



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

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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 aerosol particles. 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, 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 aerosol particles in terms of mass concentrations using Curie Point Pyrolysis-Gas Chromatography coupled with Mass Spectrometry (CPP-GC/MS). To follow this, reference standards were milled using a cryo-mill, and a calibration curve was obtained for the most common synthetic polymers present in the atmospheric environment, such as Polystyrene (PS), Polypropylene (PP), Polyethylene Terephthalate (PET), High-Density Polyethylene (HDPE), Low-Density Polyethylene (LDPE), Polyvinyl Chloride (PVC), Poly(methyl-methacrylate) (PMMA) and Styrene Butadiene Rubber (SBR). The present study determined the Limit of Quantification (LOQ) and Limit of Detection (LOD) of each standard by analysing it at different concentrations down to the lowest level with acceptable repeatability and accuracy. The current method of quantifying synthetic polymers was tested by spiking experiments on aerosol samples (PM_{10} and $PM_{2.5}$) at different concentrations. This study examines open research questions in various main areas, including developing analytical methods, size-resolved sampling, and analysing NMP and TWP in ambient aerosol particles in urban, rural, and remote areas.

Keywords: Nano- and microplastics, tire wear particles, synthetic polymers, Curie Point Pyrolysis-Gas Chromatography/Mass Spectrometry.