

# 空氣品質

## 應用定量聚合物與分子標記測定 TSP 與 PM<sub>10</sub> 中輪胎磨損顆粒之研究

### Determination of Tire Wear Particle (TWPs) Concentrations in TSP and PM<sub>10</sub> by Quantifying Polymer and Molecular Markers

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#### ABSTRACT

Tire wear particles (TWPs) are microplastics formed due to the wear and tear between rubber tires and roads. They form an essential proportion of non-exhaust emissions, especially with the recent increase in strictness of vehicle exhaust emission standards in various countries and the growing use of electric vehicles. Due to their chemical compositions, TWPs cause adverse health effects on humans and the ecosystem. To gain insight into TWPs' detrimental effects on respiratory health, estimating their concentrations in the ambient air is necessary.

There are several analytical approaches for determining TWPs. Among them, polymer markers are widely adopted since polymeric materials account for 40–50% of the composition of tires. Molecular markers specific to tires, such as 6PPD-Q, are also valuable for TWP quantification. This research quantifies tire wear particles (TWPs) in total suspended particles (TSP) and PM<sub>10</sub> using polymer markers, including natural rubber (NR), styrene-butadiene rubber (SBR), and butadiene rubber (BR) (the main polymer components in tires); and the molecular marker, 6PPD-Q. Sampling is done in residential and commercial locations in the fall. Pyrolysis gas chromatography-mass spectrometers (PY-GC/MS) is used to evaluate the polymeric markers. A high-resolution gas chromatograph/high-resolution mass spectrometer (HRGC/HRMS) is used to quantify 6PPD-Q in TSP samples, and a liquid chromatography-tandem mass spectrometer (LC-MS/MS) is used to quantify PM<sub>10</sub>.

A satisfactory match is found in the coefficients of determination between the anticipated TWP concentrations in TSP and PM<sub>10</sub> and the NR or SBR+BR concentrations. Additionally, for samples taken in industrial locations, the accuracy of using 6PPD-Q to estimate TWP concentrations in TSP and PM<sub>10</sub> has respectable coefficients of determination. In the residential regions, the levels of fit are below moderate. Therefore, although 6PPD-Q exhibits some limitations as a sole marker for TWP, a combined approach provides a more comprehensive assessment of TWP concentrations in the ambient air.

關鍵字：輪胎磨損顆粒、細懸浮微粒、PM<sub>10</sub>、聚合物標記、6PPD-Q

**Keywords:** Tire wear particles、TSP、PM<sub>10</sub>、Polymeric markers、6PPD-Q.