# Airborne Microplastic Detection and Quantification – Developing, Evaluating, and Applying Novel Laboratory and Field-based Approaches.

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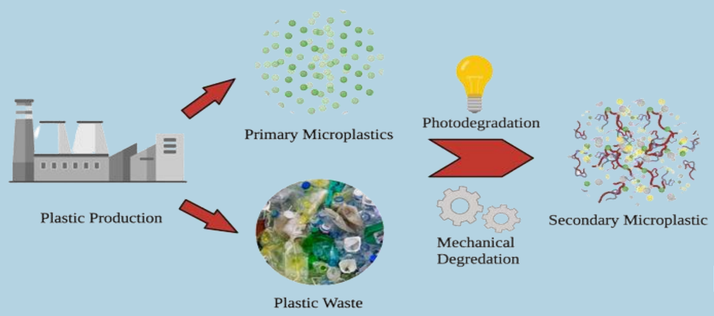
## What are Microplastics?

"Fragments of any type of plastic less than 5 mm in length"
(European Chemicals Agency)

Microplastics are separated into primary (designed for use as microplastics) and secondary (by-products of large plastic products)




[1]

*Figure 1: Generation routes of primary and secondary microplastics*

Microplastics can occur in a variety of shapes: Spheres/beads, Films, Fragments and Fibres


[2]

*Figure 2: Examples of common microplastic morphologies*

## Motivation

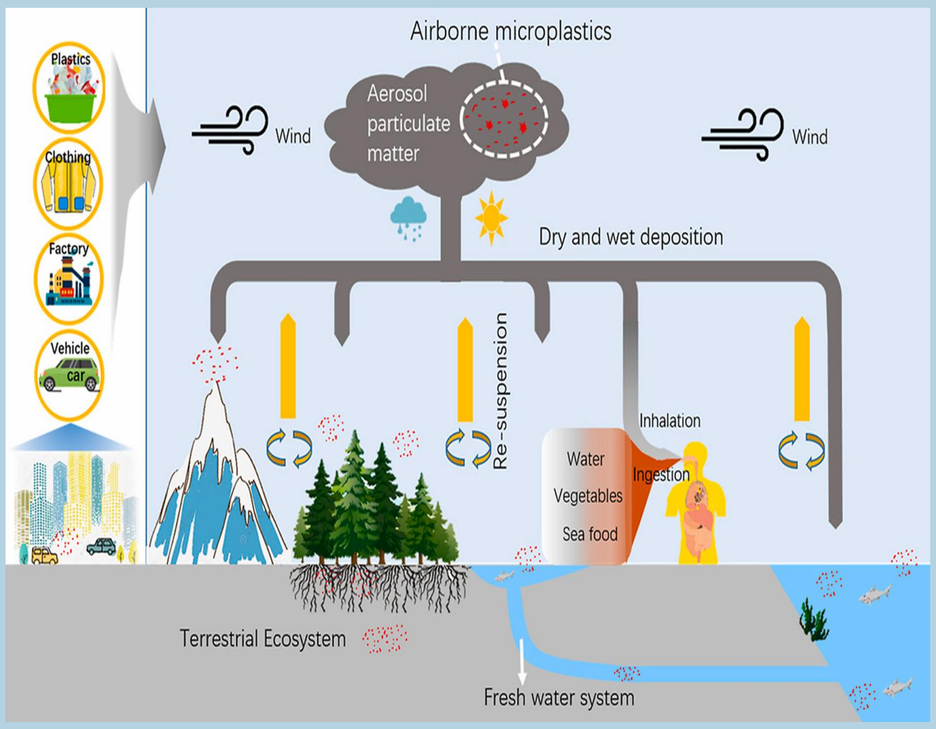



*Figure 3: Sources and routes of microplastic transport in the atmosphere* [3]

- Microplastics are a newly recognised components of air pollution
- Microplastics are stable, and persist in the environment
- Can release harmful components and transport pollutants
- Inhalation poses direct health risks
- Plastic production increasing

