Technical Specifications of SUPEC 7000

1. Application Scope

The SUPEC 7000 Inductively Coupled Plasma Mass Spectrometer is suitable for elemental analysis, isotope analysis, and elemental speciation analysis. It meets analytical requirements across a wide range of industries, including environmental monitoring, food safety, geology, metallurgy, biological samples, and chemical materials.

2. Operating Conditions

1. **Ambient temperature:** 18–24 °C
2. **Relative humidity:** 20–60% RH
3. **Power supply:** Three independent single-phase power inputs, (220 ± 20) V AC, 16A, 50 Hz
4. **Exhaust airflow:** > 12 m/s

3. System Technical Specifications:

3.1 System Hardware

*3.1.1 Ion Source

RF Generator: Patented self-oscillating, fully solid-state ICP RF generator operating at **27.12 MHz**, with a power range of **500–1700 W**, continuously adjustable with a power resolution of **0.5 W**. Power stability: **< ±0.1%** Frequency stability: **< ±0.01%** The RF load coil is water-cooled. No matching network is required. Millisecond-level fast frequency tuning enables automatic matching to plasma load changes, significantly reducing plasma extinguishment risk.

Plasma Potential Reduction Technology: Balanced-drive design effectively reduces ion kinetic energy dispersion and suppresses secondary ion formation. Secondary discharge at the interface cones is eliminated **without the need for a grounding/shield ring or other costly consumables**, significantly extending cone lifetime.

iStandby Mode: The system intelligently monitors operating status. When the instrument remains idle for more than 10 minutes, it automatically switches to an ultra-low-power standby mode at **500 W**. Stable plasma is maintained with a cooling gas flow as low as **5 L/min**, reducing argon consumption by **more than 50%**.

3.1.2 Reliable Dual-Cone Ion Interface

An improved dual-cone interface ensures smooth transition from atmospheric pressure to high vacuum, enabling efficient extraction of representative ions during the transition from ultra-high temperature to ambient temperature. Optimized cone geometry, developed through aerodynamic simulation, significantly reduces vacuum load and enhances overall instrument performance.

Cone materials: Nickel (Ni) or Platinum (Pt) optional. Platinum cones offer superior corrosion resistance and are suitable for samples containing highly corrosive matrices such as phosphoric acid.

Both **high-sensitivity cones** and **high-salt-tolerance cones** are available. The high-salt cone ensures long-term stability for high-salinity samples, while the high-sensitivity cone supports high-throughput analysis across diverse sample types.

An innovative **handle-type cone exchange system** with built-in interlock protection prevents incorrect operation. Cones can be replaced easily **without venting the vacuum system** and without moving the plasma torch assembly.

3.1.3 Extraction Lens

The extraction lens supports multiple extraction modes, including **zero potential, negative potential, and positive potential**. An adjustable voltage ranges from **–200 V to +5 V** can be applied, allowing flexible optimization of extraction conditions for different ion species and sample matrices.

When operated under **positive potential**, ions are completely isolated, preventing ion entry into the ion optics system during standby mode and effectively avoiding unnecessary contamination. This design enables **maintenance-free operation and cleaning** of the ion optics during idle periods.

3.1.4 Ion Transmission System

A **low-background ion transmission design** is employed. Dual off-axis ion deflection before and after transmission effectively removes interfering species such as **neutral particles, electrons, and photons**, ensuring optimal signal-to-noise performance for the main quadrupole mass analyzer.

A **large-aperture primary deflection lens** maximizes ion transmission efficiency and significantly enhances sensitivity. A dedicated **neutral particle collection system** prevents neutral species accumulation, eliminating the need for frequent ion lens replacement or cleaning.

3.1.5 Collision / Reaction Cell

The system is equipped with a newly designed **hexapole collision/reaction cell**. The compact cell structure combined with a composite electric field provides high ion transmission efficiency.

A **cascade-flow gas introduction design** integrated with axial field technology significantly improves collision efficiency and sensitivity, while further enhancing interference removal performance. This configuration delivers outstanding multi-element simultaneous analysis capability, especially for complex sample matrices.

