

7250 Inductively Coupled Plasma Mass Spectrometer — Technical White Paper

1. Product Overview

The 7250 inductively coupled plasma mass spectrometer (ICP-MS) incorporates an advanced, newly engineered design and innovative technologies, representing a significant advancement in domestically developed ICP-MS platforms. Its distinctive collision/reaction operating modes substantially enhance interference removal, helping address challenging analytical problems and providing a comprehensive solution for trace elemental analysis.

With advanced analytical capabilities designed to address interferences encountered in conventional ICP-MS, the 7250 series supports applications across environmental testing, food analysis, life sciences, and semiconductor manufacturing. Even when analyzing challenging, complex sample matrices, the system is designed to deliver reliable results and enable laboratories to tackle increasingly demanding analytical applications.



7250 ICP-MS Instrument — Product Photograph

2. Product Features

➤ The vertically oriented ICP torch minimizes salt deposition within the torch, extends torch service life, and helps facilitate the analysis of samples with high salt content and complex matrices. This configuration also significantly reduces argon

consumption. Heat and exhaust gases rise naturally toward the exhaust system, reducing cleaning requirements and instrument downtime.

➤ The proprietary dual-RF power supply design provides exceptionally fast impedance matching for rapid response and improved resistance to interference. With no moving components, it delivers a more stable ICP plasma while maintaining a compact footprint and enhancing analytical stability. The system is capable of direct introduction and analysis of highly volatile organic solvents, including 100% ethanol.

➤ The specialized quadrupole design increases the effective quadrupole length, reduces fringe-field effects, and improves ion acceptance, enabling sensitivity at the million-count level. Improved ion transmission also reduces quadrupole contamination, eliminating the need for routine quadrupole cleaning and maintenance.

➤ The fully Chinese-language Element V workstation software uses a centralized control architecture that supports unified management of multiple instruments. Application-specific solutions and customized method packages are available for applications such as semiconductor monitoring and online analysis. Extensive open interfaces support integration with other instruments. Powerful high-throughput batch data-processing software also supports offline data processing to improve efficiency.

3. Technical Specifications

1. ICP-MS System

1.1. System Configuration: The main instrument comprises a sample introduction system, ion source and visualization system, interface assembly, dual ion-deflection system, collision/reaction cell, mass analyzer, dual-mode detector, and data-processing platform.

1.2. Sample Introduction System

- 1.2.1. Peristaltic Pump: Four-channel peristaltic pump with bidirectional rotation and a maximum adjustable rotational speed of ≥ 80 rpm.
- 1.2.2. Nebulizer: High-efficiency concentric nebulizer resistant to hydrofluoric acid and high-salt matrices.
- 1.2.3. Spray Chamber: Low-volume cyclonic spray chamber equipped with thermoelectric (Peltier) cooling, capable of reaching a cooling temperature below -8°C ; lower attainable temperatures are preferred.
- 1.2.4. Torch: Demountable quartz torch requiring no manual connection of the plasma gas line and accommodating center tubes with different internal diameters.
- 1.2.5. Center Tube: Removable center tube.
- 1.2.6. Torch Positioning: Computer-controlled stepper motors provide three-dimensional (X, Y, Z) torch positioning with a step adjustment resolution of 0.05 mm. Positioning parameters are stored in the instrument software.
- 1.2.7. Plasma Gas Control: Four high-precision mass flow controllers independently regulate the coolant gas, auxiliary gas, nebulizer gas, and dilution gas.
- 1.2.8. Plasma Viewing System: Real-time display on a computer monitor of the plasma and the condition of the cone orifice and center tube.
- 1.2.9. Argon Humidifier: Fully integrated, temperature-controlled argon humidifier designed to prevent salt buildup on the nebulizer and torch; switching and operation can be controlled through the ICP-MS software.
- 1.2.10. Intelligent Matrix Management: Intelligent, stepwise control of nebulizer gas flow and cone voltage; the nebulizer flow can be reduced to 0.1 mL/min during non-analytical steps (sample extraction and rinsing).
- 1.3. RF Generation System
 - 1.3.1. Ion Source: Self-excited, fully solid-state RF generator operating at 27.12 MHz, with continuously adjustable RF power from 400 to 1,600 W in 0.5 W increments. Variable-frequency technology enables rapid impedance matching and supports direct analysis of light naphtha.
 - 1.3.2. The system provides suppression of secondary discharge between the load coil and interface through virtual-ground technology without requiring a shielded torch.

For instruments that employ shielded-torch technology, five replacement shielded-torch assemblies shall be provided.

1.4. Interface Assembly

1.4.1. Interface: Dual-cone interface with a sampler-cone orifice diameter of 1.0 mm and a skimmer-cone orifice diameter of 0.5mm. Its salt-tolerant design maintains sample sensitivity and supports continuous, stable analysis of samples with a salt concentration of 25% under high-sensitivity conditions.

1.5. Ion Deflection and Focusing System

1.5.1. An electric field deflects analyte ions and completely separates them from non-ionized neutrals and photons to reduce background noise. Neutral particles and photons are evacuated by the turbomolecular pump without the use of beam-blocking baffles, minimizing subsequent maintenance requirements.

1.6. Quadrupole Collision/Reaction Cell

1.6.1. A quadrupole assembly capable of mass selection shall be incorporated within the cell or positioned upstream of the cell.

