Finnigan™ ELEMENT GD
Glow Discharge Mass Spectrometer

Reset your expectations

Thermo ELECTRON CORPORATION
The Finnigan ELEMENT GD, a combination of a glow discharge ion source with a high resolution mass spectrometer, is the ultimate tool for the direct analysis of conductive materials. Almost all elements present in a solid sample, including carbon, oxygen and nitrogen can be detected and routinely quantified. Many elements can be analyzed down to the ppt (parts per trillion) range.

The Finnigan ELEMENT GD is tailored to serve high purity metal manufacturers as well as their customers in industries such as:

- **Microelectronics**
  - Copper, Aluminum, Sputter Targets
- **Aerospace**
  - Aluminum, Stainless Steel, Alloys
- **Medical/Pharmaceutical/Food**
  - Stainless Steel, Alloys
- **Nuclear**
  - Uranium, Nuclear Fuel
Reset your expectations for the elemental analysis of solid samples
With the Finnigan ELEMENT GD Thermo Electron combines components with superior attributes in an instrument incomparable in speed, sensitivity and accuracy.

**Overview**

- Fast flow, high power glow discharge cell
  - Short analysis time due to high sputter rates
  - Superior sensitivity
- State of the art double focusing mass spectrometer
  - Incomparable signal to noise ratios resulting from high ion transmission combined with a low background leading to sub-ppb detection limits
  - Maximum level of selectivity and accuracy due to high mass resolution: a prerequisite for indisputable analytical results
- More than 12 orders of magnitude automatic detection system
  - Determination of ultra-traces and matrix elements within a single scan, due to a fully automatic detector with >12 orders of linear dynamic range
  - Direct determination of the matrix elements for IBR (Ion Beam Ratio) quantification
- State-of-the-art software suite for productivity and ease-of-use
  - Full computer control of all parameters
  - Fully automated tuning, analysis and data evaluation
  - LIMS connectivity with automatic data transfer
  - Remote control and diagnostic
  - Microsoft® Windows® XP Operating System

**Figure 1: Finnigan ELEMENT GD**

- Quantitative multi-element analysis across the periodic table
- Less than 10 minutes sample turn-around
- Matrix to ultra-trace detection capabilities in a single scan
- Depth profiling
- Minimum matrix effects for straightforward quantification
The Finnigan ELEMENT GD ion source and sample holder is designed for easy sample change-over, offering routine operation and high throughput.

**Easy Sample Handling**

The ingenious and yet simple design of the Glow Discharge Source reduces sample to sample switching to a fraction of the time it used to be. The sample itself is placed in a vacuum chamber, completely eliminating any risk of leak between the sample and the GD cell (Figure 2). The sample holder can quickly and easily be removed from the ion source, simply unloaded and re-loaded, and repositioned for the next measurement (Figure 3). Opening and closing of the ion source manifold is fully automatic.

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*Figure 2: Evacuation of the vacuum manifold requires a few seconds*

*Figure 3: Placement of the Sample Holder in the GD Source*
The Ion Source

A glow discharge occurs when a potential difference is applied between two electrodes in a cell filled with gas (in most cases Ar) at reduced pressure. In a configuration for elemental analysis the sample acts as the cathode, and its surface is sputtered by impacting gas ions. The sputtered neutral atoms are ionized downstream in the plasma. Because the processes of sputtering and ionization are separated, minimal non-spectral matrix effects are observed. Therefore, perfect conditions can be achieved for the establishment of Relative Sensitivity Factors (RSF), enabling quantitative analysis or using simple Ion Beam Ratios (IBR) for semi-quantitative analysis.

The new Finnigan ELEMENT GD ion source takes full advantage of the intrinsic features of a glow discharge ion source, delivering RSF stability and high sputter rates. At the same time it offers a simple and fast sample change-over, providing routine operation and high throughput without any compromise in performance.

