

Quantitative analysis of airborne microplastics by pyrolysis-GC/MS

Part 1: Preliminary study by evolved gas analysis (EGA)-MS

[Background] Fine airborne microplastics (AMP) can be inhaled by humans, raising concerns about their adverse health effects. However, analytical studies on AMP are limited, and detailed knowledge of their environmental behavior and health impacts remains insufficient. This study aimed to establish a method for qualitative and quantitative analysis of AMP contained in atmospheric particulate matter (PM) such as PM_{2.5} and PM₁₀ by pyrolysis (Py)-GC/MS. In Part 1, the thermal behavior of AMP was characterized by EGA-MS, and the resulting EGA curves were used to determine the suitable furnace temperatures for subsequent experiments.

[Experimental] Particulate matters in air were collected on the rooftop of the Pharmaceutical Sciences building at Tokushima University using a Multi-Nozzle Cascade Impact (MCI) sampler (Tokyo Dylec) connected to a vacuum pump. A schematic of the collection process is shown in Fig. 1. PM samples were collected using a three-stage quartz filter system, with collecting particles of >PM₁₀ on the top stage, followed by PM_{2.5-10}, and PM_{2.5}. The sampling was carried out twice on different periods, and the collected PM samples are designated PM-A and PM-B. The details of the collected PM samples are summarized in Table 1. For EGA measurements, a Multi-Shot Pyrolyzer (EGA/PY-3030D) was directly connected to the GC/MS inlet, which was connected to a mass detector through a deactivated metal tube and a Vent-free GC/MS adapter. The PM-collected quartz filter was punched into 4 mm disks, and three of them were placed in a sample cup and introduced into the pyrolyzer's furnace for EGA measurement.

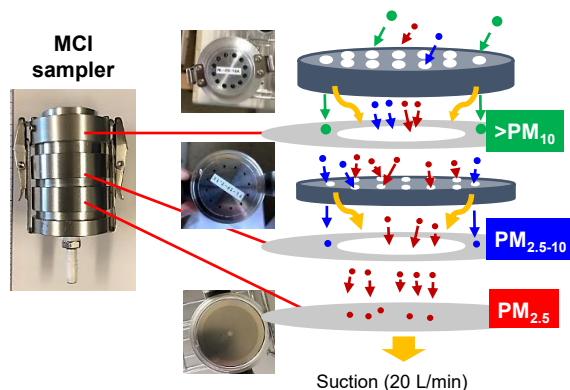


Fig. 1 Schematic of PM collection using an MCI sampler.

[Results] Fig. 2 shows the EGA curves of size-classified fractions of the PM-A sample. The presence of the characteristic ions of polymers was confirmed in the average mass spectrum of each EGA curve, and their extracted ion chromatograms (EICs) are also shown in Fig. 2 in addition to total ion current chromatogram (TICC). In the 100-300 °C range, phthalates (*m/z* 149), carbon dioxide (*m/z* 44), nitrogen monoxide (*m/z* 30), and sulfur dioxide (*m/z* 64) were observed. Thus, these compounds can be measured by thermal desorption (TD) at 300 °C. The peaks observed above 400 °C originate from the polymer pyrolysis, which is completed by 600 °C. Based on the above, double-shot measurements in the next note (PYA1-184E) will use the following furnace temperatures: 1st stage (TD): 100 - 30 °C/min - 300 °C (3 min), 2nd stage (PY): 600 °C.

Table 1 Collection status of PM samples

Sample	AMP collection period	PM concentration* / mg m ⁻³			Total volume of air / m ³
		>PM ₁₀	PM _{2.5-10}	PM _{2.5}	
PM-A	7/15 15:08 - 7/27 10:44	0.002938	0.004114	0.007934	340.3
PM-B	6/2 16:48 - 6/26 18:12	0.001976	0.005434	0.005928	404.9

* Concentrations were determined from the difference in filter mass before and after air sampling.

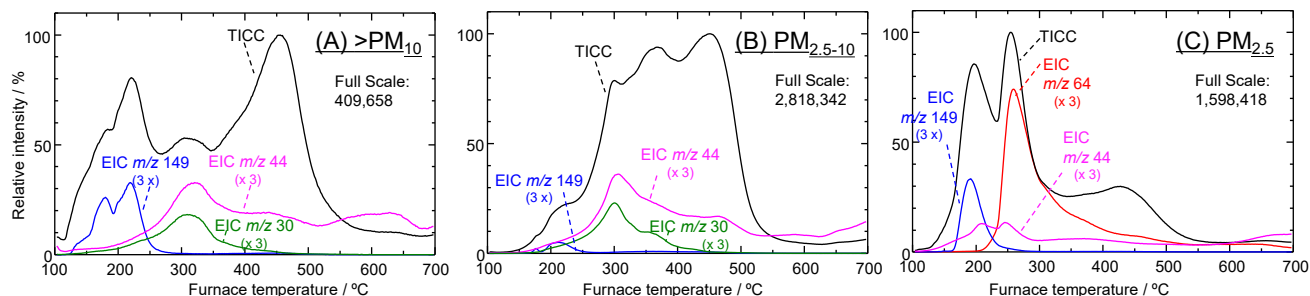


Fig. 2 EGA curves of size-classified fractions of the PM-A sample.

Furnace temp.: 100-20 °C/min-700 °C, Furnace-interface temp.: Auto mode (300 °C max), GC injector temp.: 300 °C, Split ratio: 1/10, Column flow rate: 2 mL/min, EGA tube: UADTM-2.5N (L=2.5 m, i.d.=0.15 mm), GC oven temp.: 250 °C, GC/MS interface temp.: 250 °C, MS scan range: *m/z* 29-500, MS scan rate: ca. 0.2 scan/s

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, Eco-Cup LF, UADTM-2.5N, Packed GC glass insert, Vent-free GC/MS adapter, F-Search MPs

Applications : Environmental analysis, Trace analysis, General polymer analysis

Related technical notes : PYA1-184E (Part 2), PYA1-185E (Part 3)

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