3.1.6 Quadrupole Mass Analyzer

A proprietary high-precision quadrupole fabricated from **pure molybdenum (Mo)** ensures excellent mass-axis stability. The quadrupole operates at a **low RF drive frequency of 2.0 MHz**, enabling a

wider mass range and superior mass-axis stability.

Mass range: 2–290 amu, Real-time mass spectral information is displayed via the system software.

3.1.7 Resolution

The system supports both **standard resolution** and **high-resolution** modes, as well as additional user-defined resolution settings. Resolution is continuously adjustable over a range of **0.3–2.0 amu**.

More than three resolution modes can be applied within a single analytical method, allowing flexible optimization and expansion of analytical capability by dynamically adjusting resolution during analysis.

3.1.8 Detector

A **pulse/analog dual-mode discrete dynode detector** is employed, supporting both analog and pulse counting modes with automatic switching between modes.

This configuration enables simultaneous determination of trace-level and major elements within a single analysis, delivering an ultra-wide **dynamic range of up to 10 orders of magnitude**.

3.1.9 Plasma Viewing System

The system is equipped with a **real-time plasma observation system with electromagnetic shielding**.Through the workstation software, users can monitor plasma conditions in real time, including full-color visualization of the plasma, interface cones, and injector tube status, facilitating analytical optimization and maintenance verification.

3.2 Sample Introduction System

3.2.1 Nebulizer

Multiple nebulizer options are available, including:

- Standard high-efficiency quartz concentric nebulizer
- High-salt-tolerant concentric nebulizer
- PFA micro-flow nebulizer

All options provide high nebulization efficiency and compatibility with **hydrofluoric acid (HF)** sample introduction.

A dedicated nebulizer cleaning kit of the same brand is supplied as standard. When abnormal nebulizer gas pressure is detected by the software, rapid maintenance can be performed via high-pressure flushing.

3.2.2 Spray Chamber

A **quartz Scott-type spray chamber** is supplied as standard. The dual-pass design reduces random signal fluctuations.

An integrated **TEC temperature control module** provides temperature control down to **≤ –15 °C**, significantly improving long-term stability and organic solvent analysis capability. This design effectively reduces oxide formation, eliminates signal drift caused by laboratory environmental fluctuations, and enhances overall system stability.

3.2.3 Torch

Multiple injector options are available. The torch features a **separated injector design**, enabling easy replacement and maintenance. By simply changing the injector, the system can be adapted for organic solvents, high-salt matrices, high-sensitivity applications, and HF-resistant operation.

3.2.4 Injector

Various injector types are available. The separated injector–torch design allows flexible configuration for different applications, including organic matrices, high-salt samples, high-sensitivity analysis, and HF-resistant sample introduction, while ensuring easy replacement and maintenance.

3.2.5 Peristaltic Pump

A **4-channel, 12-roller peristaltic pump** ensures stable sample introduction and supports simultaneous operation of sample tubing, internal standard tubing, and waste tubing.

3.2.6 Gas Flow Control

The system is equipped as standard with **four high-precision mass flow controllers (MFCs)**, offering control accuracy better than **0.5%**. Standard gas lines include nebulizer gas, auxiliary gas, plasma gas, and collision gas. Up to **eight MFC channels** can be configured, with optional support for dilution gas, compensation gas, hydrogen collision gas, and auxiliary oxygen addition.

3.3 Analytical Software

3.3.1 Operating System Compatibility: The analytical software is compatible with operating systems, including **Kylin OS** and **UOS (UnionTech OS)**.

3.3.2 Automated Analytical FunctionsThe software provides comprehensive automation capabilities, including but not limited to:

- Graphical instrument interface
- Automatic tuning
- Automatic diagnostics

- Customized user report generation
- Automatic vacuum start-up and shutdown
- Torch position adjustment
- Plasma parameter and ion lens voltage optimization
- Switching between standard mode and collision cell operation modes

These functions enable simplified operation, improved reproducibility, and reduced operator dependency.