High throughput is additionally supported by electronic (Peltier) sample cooling (or heating), eliminating the need for cooling with cryogenic gases. The cooling of the cell ensures the stabilization of the sputtering process to obtain results with high precision. There is a much reduced requirement for perfectly flat samples because the sample is not used as a vacuum seal. Proper vacuum condition is guaranteed by a separate vacuum manifold employing an optimized sealing mechanism. This, due to its negligible leak rate, enables the measurement of oxygen, nitrogen and carbon at low concentrations.

Figure 4: The Glow Discharge process

The Finnigan ELEMENT GD glow discharge mass spectrometer allows for the analysis of 50 elements in the low ppb range within 5 minutes. The discharge parameters are optimized to ensure high sensitivity and high precision.

Table 1: Finnigan ELEMENT GD discharge parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge gas flow</td>
<td>200 - 400 mL/min</td>
</tr>
<tr>
<td>Voltage</td>
<td>700 - 2000 V</td>
</tr>
<tr>
<td>Current</td>
<td>5 - 150 mA</td>
</tr>
</tbody>
</table>

Table 2: Characteristics of the Finnigan ELEMENT GD Glow Discharge Source

- 2-3 minutes data acquisition time at ppb concentrations
- High sensitivity for short analysis times
- Fast and simple sample to sample switching
- No cryo-cooling
- Flexible cell for flat samples or pressed powders
- Disposable flow tubes to eliminate the risk of cross contamination
- Easy and fast changeable anode
- Variable sputter rates for bulk analysis or depth profiling
- Large sputtered sample area for representative surface sampling
The Mass Spectrometer

The Finnigan ELEMENT GD’s mass spectrometer uses advanced high resolution magnetic sector field technology. The primary limitation of GD-MS is the presence of spectral interferences arising from the combination of matrix elements and the discharge gas with other species in the plasma. Consequently high mass resolution is a prerequisite for the accurate determination of analytes, separated from the majority of possible interferences. The Finnigan ELEMENT GD provides interference free measurements resulting in simple linear calibration curves for quantification. Three fixed resolution settings, with switching times of < 1 s, ensure optimum conditions to reliably remove spectral interferences. Any combination of resolution setting can be performed within a single analysis. The patented fixed-slit design guarantees maximum stability and reproducibility.

The Finnigan ELEMENT GD’s analyzer is optimized for speed and mass stability. The magnet is designed for the mass range 2-260 u, just right for the demands of elemental analysis. It is relatively small, highly laminated, water cooled and driven by a sophisticated high power regulator: Magnet switching and settling times do no longer slow down the analysis.

High precision and accuracy of the mass calibration is vital for short analysis times, allowing precise peak top jumping. Due to an ingenious, fully automatic mass locking process, mass calibration is necessary only once per several months.

### Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass stability</td>
<td>25 ppm / 8 hour</td>
</tr>
<tr>
<td>Scan speed</td>
<td>&lt; 150 ms from m/z 7 to 238 to 7</td>
</tr>
<tr>
<td>Resolutions</td>
<td>≥ 300, ≥ 4000, ≥ 10000 with &lt; 1 s switching times</td>
</tr>
<tr>
<td>Sensitivity (peak height, total ion current)</td>
<td>&gt; 1 x 10^{10} cps, 1.6 x 10^{-9} A for copper in medium resolution (R ≥ 4000)</td>
</tr>
</tbody>
</table>

Table 2: Finnigan ELEMENT GD specifications

Finnigan ELEMENT GD:
Measure 50 elements at low ppb within 5 minutes
Detection System

A sophisticated detection system completes the refined design of the Finnigan ELEMENT GD.

