Czech Chemical Society Lecture

Thursday, March 5, 2026, 14:00

University Campus Bohunice, Kamenice 5, Building B11 / room 132

Characterization of single particle analysis using Laser-Ablatio ICP-MS

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Investigating single particles has become increasingly important in recent years. In materials science, for example, nanoparticles are used for a wide variety of applications. To adapt their properties for specific applications, comprehensive analytical characterization is required. A topic that is emerging in the field of life sciences is the investigation of nano- and microplastics, which are formed in the environment during the degradation and weathering of various plastic products.

Over the last decade, single-particle inductively coupled plasma mass spectrometry (SP-ICP-MS) has become an essential analytical tool for the characterization of nano- and microparticles, providing information about their composition, size and number concentrations [1]. However, traditional SP-ICP-MS, designed for analysis of nano- and microparticles in suspension, presents challenges related to sample stability, sample introduction efficiency, and potential spectral interferences from the suspension medium. To overcome these challenges, employing laser ablation as a solid sample analysis technique offers significant advantages for particle characterization [2,3].

In this work, we present the development of an LA-ICP-MS-based approach for analysis of single particles [4]. For LA sampling, the particles were embedded in a polymer thin film created using spin coating. Optimization of sample pretreatment and ablation parameters enabled analysis of single nanoparticles, which are transported into the ICP-MS as intact particles. Each introduced nanoparticle generated a short spike in the transient signal, providing accurate information about the mass and size of the investigated nanoparticles. To circumvent the need for certified reference materials, we applied a matrix matched calibration strategy that utilizes polymer thin films spiked with defined amounts of the targeted analytes. Applicability of this approach for the determination of the mean nanoparticle composition was demonstrated by analyzing a commercially available nanomaterial with a known sample stoichiometry. Furthermore, the suitability of this approach for the analysis of microplastics is demonstrated [5]. Finally, we present an approach for the analysis of particle suspensions using LA-ICP-MS. This method can be used to determine the occurrence of nano- and microparticles in liquid environmental samples, such as rainwater or fresh water.

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[4] L. Kronlachner, Z. Gajarska, P. Becker, D. Günther and A. Limbeck, J. Anal. At. Spectrom., 2025, 40, 467–477.
[5] L. Brunnbauer, L. Kronlachner, E. Foisner and A. Limbeck, J. Anal. At. Spectrom., 2025, 40, 753-761.