*3.3.3 HPLC–ICP-MS Interface：An integrated **HPLC–ICP-MS interface** is available, allowing simultaneous control of both the HPLC system and the ICP-MS using a single software platform. The system supports fully automated online analysis, including:

- Real-time signal display
- Real-time data processing
- Spectral overlay
- Retention time management
- Peak integration
- Calibration curve construction
- Automated sample injection and analysis

*3.3.4 Configurable Fully Automated Microwave－ICP-MS Interface

A configurable **fully automated advanced microwave digestion－ICP-MS interface** is available. Using the same software platform, both the automated microwave digestion system and the ICP-MS can be controlled simultaneously to achieve fully automated **“one-button” online analysis**. Automated functions include acid addition, vessel sealing, digestion, volume adjustment, mixing, plasma ignition, sample introduction, calibration curve establishment, and report generation, enabling a complete end-to-end automated analytical workflow.

3.3.5 Single Particle Analysis Software

Dedicated **single particle ICP-MS (sp ICP-MS)** data processing software is provided, including:

- Method setup for single particle analysis
- Core data processing technologies such as background threshold algorithms, multiple particle event recognition algorithms, particle signal integration, and transport efficiency calculation
- Comprehensive data interpretation, including dissolved ion concentration analysis, particle number concentration determination, and particle size distribution analysis

3.3.6 Real-Time Data and Reporting

The software supports **real-time data display and real-time report generation**. Additional intelligent functions include dynamic adjustment of sample uptake and rinse times, user method library management, and integrated **QC functions compliant with EPA method QC requirements**.

3.3.7 Offline Data Processing

The ICP-MS operating software can be installed on a personal computer.

Sample analysis data can be processed offline using this software, with full report generation capability.

3.4 Instrument Performance

3.4.1 Start-Up Time

Under cold start conditions, the instrument completes the entire start-up procedure and reaches analysis-ready status within 30 minutes.

*3.4.2 Sensitivity in Standard Mode

- Low mass (Li): > 50 M cps/ppm
- Medium mass (In): > 300 M cps/ppm
- High mass (U): > 350 M cps/ppm

3.4.3 Background (Standard Mode, No Gas)

Random background signal: < 0.5 cps at 5 amu

3.4.4 Abundance Sensitivity

- Low-mass side: 1×10^{-6}
- High-mass side: 5×10^{-7}

3.4.5 Oxide and Doubly Charged Ions

- Oxide ratio (CeO^+/Ce^+): < 2%
- Doubly charged ratio (Ce^{2+}/Ce^+): < 2%

3.4.6 Instrument Detection Limits

- Light mass elements (Li): < 0.5 ppt
- Medium mass elements (In): < 0.1 ppt
- High mass elements (U): < 0.1 ppt

*3.4.7 Short-Term Stability (RSD)

< 2% over 20 minutes

*3.4.8 Long-Term Stability (RSD)

< 3% over 4 hours

3.4.9 Mass Axis Stability

< 0.02 amu per 24 hours

3.4.10 Dynamic Range

Up to 10 orders of magnitude

*3.4.11 Isotope Ratio Precision

< 0.2% for ^{107}Ag / ^{109}Ag, with capability for uranium isotope ratio measurements

4. Auxiliary Systems and Accessories

Standard Configuration

4.1 Computer System (or Upgraded Configuration)

- Intel i5-8500 processor
- 8 GB RAM
- 1 TB hard disk drive
- 23-inch high-definition monitor
- Dual network interfaces

4.2 Foreline Pump

- Pumping speed: 40 m^3/h
- Inlet: KF25
- Exhaust outlet: 14 mm hose barb
- Power supply: 230 V / 400 V

Optional Accessories

4.3 Recirculating Cooling Water System

- CE-certified
- Start-up and shutdown controllable via ICP-MS software
- Cooling capacity: 2100 W
- Water tank volume: > 2 L
- Power supply: 220 V

4.4 Laser Printer

- Monochrome laser printer

4.5 AC Voltage Stabilizer

- Capacity: 15 kVA
- Input voltage: 140–300 V
- Output voltage: 220 V ±1%

4.6 Uninterruptible Power Supply (UPS)

- Capacity: 10 kVA
- Backup time: 1 hour
- High-frequency UPS
- Battery configuration: 16 × 12 V / 38 Ah