 mL digested sample

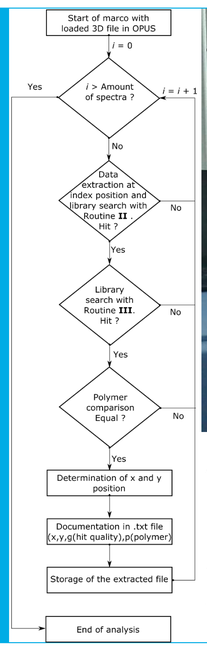
FlowCam





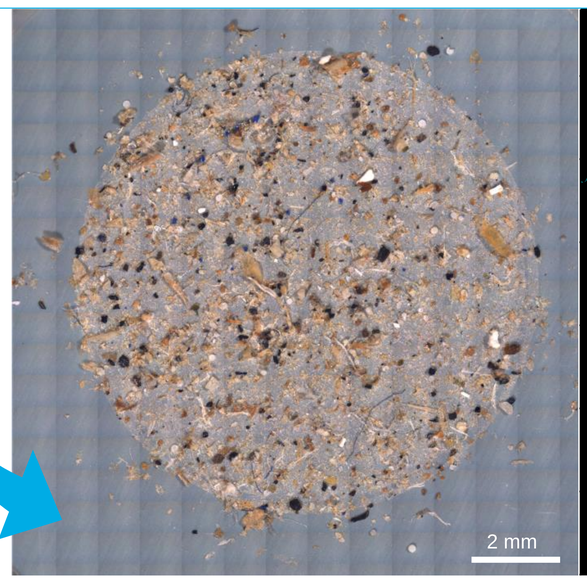
Determine volume of the sample that would cover (A) the filter area (ø 10 mm) without overloading (B) it, by calculating coverage of particles per 1 mL sample

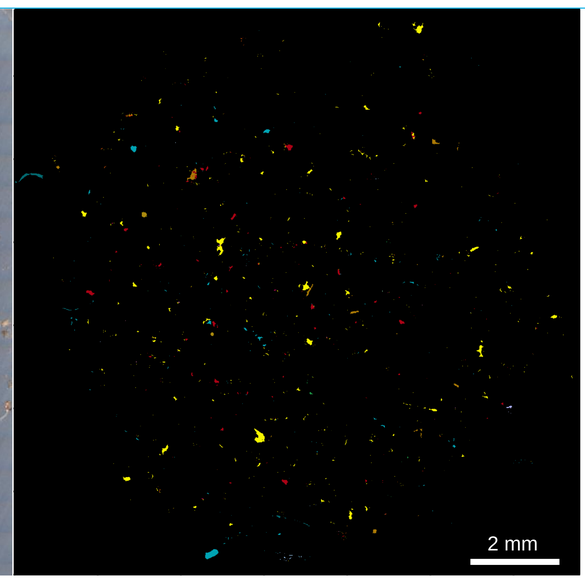
Detection



µFTIR spectroscopy

An automated analysis pipeline by Primpke et al. (2017) compares all spectra, measured on the whole filter area, to a profound database [4]





