Qualitative and quantitative analysis of synthetic polymers in ambient aerosols by Curie Point Pyrolysis-Gas Chromatography/Mass Spectrometry

Ankush Kaushik, Majda Mekic, Manuela van Pinxteren, Anju Elizbath Peter and Hartmut Herrmann

Leibniz Institute for Tropospheric Research (TROPOS), Atmospheric Chemistry Department (ACD), Permoserstraße 15, 04318, Leipzig, Germany

Contact: kaushik@tropos.de

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Introduction:

Nano- and micro-plastics (NMPs) have been observed in all environmental matrices, including the atmosphere[1]. NMPs in the atmosphere have gained attention due to their persistence and eco- and human-toxicological hazards[2].

Motivation:

- Most attention is focused on deposited particulates in atmospheric NMPs research, while little is known about submicron-suspended particles expressed as mass per volume[3].
- Inconsistencies occurs in the sampling, processing, analysing, and Quality Assurance (QA) and Quality Control (QC) processes of NMPs, making it difficult to examine their spatiotemporal patterns.
- A standard methodology is needed to analyse NMPs at submicron levels.

Objective:

Investigation of synthetic polymers in atmospheric submicron particles using Curie-Point Pyrolysis Gas Chromatography (CPP-GC-MS).

Sample Collection:

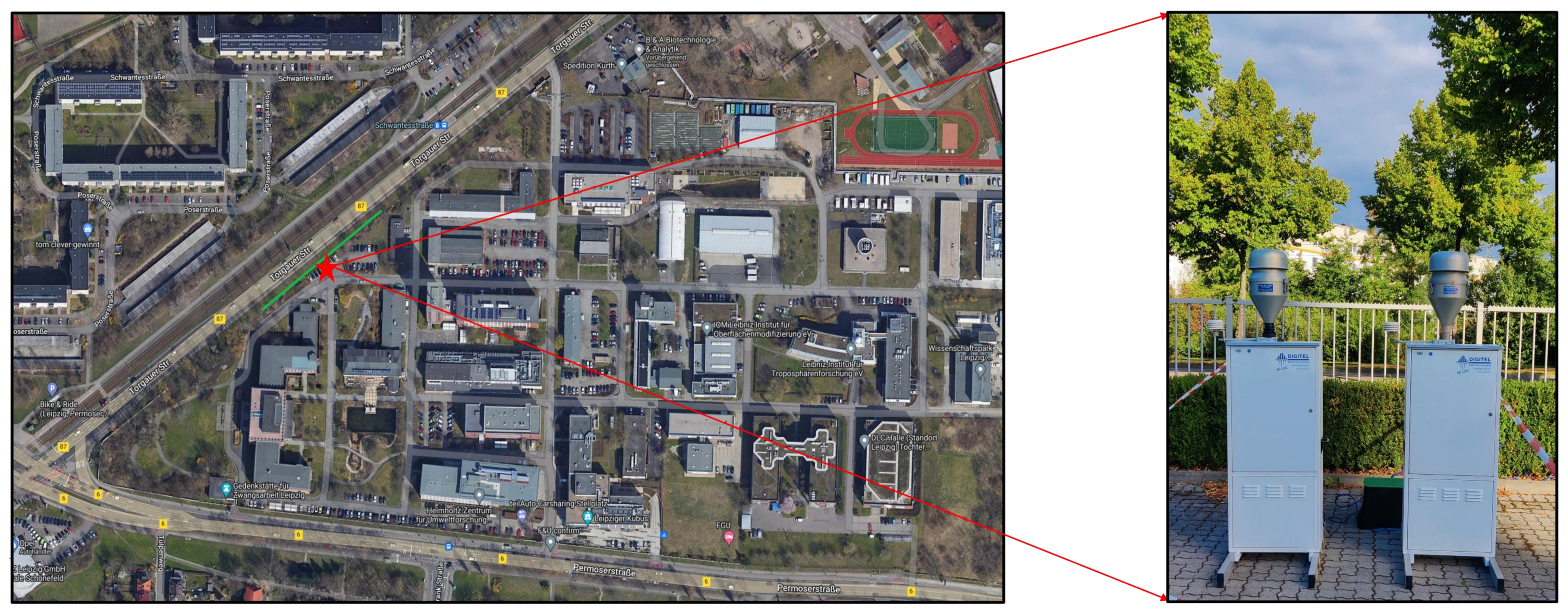

Fig. 1: Image shows the geographic Location (Torgauer Straße, Leipzig) of sample collection site.

