High Efficiency Sample Introduction System for Superior ICP-MS Performance of Single-Cell, Single-Particle, Nanoparticle, and Low-Volume Analysis

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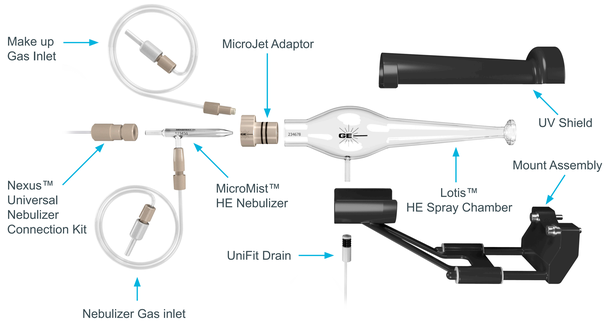
Transport efficiency of up to 95% for single-cell, single-particle, nanoparticle, and low-volume samples is now possible with the use of Glass Expansion's High Efficiency Sample Introduction System (HE-SIS) for inductively coupled plasma mass spectrometry (ICP-MS) analysis. While originally designed for single-cell analysis, the HE-SIS has been updated to deliver exceptional performance across a broad range of applications.



Glass Expansion's HE-SIS Kit Features:

This specially designed concentric glass nebulizer is based on our popular MicroMist™ design, capable of efficiently nebulizing limited sample volumes at low sample and argon gas flow rates.

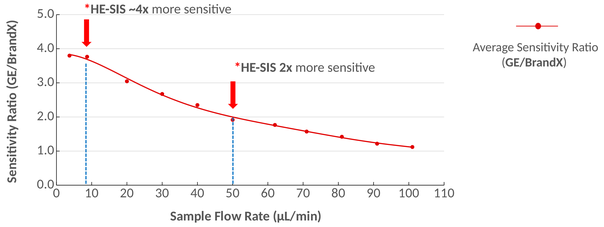
Our MicroJet™ gas adapter (Patent approved) shapes the nebulizer aerosol plume to reduce sample deposition on the spray chamber walls and enhance transport efficiency.

The Lotis™ HE spray chamber directly couples to the ICP-MS torch, providing the highest transport efficiency and excellent washout between samples.

Every HE-SIS is designed to suit a specific instrument model, and includes an instrument-specific mounting bracket support.

Average Sensitivity Ratio - Comparison Brand X

In a comparison study, the Glass Expansion HE-SIS demonstrated significantly higher sensitivity compared to another commercially available system, referred to as Brand X. The typical sample flow rate for single-cell, single-particle, and nanoparticle analyses is in the range of 10 to 50 µL/min sample flow rate. In this range the HE-SIS exhibited an increase in sensitivity approaching 4x the sensitivity of Brand X at 10 µL/min and 2x at 50 µL/min. By employing Glass Expansion's HE-SIS, researchers can unlock deeper insights from their single-cell, single-particle, nanoparticle, and low-volume ICP-MS analyses due to the improved transport efficiency provided by the MicroMist HE, MicroJet, and Lotis designs.

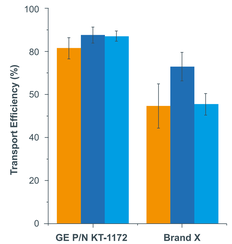


A Collaborative Study with Universidad de Oviedo

M. Montes Bayón, J. Bettmer, M. Corte-Rodríguez

The group led by Dr. Maria Montes Bayón at Universidad de Oviedo has been using the Glass Expansion HE-SIS for much of their research, reporting the Glass Expansion system has provided the best results compared to all commercially available sample introduction systems they have tested. Additionally the Glass Expansion HE-SIS has proved to be adequate for a range of different cell sizes, ranging from 6 to 20 microns, including yeast, several types of bacteria, and human cells.

With the Glass Expansion HE-SIS transport efficiencies approach 90% for nanoparticles, bacteria, yeast cells, and eukaryotic cells with the HE-SIS.



	Nebulizer Flow (L/min)	Additional Gas Flow (L/min)	Sample Flow Rate (µL/min)
KT-1172	0.58	0.65	10
Brand X	0.38	0.87	10

Au Nanoparticles
Eu Beads
Yeast

Microplastics - Detection and Quantification by Single Particle ICP-MS using NexION 5000

Chady Stephan, Director Market Development, PerkinElmer

Figure 1. (A) Plastic Tea Bag, (B) Plastic microparticles floating on surface of freshly brewed tea.