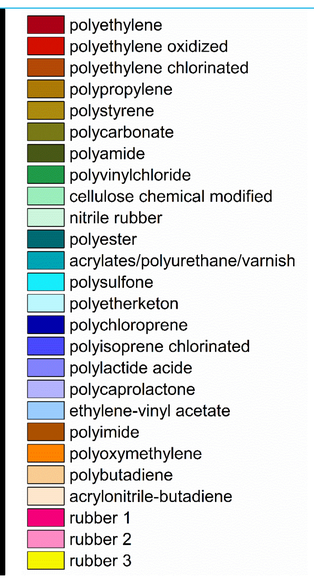
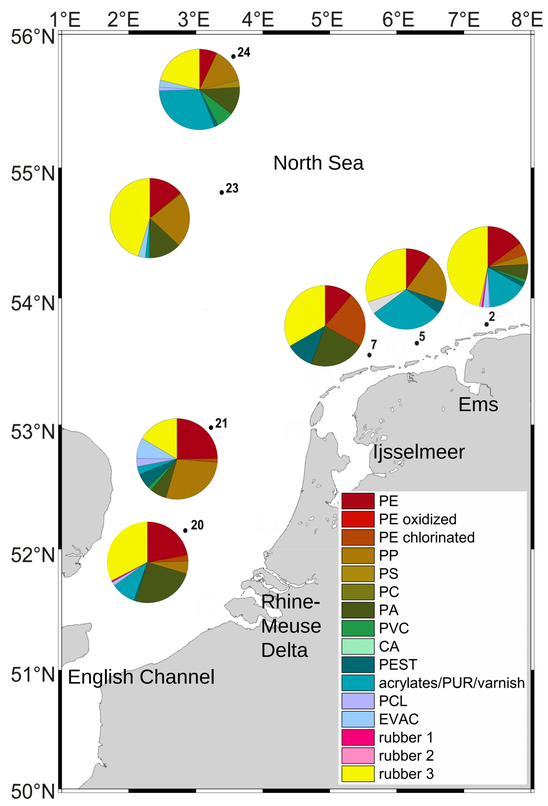
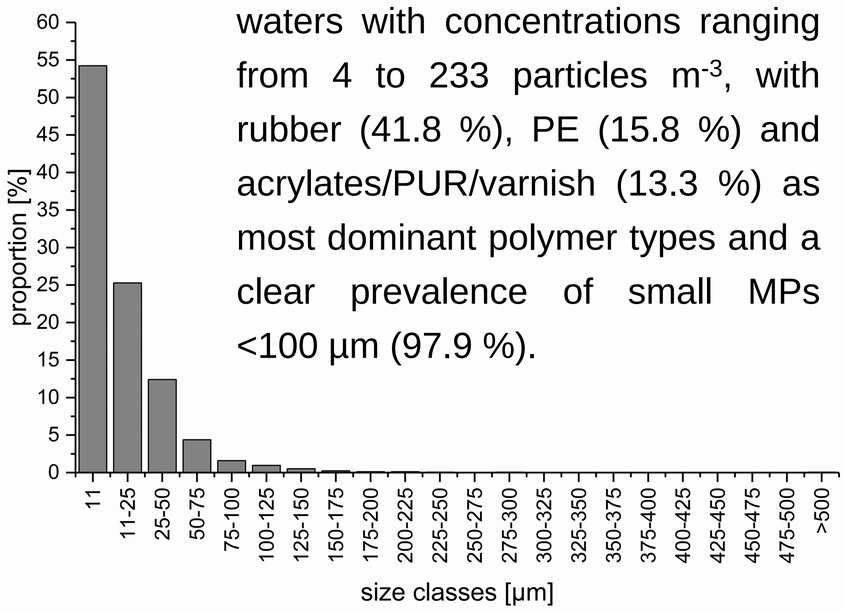


Image analysis [4] provides data on polymer composition, abundance and size distribution

Results and Conclusion



A first evaluation of seven samples from the North Sea showed an omnipresence of MPs in surface waters with concentrations ranging from 4 to 233 particles m^{-3}, with rubber (41.8 %), PE (15.8 %) and acrylates/PUR/varnish (13.3 %) as most dominant polymer types and a clear prevalence of small MPs <100 µm (97.9 %).



- ☆ Successful application of a highly efficient enzymatic-oxidative purification in newly developed MP reactors to approach challenging and elaborate preparation of samples
- ☆ Prevention of overloaded filters via FlowCam measurements
- ☆ Cutting-edge analysis with µFTIR spectroscopy and an automated analysis to produce valid data on polymer composition, abundance and size distribution with an identification down to a size limit of 11 µm

[1] European Parliament Council (2008) Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).1-22
[2] Gerdts G (2017) Reaktor zur enzymatischen Mazeration biogener Bestandteile einer Partikelprobe und Verwendung des Reaktors, DE102016123324 (B3)
[3] Löder MGJ, Imhof HK, Ladehoff M, Löschel L, Lorenz C, Mintenig S et al. (under revision) Enzymatic purification of microplastics in environmental samples.
[4] Primpke S, Lorenz C, Rascher-Friesenhausen R, Gerdts G (2017) An automated approach for microplastics analysis using focal plane array (FPA) FTIR microscopy and image analysis. Anal Methods 9:1499-1511

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