

Quantification of tire wear particles in road dust

[Introduction] The industrial production of plastics over the past decades has created a variety of environmental impacts, due to inappropriate disposal of plastic waste. In accordance with the increased waste plastics, the amount of microplastics (MPs) in the environment has been increasing, posing a threat to human health and marine ecosystems. One of the major contributors of MPs is the wearing of automobile tire treads, i.e., tire and road wear microparticles (TRWMPs), accumulated in road dust (RD). This note reports the quantification of TRWMPs in RD samples using pyrolysis (Py)-GC/MS.

[Experimental] RD samples were collected by the vacuum sweep method from industrial and residential areas of Seoul. The RD samples were dried in an oven at 120 °C, and then sieved to obtain particles with sizes less than 75 µm in diameter. The raw materials of tire components, i.e., natural rubber (NR) and styrene-butadiene rubber (SBR 1502, styrene content: 23.5 %) were cryo-milled and used as standard materials. For EGA-MS and Py-GC/MS measurements, a Py-GC/MS system equipped with a Multi-Shot Pyrolyzer (EGA/PY-3030D, Frontier Lab.) directly interfaced to the GC injector was used. In EGA-MS analysis, 20 mg of RD and tire tread in sand was put in a sample cup and heated from 100 °C to 800 °C in the pyrolyzer furnace under a helium gas stream of 100 mL/min. Evolved gases were introduced to a mass detector through a deactivated metal tube installed in the GC oven. In flash pyrolysis, 20 mg of a RD sample in a sample cup was introduced into the pyrolyzer furnace heated at 670 °C, and pyrolyzates were separated and detected by GC/MS with a separation column. Quantification of TRWMPs was done according to ISO/TS 20539 method.

[Results] An EGA-MS thermogram of the RD sample is shown in Fig. 1. The presence of SBR, BR, and NR in the RD sample is indicated by the observation of typical ions (m/z 69, 91, 93, 105, etc.) as their pyrolyzates. The pyrogram obtained from the Py-GC/MS analysis of the RD sample at 670 °C is shown in Fig. 2. A variety of gases such as CO₂, butadiene, isoprene, and aromatic hydrocarbons such as benzene, toluene, 4-vinylcyclohexene, styrene, methylstyrene are generated through the thermal decomposition of rubbers and intramolecular cyclization. The typical pyrolyzates of BR (butadiene, 4-vinylcyclohexene), SBR (butadiene, styrene), and NR (isoprene, dipentene) showed high intensity peaks. Hence, SBR 1502 was used as the standard for the quantification of BR and SBR. Dipentene (isoprene dimer) was used as the indicator ion of NR for its quantification. It was found that the average concentration of TRWMPs was 22,581 µg/g in the industrial area and 9,818 µg/g in the residential area of Seoul, indicating that the industrial area has 2.5 times higher TRWMPs concentration.

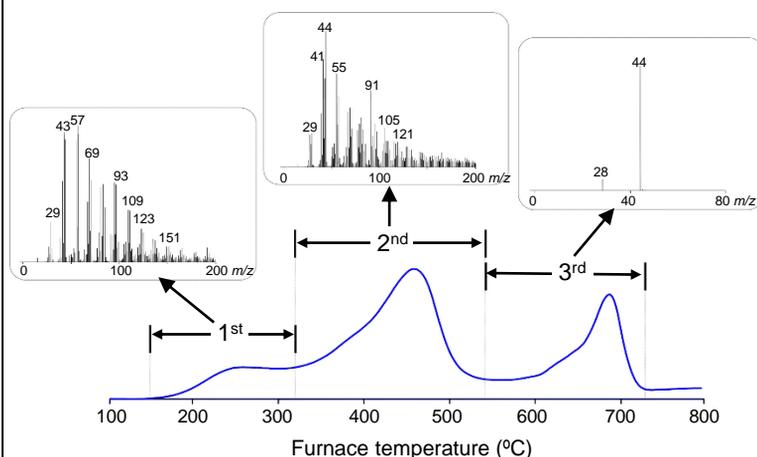


Fig. 1 Thermogram of an RD sample obtained by EGA-MS.
(Heating rate: 20 °C/min)

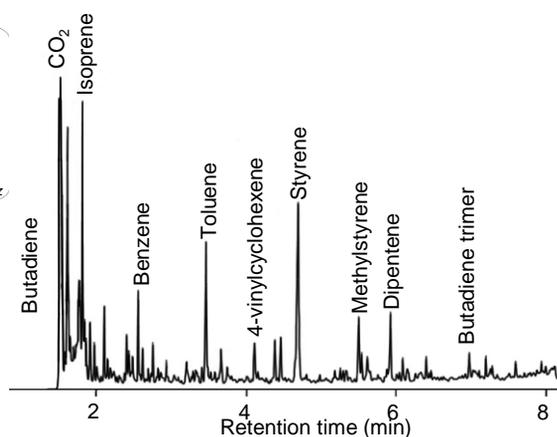


Fig. 2 Chromatogram of an RD sample obtained by Py-GC/MS at 670 °C.

Contents extracted from [J-S Youn, Y-M Kim, M. Z. Siddiqui, A. Watanabe, S. Han, S. Jeong, Y-W Jung, K-J Jeon, Sci. Total Environ. 784 \(2021\) 147177](#)

Keywords : Tire wear particles, Road dust, Microplastics, Natural rubber (NR), Styrene-butadiene rubber (SBR)

Products used : Multi-Shot Pyrolyzer

Applications : Environmental assessment

Related technical notes : [PYA1-115E](#)

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