

A robust sample preparation and calibration strategy for nanoparticle analysis using laser ablation single particle-ICP-MS

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Nanoparticles are widely used in technological and biomedical applications due to the unique physicochemical properties that emerge at the nanoscale [1,2]. Therefore, robust analytical strategies for nanoparticle characterization are required, both for quality control in material production and for evaluating potential environmental and human health impacts. Single-particle inductively coupled plasma mass spectrometry (SP-ICP-MS) is a well-established analytical technique for determining particle sizes and number concentrations [1]. However, conventional implementations relying on liquid suspensions can be affected by suspension stability, transport efficiency, and spectral interferences from the suspension medium.

To mitigate these limitations, solid sampling can be implemented using laser ablation combined with SP-ICP-MS (LA-SP-ICP-MS) [2,3], allowing direct analysis of nanoparticles embedded in solid matrices. Furthermore, embedded nanoparticles are preserved in the solid polymer film without requiring resuspension. As in conventional liquid-based analysis of nanoparticles, a key requirement for quantitative LA-SP-ICP-MS is the availability of suitable calibration standards.

Here, we report a sample preparation and calibration strategy based on spin-coated polymer thin films containing dispersed nanoparticles [4]. Spin coating was used to reproducibly produce homogeneous thin films with isolated particles while minimizing agglomeration. Spin-coated polymer thin films are also used as calibration standards by incorporating a defined amount of dissolved elemental standard and ablating a well-defined area of the film with known thickness.

Nanoparticles composed of single elements were analysed using quadrupole ICP-MS, whereas multi-element nanoparticles were characterized using time-of-flight ICP-MS. Further developments focus on strategies enabling the use of ICP-Q-MS/MS for multi-element particles, relying on reaction gases for temporal broadening of the transient particle signals. The proposed polymer thin-film strategy provides a promising approach toward standardized, reproducible calibration materials and, by that, supports ongoing development of LA-SP-ICP-MS for nanoparticle sizing and counting in solids.

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