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Sizing of microplastic particles by downward-oriented nitrogen MICAP–TOF-MS

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The widespread occurrence of microplastics in the environment calls for robust analytical strategies for particle characterization to study sources, transport pathways, and potential impacts on the ecosystem. Single-particle inductively coupled plasma mass spectrometry (sP-ICP-MS), originally developed for analyzing particles in the nanometer size range [1], has recently been adapted for detecting and characterizing microplastics by monitoring elemental carbon ion signals [2]. However, routine analysis of particles larger than ~10 µm remains challenging due to size-dependent transport limitations in conventional sample introduction systems. These constraints can be mitigated using a downward-oriented plasma geometry that enhances transmission of larger particles via gravity-assisted transport, extending the measurable size range up to 20 µm [3].

Recent advances in ICP-MS instrumentation have demonstrated the feasibility of replacing conventional argon plasmas with nitrogen microwave inductively coupled atmospheric-pressure plasmas (MICAP), achieving broadly comparable analytical performance while improving sustainability by using nitrogen as the plasma gas [4].

Here, we explore the applicability of a downward-oriented nitrogen MICAP coupled to time-of-flight mass spectrometry (DW-MICAP–TOF-MS) for sizing microplastic particles. The TOF based mass spectrometer enables time-resolved detection of carbon signals and quasi-simultaneous monitoring of additional elements gaining further complimentary insight into microplastic compositions.

Calibration was performed using a microdroplet generator to deliver monodisperse droplets containing a defined carbon mass from citric-acid solution as external standards, enabling non-matrix-matched calibration. Microplastic particles ranging from 8 µm to 20 µm and above were studied and sized. The capabilities of downward-oriented nitrogen MICAP–TOF-MS for microplastic analysis in the low-micrometer size regime, along with the corresponding figures of merit, will be presented in detail.

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[2] Bolea-Fernandez, Rua-Ibarz, Velimirovic, Tirez & Vanhaecke (2020), *J. Anal. At. Spectrom.*, 35, 455–460.

[3] Fazzolari, Hattendorf & Günther (2024), *J. Anal. At. Spectrom.*, 40, 276–285.

[4] Schild, Gundlach-Graham, Menon, Jevtic, Pikelja, Tanner, Hattendorf & Günther (2018), *Anal. Chem.*, 90, 13443–13450.