PM_{10} and $PM_{2.5}$ samples were collected on quartz fibre filters with 150 mm diameter using DIGITEL high-volume sampler.

Outlook and Future Work:

- This research facilitates routine analysis of ambient aerosol samples for synthetic polymers.
- Analysis of more synthetic polymer standards like PE, PP, PET, PVC, PU, PMMA, and TWPs in pure substance and in mixtures 'doped' in varying concentrations using CPP-GC-MS.
- Determination of instrumental LOD and LOQ for the analysed polymers.
- Quantification of NMPs in size classes relevant to air quality is aimed at submicron levels.
- Chamber studies on the formation and ageing of airborne NMPs and TWPs.
- Modelling for mobilization and atmospheric spread will be developed.

Methodology:

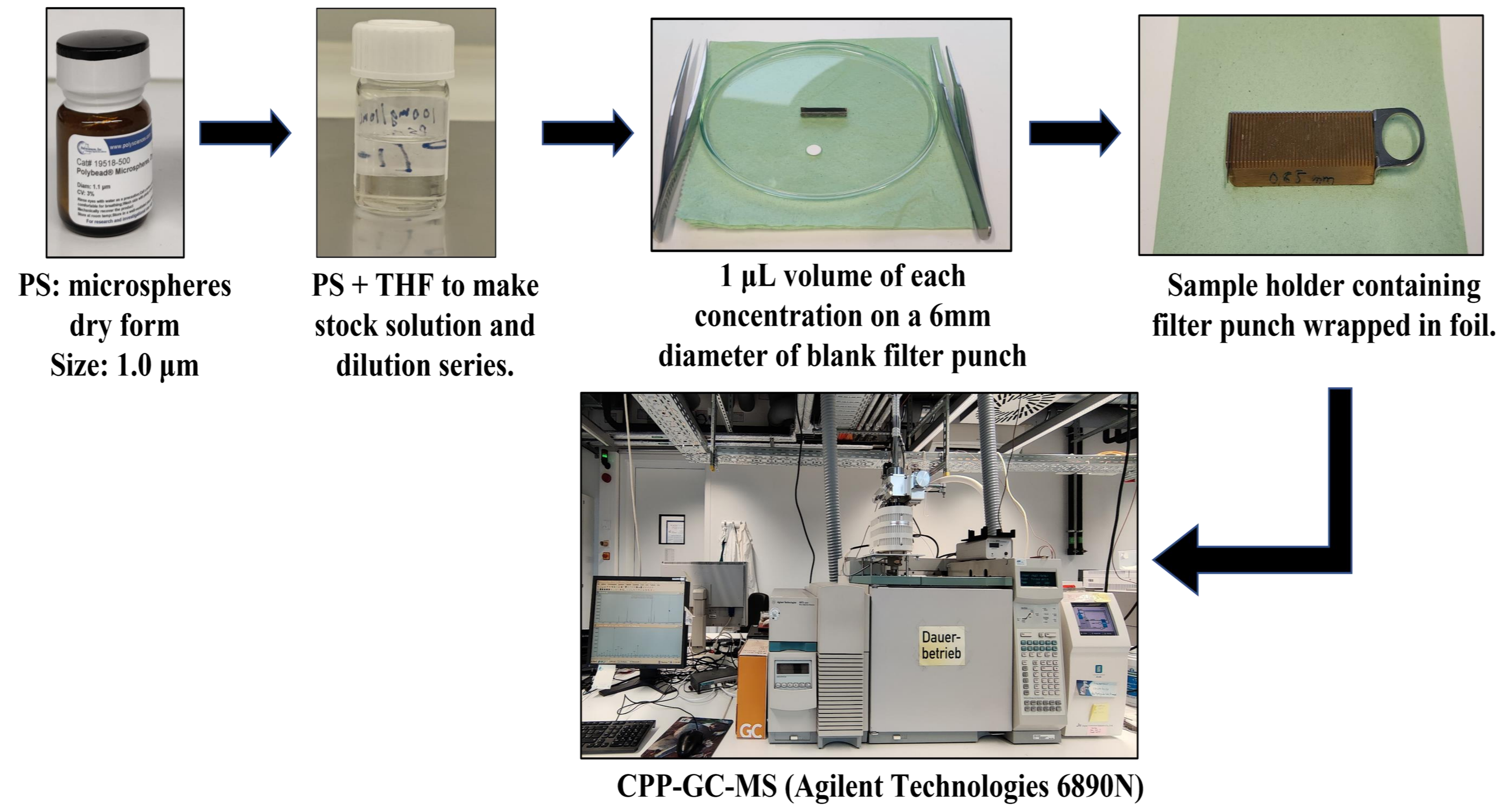

Fig. 2: Detailed methodology followed for the analysis of PS standard using CPP-GC-MS.