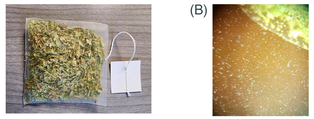
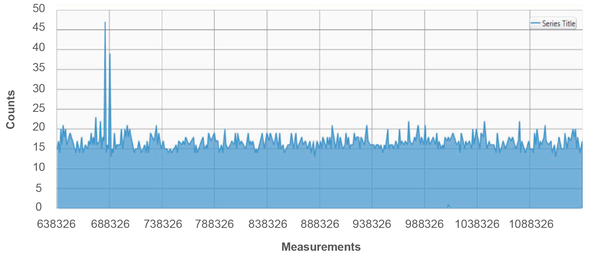


Figure 2. Real-time signal measuring single particles of microplastics from tea bag sample, 3 particles per 5 µL at 80% TE => 40,000 particles in 100 mL tea serving.



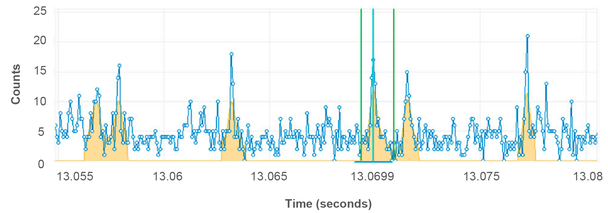
Measuring carbon isotopes ^{12}C and ^{13}C by SP-ICP-MS is fraught with difficulty. Mainly due to the high ionization potential of 11.3 eV, and that high backgrounds of carbon dioxide (CO_2) can be present as impurities in argon, solutions and labware. However, in Dr. Stephan's presentation he demonstrated that when Glass Expansion's High Efficiency Sample Introduction System (HE-SIS) is coupled to PerkinElmer's NexION 5000 ICP-MS it creates a feasible configuration for rapid screening of microplastics in consumer products. One example is the microplastic content of using tea bags made from plastic (see Figure 1, A & B). Figure 2 illustrates that one 100 mL serving of tea contains >40,000 particles, where Glass Expansion's HE-SIS operated with an 80% transport efficiency (TE) delivering 3 particles per 5 µL.

Screening for microplastics by SP-ICP-MS is a rapidly growing technique of choice for its ~2–3 minutes sample analysis speed. Employing the unique features of the HE-SIS and NexION 5000 as a SP-ICP-MS for microplastics, counting by quantification of carbon is feasible. The PerkinElmer NexION 5000 can effectively utilize various reaction gases and cell conditions to reduce the C background, while Glass Expansion's HE-SIS delivers remarkable transport efficiencies of at least 80% in this single-particle study.

Very low mass isotope data collection with the Nu Vitesse, measurement of microplastic particles (Vitesse Note NT10)

Nu Instruments Ltd and Prof. Dr. David Clases, nanomicroLab, University of Graz, Austria

Figure 1. Chromatogram for 12C showing the traces for individual particles collected with 80 µs spectra. The data smoothing and peak search algorithms allows 1 µm microplastic signals to be differentiated from the baseline noise.



Microplastics and nanoplastics are entering the food supply through our environment and have become of increasing concern in determining if they pose a risk to human health, so establishing effective techniques for characterizing the presence of nano- and microplastics in samples is critical. Prof. Dr. David Clases at the University of Graz, Austria, utilized Glass Expansion's HE-SIS on their Nu Instruments, Vitesse TOF-ICP-MS for low mass isotope measurements of microplastic particles. The chromatogram in Figure 1 exemplifies the ability of the HE-SIS and Vitesse to distinguish 1 µm polystyrene particles from the 12C background when using 80 µs dwell times. With this sample introduction configuration on the Vitesse, it's possible to collect data for carbon in microplastics, and easily distinguish the signals for sub-micron particles from the ionic 12C background.

Key Takeaways:

- The proprietary designs of the key HE-SIS components significantly differentiates Glass Expansion's system from other commercially available laminar-flow designs.
- Glass Expansion's HE-SIS is 2–4x more sensitive than other commercially available systems.
- When used for SC-ICP-MS, the HE-SIS has exhibited up to 90% transport efficiency for analyzing cell sizes ranging from 6–20 µm diameters, which includes but is not limited to yeast, several types of bacteria, and human cells.
- Nanoplastics and microplastics can be quantitated in SP-ICP-MS applications with impressive transport efficiencies of 80% or more.

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