## Objectives

Aim: Develop a robust analytical technique to enable the study of airborne microplastics

1. Collect size fractionated microplastic samples from a range of environments
2. Optimise Pyrolysis Gas Chromatography Mass Spectrometry (Py-GCMS) for microplastics analysis
3. Improve understanding of inhalable microplastics composition
4. Engineer environmentally representative microplastic reference materials
5. Evaluate the efficacy of Ultraviolet-laser Induced Fluorescence (UV-LIF) as an in-situ online measurement technique

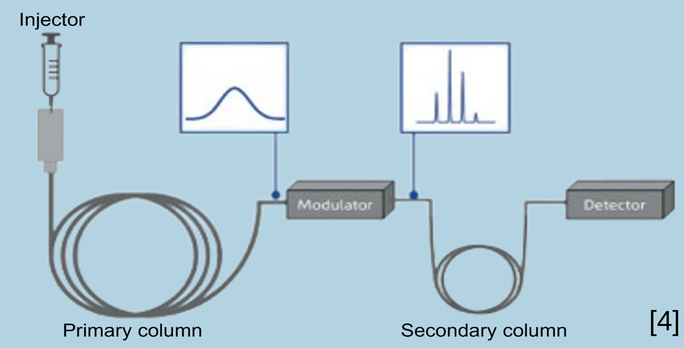
## Methodology

Analysis will be performed by Pyrolysis Gas Chromatography – Mass Spectrometry and Ultraviolet Laser Induced Fluorescence

<u>Mass Spectrometry:</u>
Using pyrolysis allows for direct sample injection with minimal sample preparation. Pyrolysis breaks down large molecules into constituent parts which produce a unique chemical signature for specific polymers and data generated is independent of particle morphologies. 2 dimensional analysis (Figure 6) provides higher resolution and can identify co-eluting compounds

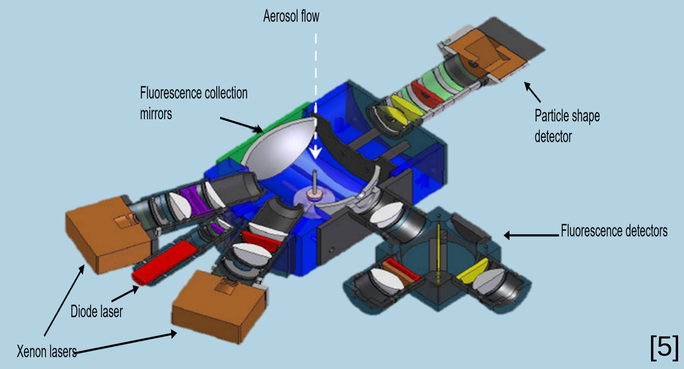
<u>Fluorescence:</u>
The fluorescence instrument is portable enabling In-situ measurements and provides multi-parameter data on Individual particles including size and shape.

New neural net algorithms will be employed to identify airborne particulate matter and use fluorescence lifetime and phase shift to identify polymers




[4]