Results:

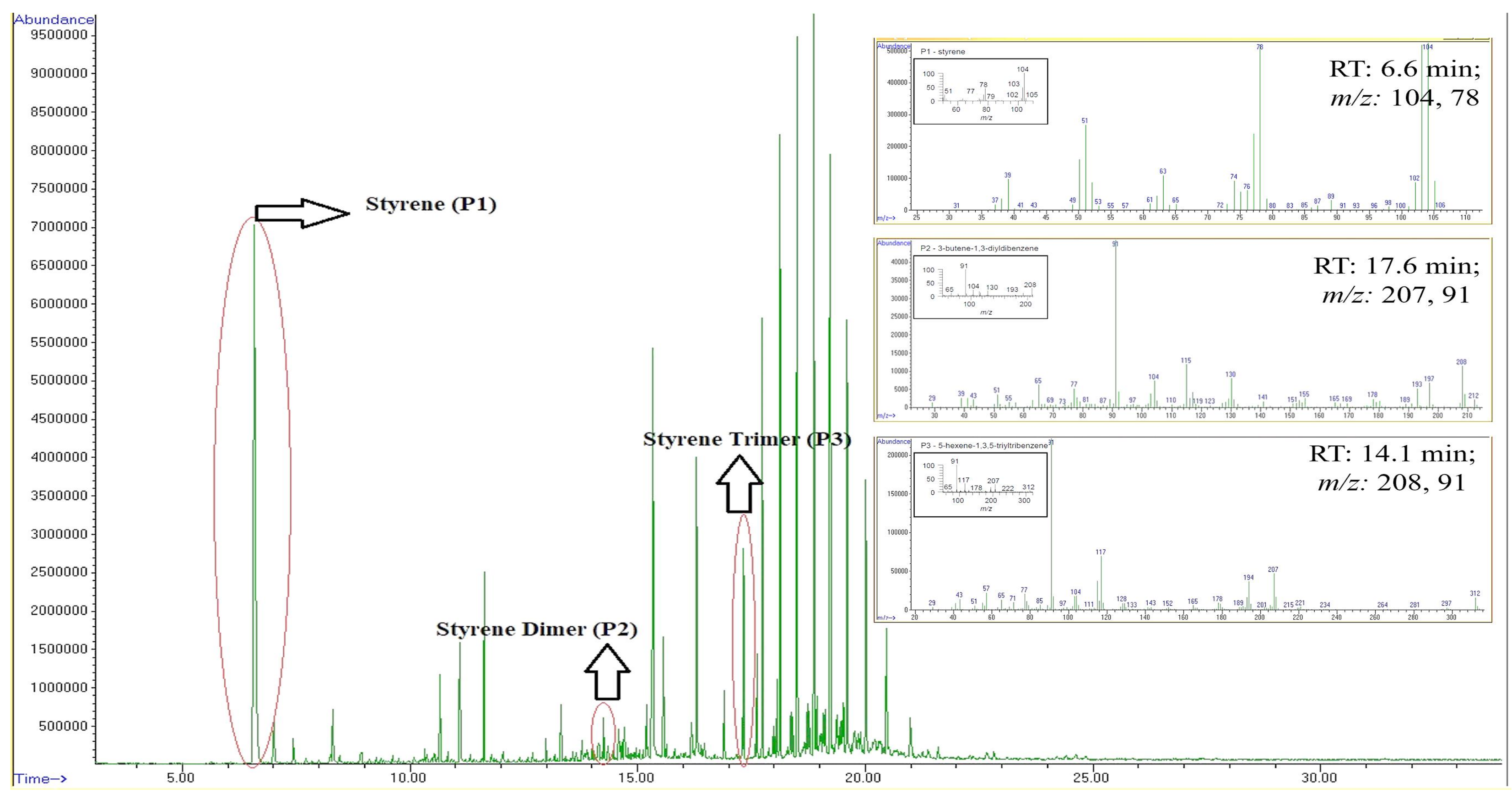

Fig. 3: Total ion chromatogram and m/z ratio from the analysis of PS standard.