1.6.2. The cell supports standard mode (STD), collision mode (kinetic energy discrimination, KED), and reaction mode (CCT) for interference removal and sample analysis. In each mode, the quadrupole bandwidth can be adjusted to select an appropriate mass range for improved interference elimination.

1.6.3. Supported collision/reaction gases include He, O₂, H₂ /He mixtures, and NH₃ /He mixtures.

1.7. Quadrupole Mass Analyzer

1.7.1. Extended-length quadrupole rods fabricated from pure molybdenum (Mo) provide a hyperbolic electric potential field for optimized mass resolution and abundance sensitivity. The quadrupole operates at a low RF drive frequency of 2.0 MHz.

1.7.2. Adjustable quadrupole mass resolution allows different resolution settings to be assigned to individual elements within the same method, with automatic switching between resolution settings during a single sample run.

1.7.3. Mass Range: 2 – 290 amu.

1.8. Detector

1.8.1. Simultaneous pulse-counting/analog dual-mode electron multiplier with automatic switching between modes. The system shall support both scanning and peak-hopping acquisition (qualitative and quantitative analysis) during a single sample introduction. The detector shall be capable of counting signals of ≤ 0.1 cps or $\geq 5 \times 10^{10}$ cps, with dwell times as short as 0.1 ms in both acquisition modes.

1.9. Analytical Capabilities

1.9.1. Collision mode can directly eliminate ArAr^+ polyatomic interference affecting selenium (Se), achieving a Se detection limit of 3 ppt without using CH_4 or H_2 reaction gas.

1.9.2. Complete separation of six arsenic species within 2 minutes: arsenobetaine, dimethylarsinic acid, arsenite (As(III)), arsenocholine, monomethylarsonic acid, and arsenate (As(V)).

1.10. Software

1.10.1. Fully automated analytical functions, including instrument startup/shutdown, torch positioning, plasma parameter control, ion-lens control, switching between standard and cool-plasma conditions, and switching between standard operation and collision-cell operation.

1.10.2. Time-resolved signal analysis software for coupling with chromatographic systems, laser-ablation sample introduction systems, and similar accessories. Functions include data acquisition for hyphenated techniques, chromatographic peak integration, and report generation.

1.11. Instrument Performance

Instrument performance shall be based on the specifications published in the English-language product brochure available for download from the manufacturer's official website. These specifications shall be consistent with the instrument installation and acceptance criteria.

1.11.1. Sensitivity in Standard Mode: Mid-mass elements (Y or In): ≥ 500 Mcps/ppm; high-mass elements (Tl or U): ≥ 600 Mcps/ppm.

1.11.2. Random Background: Standard (no-gas) mode: ≤ 1 cps at 4.5 amu; He mode: ≤ 0.5 cps at 4.5 amu.

1.11.3. Signal-to-Noise Ratio in Standard Mode: >220 million (1 ppm solution of a mid-mass element; sensitivity divided by random background).

1.11.4. Oxide Ion Ratio ($\text{CeO}^+ / \text{Ce}^+$): $\leq 2\%$; doubly charged ion ratio ($\text{Ce}^{2+} / \text{Ce}^+$): $\leq 3\%$.

1.11.5. Instrument Detection Limits

Low-mass elements: ≤ 0.3 ppt.

Mid-mass elements: ≤ 0.1 ppt.

High-mass elements: ≤ 0.1 ppt.

1.11.6. Short-Term Stability (10 min, RSD): $\leq 2\%$.

1.11.7. Long-Term Stability (2 h, RSD): $\leq 3\%$.

1.12. ICP-MS Autosampler: Sample rack capacity ≥ 240 positions.

1.13. Liquid Chromatography System: Quaternary gradient pump with a maximum pressure rating of ≥ 650 bar; capacity for $\geq 200 \times 2$ mL sample vials; dual-wavelength UV detector.

1.14. Operating Conditions

Ambient Operating Temperature: $15 - 30^\circ \text{C}$; relative humidity: $<80\%$ (non-condensing); power supply: single-phase 200 – 240 V, 50 Hz.

(2) System Configuration

1. ICP-MS main instrument: 1 unit.

2. 240-position autosampler: 1 set.

3. ICP-MS workstation software: 1 set.

4. Recirculating cooling-water system: 1 set.

5. Liquid chromatography system (including quaternary pump, autosampler, column oven, and UV detector): 1 set.

6. Liquid chromatography workstation software: 1 set.

7. LC – ICP-MS coupling interface (including software and hardware): 1 set.

8. Consumables:

Nebulizer: 1; quartz torch: 1; quartz center tube: 1; nickel sampler cone: 1; nickel skimmer cone: 1; graphite gaskets: 10; sample uptake pump tubing: 12; waste drain tubing: 12; PTFE capillary tubing: 5 m; sample tubes: 1,000; rotary-vane vacuum pump oil: 1 bottle; chromatography columns of the same brand: 1 set of an anion-exchange column plus guard column (for arsenic, mercury, and other species analysis), and 1 C18 column.

9. Auxiliary Equipment and Spare Parts

9.1. Dedicated workstation computers: 2 sets.

9.2. Dedicated output device: 1 unit.

9.3. Power supply/UPS: 1 unit (15 kVA, 30-minute backup time).