

Unravelling the chemical complexity of artificially aged tire wear particles by Py-GCxGC-MS

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Plastics and microplastics are ubiquitous in the global environment, drawing increasing attention due to their adverse environmental impacts. Particles originating from tyre abrasion represent a substantial share of the microplastic pollution, mainly pronounced in traffic-dominated and urban environments. Following their release, several environmental processes encompassing for instance mechanical abrasion, and physicochemical degradation such as UV-irradiation. The latter mechanisms can lead to pronounced changes in the chemical fingerprint and functional characteristics of tire wear particles (TWPs), hence their overall impact has not been elucidated. This knowledge gap is predominantly originating from the complex analytical approach required to tackle these heterogeneous samples. Conventional pyrolysis coupled to gas chromatography mass spectrometry (Py-GC-MS) is seen as the go to strategy to characterize TWPs by identifying its polymer-specific marker compounds. However, due to the sample complexity, Py-GC-MS faces limitations in resolving power, restricting research to unravel the full chemical fingerprint of TWPs. Comprehensive two-dimensional gas chromatography hyphenated with analytical pyrolysis and time-of-flight mass spectrometry (Py-GCxGC-ToFMS) can present a potential solution to overcome the conventional shortcomings.

In the current study, human-produced TWPs were artificially aged using a weathering chamber with UV-irradiation, and every week a subsample was taken for four weeks. The pristine and aged TWPs were subsequently analysed using Py-GCxGC-ToFMS, revealing a temporal alteration pattern in the relative abundance of characteristic pyrolysis compound groups obtained in the 2D pyrograms. This outcome supports the hypothesis that UV-irradiation can induce degradation of TWPs altering their chemical composition, and in turn complicating accurate quantification. In conclusion, such non-targeted screening approaches are of major importance for tracing degradation products and acquiring reliable TWP data for environmental mitigation strategies.

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