PS has three favoured indicator compounds, styrene monomer (P1), styrene dimer (P2) and styrene trimer (P3)[4]. P1 is abundant, and therefore, it is a perfect indicator compound for PS quantification[4].

Results:

The calibration curve represents the consistency and good reproducibility of instrumental analysis.

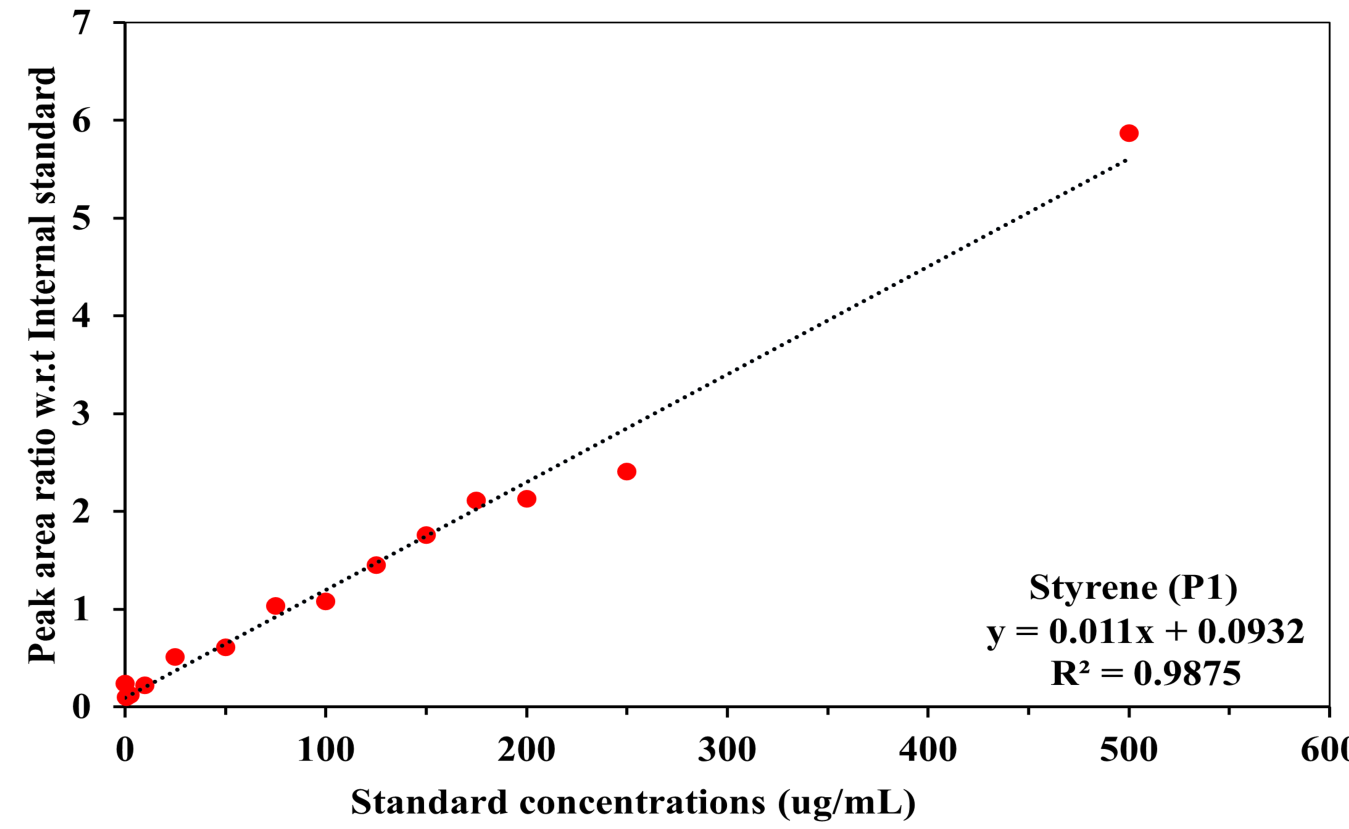

Fig. 4: Calibration curve obtained for Styrene (P1)

The results showed that styrene was present in the PM_{10} samples. Therefore this complements our adopted methodology for synthetic polymer analysis by CPP-GC-MS.

