Method development for analysing synthetic polymers in atmospheric submicron particles by Curie-Point Pyrolysis-Gas Chromatography-Mass Spectrometry

Ankush Kaushik, Majda Mekic, Manuela van Pinxteren, Simeon Schum and Hartmut Herrmann
Atmospheric Chemistry Department (ACD), Leibniz Institute for Tropospheric Research (TROPOS), Permoserstraße 15, Leipzig, 04318, Germany
Keywords: Nano- and microplastics, tire wear particles, synthetic polymers, atmospheric particles, Curie-Point Pyrolysis-Gas Chromatography-Mass Spectrometry.
Associated conference topics: Special Sessions (Airborne Nano- and Microplastics), 3.5 and 3.7
Presenting author email: kaushik@tropos.de

Nano- and microplastics (NMP), including tire wear particles (TWP), are now a global concern in the terrestrial and marine environment and are subject of intense study. The existence of NMP and TWP in many different environments has been reported, including soil, sediment, dust, glaciers, lakes, rivers, seas, and oceans. However, only a few studies have examined the abundance and fate of synthetic polymers in ambient atmospheric particles (Luo *et al* (2023), Costa-Gómez *et al* (2023*),* Goßmann *et al* (2021 and 2022)). The dispersion, atmospheric transport and deposition of NMP and TWP are important steps in the biogeochemical cycle of plastic. The inconsistencies in the methods of sampling, processing, analysis, and the Quality Assurance (QA)/ Quality Control (QC) procedures of NMP and TWP hinder our ability to examine these contaminants' spatial and temporal patterns in the atmosphere. Based on the previously reported research on the analysis of NMP and TWP in the air, it becomes necessary to develop a comprehensive standard methodology that should be established for detecting microplastics in the atmosphere at submicron level (PM_{10} and $PM_{2.5}$). Since synthetic polymers are difficult to quantify at low concentrations, Pyrolysis-Gas Chromatography coupled with Mass Spectrometry provides an effective technique for detecting NMP and TWP. As part of the present study, an advanced analytical method is currently being developed for the qualitative as well as quantitative (in terms of mass concentrations) measurement of plastic polymers in the atmospheric submicron particles using Curie-Point Pyrolysis Gas Chromatography coupled with Mass Spectrometry (CPP-GC-MS). We aim to develop and provide methods and measurement approaches that would facilitate the routine analysis of PM_{10} and $PM_{2.5}$ samples for synthetic polymers in atmospheric particles in terms of mass concentrations using CPP-GC-MS. In order to achieve this the initial aim is to analyse synthetic polymer standard like polystyrene (PS), polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET), polyvinyl chloride (PVC), poly- (methyl methacrylate) (PMMA), tire wear particles (TWP) in pure substance and in mixtures 'doped' in varying concentrations using CPP-GC-MS followed by the determination of Limit of Detection (LOD) and Limit of Quantification (LOQ) of each standard by analysing it at different concentrations down to the lowest level with acceptable repeatability and accuracy. In preparation for first measurement, PS markers from the standard and atmospheric aerosol samples (PM_{10} and $PM_{2.5}$) were identified via CPP-GC-MS (Figure 1). Similarly, more analysis will be performed in future for the most common plastic polymers present in the atmospheric environment. The present study examines open research questions in various areas, such as analytical method development, size-resolved sampling, and analysis of NMP and TWP in ambient atmospheric particles in urban, rural, and remote areas.

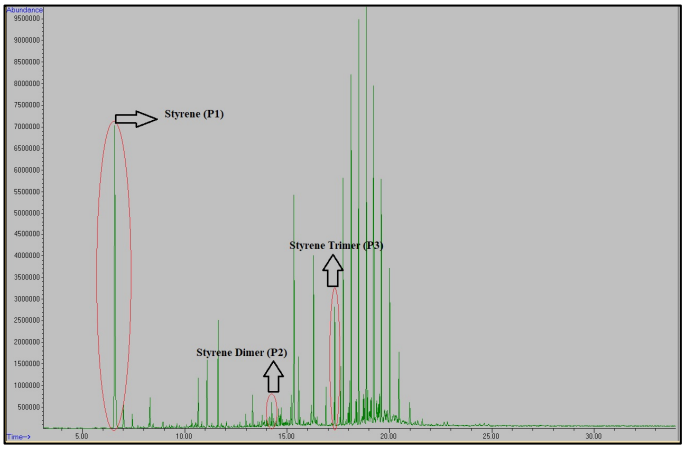

Figure 1. Total ion chromatogram (TIC) of identified PS markers.

Acknowledgment: This work is a part of "AirPlast" project funded by the German Leibniz Association under the project no. K389/2021.

References:

Luo, P., Bai, M., He, Q., Peng, Z., Wang, L., Dong, C., and Cai, Z. (2023). *Analytical Chemistry,* 95 (7), 3556-3562.

Costa-Gómez, I., Suarez-Suarez, M., Moreno, J. M., Moreno-Grau, S., Negral, L., Arroyo-Manzanares, N., and Peñalver, R. (2023). *Science of The Total Environment*, 856, 159041.

Goßmann, I., Süßmuth, R., and Scholz-Böttcher, B. M. (2022). *Science of The Total Environment*, 832, 155008.

Goßmann, I., Halbach, M., and Scholz-Böttcher, B. M. (2021). *Science of the Total Environment*, 773,145667.