

# Quantitative analysis of airborne microplastics by pyrolysis-GC/MS

## Part 3: Determination of polymer components

**[Background]** The previous note (PYA1-184E) described double-shot measurements for airborne microplastics (AMP) in atmospheric particulate matter (PM), and volatile and polymer components of AMP were identified. In this note, concentrations of polypropylene (PP), polystyrene (PS) and styrene-butadiene rubber (SBR) in atmospheric PM were determined by Py-GC/MS based on the indicator ions of the characteristic pyrolyzates of polymers.

**[Experimental]** For measurements, a GC/MS system equipped with a Multi-Shot Pyrolyzer (EGA/PY-3030D) directly interfaced to the GC inlet was used. A metal capillary column (UA5-30M-0.25F) was used as a separation column and connected to the mass detector via Vent-free GC/MS adapter. The split ratio of the GC injector was set to 1/10. The PM-collected filter was punched into 4-mm-disks, and three of them were placed in a sample cup and were subjected to the double-shot measurement. The absolute calibration curve method was used to determine the polymer content (absolute amount). For creating the calibration curves, the MP calibration standard (MPs-SiO<sub>2</sub>, Frontier Lab.) was used after diluting 100-fold with silica powders (diluent SiO<sub>2</sub>, Frontier Lab.). As shown in Fig. 1, the distribution area of collected particles differs depending on the sized fractions, and therefore the calculation method for quantitative values also differs. For PM<sub>10</sub> and PM<sub>2.5-10</sub>, PM was distributed as 12 spots on the filter, and three spots of them including the whole sampling area were punched into 4 mm disks for qualitative analysis. Accordingly, the quantified amount was multiplied by four and divided by the total volume of air that passed through the MCI sampler during the sampling period (see Part 1), yielded the polymer concentration (ng m<sup>-3</sup>). For PM<sub>2.5</sub>, since PM was collected over the entire effective filtration area of a 40 mm filter, the quantified amount was multiplied by 100/3 and divided by the total air sampled volume yielded the polymer concentration.



Fig. 1 PMs collected on filters of the MCI sampler

**[Results]** Table 1 summarizes the indicator compounds and ions used for quantifying each polymer, along with the calibration curve equations and LOD. The calibration curves showed a good linearity. Table 2 summarizes the quantification results for PP, PS, and SBR in air. PP and PS were predominantly detected in PM<sub>2.5</sub>, while SBR was present in larger particles >PM<sub>10</sub>. Whereas, other polymers showed results below the LOD. This indicates that more sensitive analytical methods are required for the determination of polymer components in atmospheric PM. Consequently, the use of highly sensitive analytical methods, such as Py-GC/MS using the F-Splitless injection, would be viable for future work. In summary, the quantitative results on AMP obtained by the double-shot method with split injection revealed that PS and PP predominantly exist as PM<sub>2.5</sub> with smaller aerodynamic diameters, while SBR tends to exist as >PM<sub>10</sub> with larger aerodynamic diameters.

Table 1 Polymer pyrolyzates used for identification and LODs.

Polymer	Pyrolyzate used for identification	Indicator ion (m/z)	Calibration curve (correlation coefficient)	LOD / μg
PP	2,4-Dimethyl-1-heptene	82	$y = 2.34 \times 10^4 x$ ( $r = 0.992$ )	0.03
PS	5-Hexene-1,3,5-triyltr benzene (styrene trimer)	91	$y = 3.35 \times 10^4 x$ ( $r = 0.997$ )	0.004
SBR	4-Phenylcyclohexene (SB hybrid dimer)	104	$y = 4.68 \times 10^5 x$ ( $r = 0.993$ )	0.01

Table 2 Polymer contents determined for AMPs.

Sample	Classification	Sample weight <sup>a</sup> / mg	Found value <sup>b</sup>		
			PP / ng m <sup>-3</sup>	PS / ng m <sup>-3</sup>	SBR / ng m <sup>-3</sup>
PM-A	>PM <sub>10</sub>	2.5±0.1	< LOD	0.25±0.08	6.3±0.7
	PM <sub>2.5-10</sub>	2.8±0.1	0.83±0.16	0.44±0.05	< LOD
	PM <sub>2.5</sub>	3.5±0.2	3.5±0.5	0.76±0.37	< LOD
PM-B	>PM <sub>10</sub>	2.7±0.2	< LOD	0.09±0.02	2.3±0.4
	PM <sub>2.5-10</sub>	3.1±0.1	0.36±0.07	0.109±0.003	1.4±0.2
	PM <sub>2.5</sub>	3.7±0.1	< LOD	< LOD	< LOD

a : Total mass of three punched disk filters used for measurements, b: Average value of three repeated measurements.

1) H. Mizuguchi et al., *J. Anal. Appl. Pyrolysis* 171 (2023) 105946.

**Keywords :** Environmental sample, Environmental pollutants, Airborne microplastic, MPs, Airborne particles, Particulate, Air sampler

**Products used :** Multi-Shot Pyrolyzer, Auto-Shot Sampler, MP calibration standard set, Eco-Cup LF, UA<sup>+</sup>-5, Packed GC glass insert, Vent-free GC/MS adapter, F-Search MPs

**Applications :** Environmental analysis, Trace analysis, General polymer analysis

**Related technical notes :** PYA3-050E (Part 1), PYA1-184E (Part 2)

Please forward your inquiries via our web page or send us a fax message.

**R&D and manufactured by :**

**Frontier Laboratories Ltd.**

Phone: (81)24-935-5100 Fax: (81)24-935-5102

[www.frontier-lab.com](http://www.frontier-lab.com)