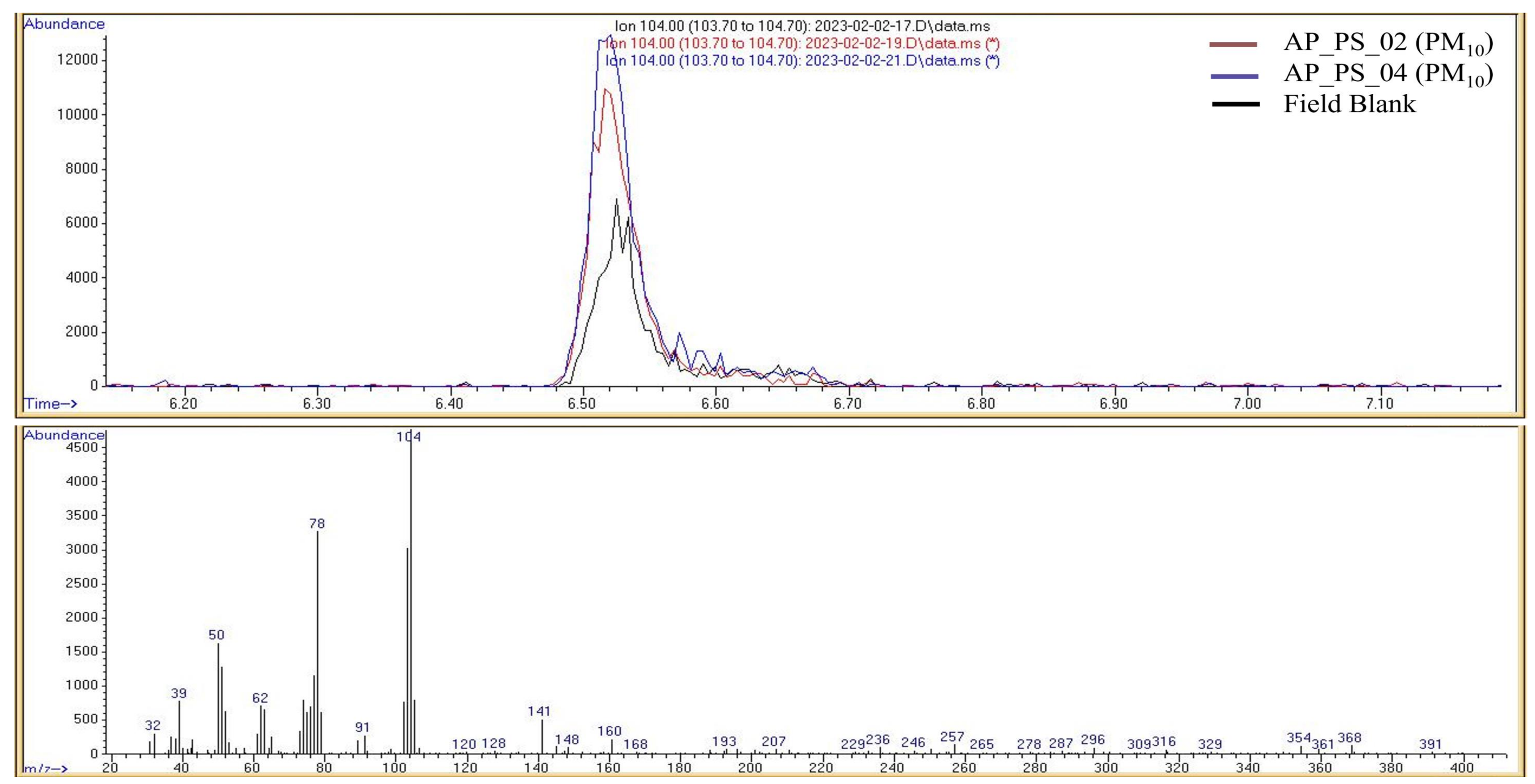

Fig. 5: Ion extracted (P1) overlay peaks for PM_{10} samples and field blank.

Acknowledgement:

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References:

[1] Fan et al., (2022), Environmental Science & Technology 56 (24), 17556-17568. **[2] Barbosa et al., (2020)**, Environmental Research, 182, 109089. **[3] Costa-Gómez et al., (2023)**. Science of The Total Environment, 856, 159041. **[4] Fischer et al., (2017)**. Environmental science & technology, 51(9), 5052-5060.