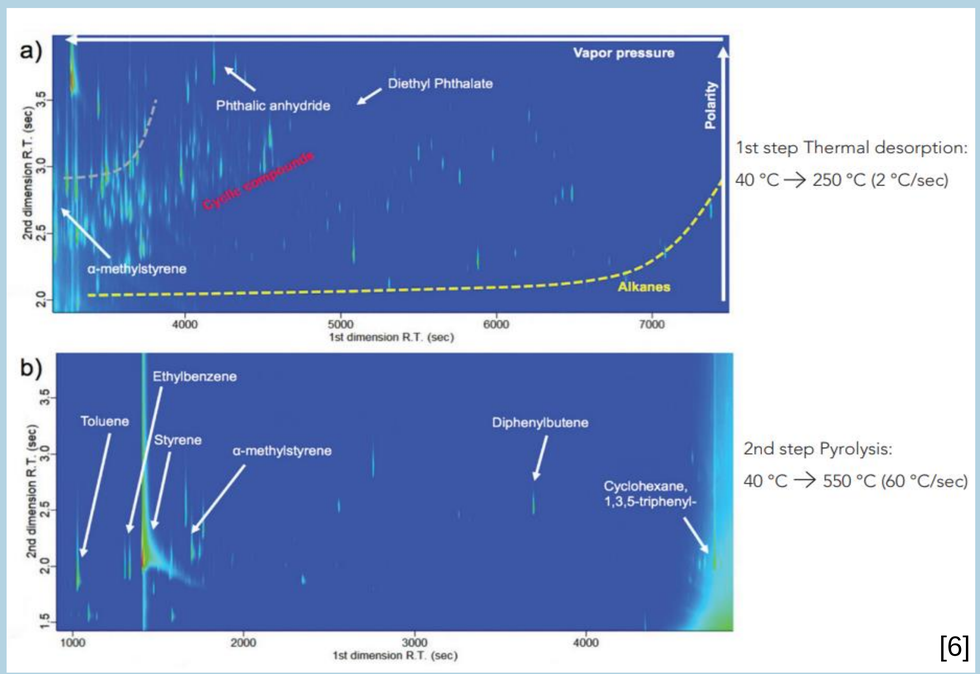
*Figure 4: Schematic of a 2 dimensional gas chromatography system*




[5]

*Figure 5: Schematic of a Wideband Integrated Bioaerosol Sensor (WIBS)*

## 2D Gas Chromatography




[6]

*Figure 6: 2 dimensional chromatograms of an ambient aerosol sample*

## Policy

There is minimal current legislation regarding microplastic emission which is mostly focused on marine microplastics and limiting primary microplastic emissions e.g. the UK 2018 microbeads ban.

This project may address the lack of reliable monitoring and provide evidence required for enforceable microplastic emission limits, which will complement existing air quality legislation.

## Responsible Innovation

Due to the ubiquity of plastic materials the introduction of new regulations on microplastic emission could have an adverse effect on the global economy.

Developing new materials or decreasing production to comply with these regulations could become costly to businesses and these costs may be passed onto consumers particularly in areas such as textiles, packaging and construction.

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[2] N. Beriot, 'EIP-AGRI Focus Group Reducing the plastic footprint of agriculture - starting paper', May 2020. Accessed: Apr. 06, 2023. [Online]. Available: https://ec.europa.eu/eip/agriculture/en/publications/eip-agri-focus-group-plastic-footprint-starting

[3] L. Shao et al., 'Airborne microplastics: A review of current perspectives and environmental implications', J Clean Prod, vol. 347, p. 131048, Mar. 2022, doi: https://doi.org/10.1016/j.jclepro.2022.131048.

[4] D. Barden and L. McGregor, 'A Guide to Modern Comprehensive Two-Dimensional Gas Chromatography.', The Column, vol. 13, no. 10, pp. 14–20, Jul. 2017, Accessed: Apr. 06, 2023. [Online]. Available: https://www.chromatographyonline.com/view/guide-modern-comprehensive-two-dimensional-gas-chromatography-0

[5] 'WIBS-5 Wideband Integrated Bioaerosol Sensor', Droplet Measurement technologies, 2023. https://www.dropletmeasurement.com (accessed Apr. 06, 2023).

[6] N. Jones, J. Wendt, S. Wright, E. Hartner, and T. Groeger, 'Analysis of Microplastics in Environmental Samples by Pyrolysis/Thermal Desorption-(GC)xGC-TOFMS', Chromatography Today, May 26, 2021. https://www.chromatographytoday.com/article/columns-gc/52/leco-instruments/analysis-of-microplastics-in-environmental-samples-by-pyrolysisthermal-desorption-gcxgc - tofms/2954 (accessed Apr. 06, 2023).