Detection System

Since matrix elements (~ 100 %), majors (%), minors (ppm), traces (ppb) and ultra-traces (ppt) need to be analyzed simultaneously, the detection system offers:

- Wide dynamic range: 0.2 cps to > $10^{12}$ cps
- High speed: down to 1 ms integration time
- Automatic, fast switching between different detection modes
- Automatic cross calibration between different detection modes

In the Finnigan ELEMENT GD this is achieved through the use of a unique and novel combination of a dual mode (dark noise <0.2 cps) secondary electron multiplier (SEM) and a Faraday collector (maximum current > $10^{12}$ cps). The Faraday detector does not lengthen analysis time: due to its fast detection electronics it does not suffer decay times and allows integration times down to 1 ms.

Figure 7: Detection System of the Finnigan ELEMENT GD

![Detection System Diagram](image_url)

Figure 8: Dynamic range of the Finnigan ELEMENT GD detection system
The mass spectrometer of the Finnigan ELEMENT GD is proven in more than 300 Finnigan ELEMENT High Resolution ICP-MS installations worldwide.

### Specifications and Installation Requirements

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
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<tbody>
<tr>
<td>Sensitivity (peak height, total ion current)</td>
<td>&gt; 1 x 10^{10} cps, 1.6 x 10^{-9} A for copper in medium resolution (R ≥ 4000)</td>
</tr>
<tr>
<td>Dark Noise</td>
<td>&lt; 0.2 cps</td>
</tr>
<tr>
<td>Dynamic Range</td>
<td>&gt; 10^{10} linear with automatic cross calibration</td>
</tr>
<tr>
<td>Minimum integration times</td>
<td>Counting mode: 0.1 ms, analog mode: 1 ms, Faraday mode: 1 ms</td>
</tr>
<tr>
<td>Mass Resolution</td>
<td>3 fixed resolutions: ≥ 300; ≥ 4.000; ≥ 10.000</td>
</tr>
<tr>
<td>Resolution Switching Times</td>
<td>&lt; 1 s</td>
</tr>
<tr>
<td>Mass Stability</td>
<td>25 ppm / 9 hour</td>
</tr>
<tr>
<td>Scan Speed (magnetic)</td>
<td>&lt; 150 ms from m/z 7 to 238 to 7</td>
</tr>
<tr>
<td>Scan Speed (electric)</td>
<td>1 ms/jump, independent of mass range</td>
</tr>
<tr>
<td>Power</td>
<td>3-phase, 230/400 V ± 10 %, 50/60 Hz fused 32 A per phase</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>max. 8 kVA</td>
</tr>
<tr>
<td>Temperature</td>
<td>18 - 24 °C (64 - 75 °F)</td>
</tr>
<tr>
<td>Humidity</td>
<td>50 - 60 %, non-condensing, non-corrosive</td>
</tr>
<tr>
<td>Cooling Water</td>
<td>~200 L/h</td>
</tr>
<tr>
<td>Argon</td>
<td>Temperature 10 - 20 °C</td>
</tr>
<tr>
<td>Argon</td>
<td>4 - 6 bar (43 - 65 psi)</td>
</tr>
<tr>
<td>Regulated pressure</td>
<td>1 L/min Argon 5.0 (or higher); 5 L/min Argon 4.6</td>
</tr>
<tr>
<td>Pump Exhaust</td>
<td>8 - 10 bar (116 - 145 psi)</td>
</tr>
<tr>
<td>Electronic Exhaust</td>
<td>1 x 25 mm, 1 L/min</td>
</tr>
<tr>
<td>Electronic Exhaust</td>
<td>1 x 150 mm, 400 m^3/h</td>
</tr>
</tbody>
</table>

### Table 3: Finnigan ELEMENT GD System

#### Finnigan ELEMENT GD, Footprint and Dimensions

![Dimensions Finnigan ELEMENT GD in cm](image)

Figure 9: Dimensions Finnigan ELEMENT GD in cm
Optimized Laboratory Software

The software package is optimized for the needs of a routine laboratory, providing a simple to use interface to fully utilize the power of the Finnigan ELEMENT GD.

Using Microsoft Windows XP Professional as the operating system and standardized programming assures a flat learning curve, easy network connection for data transfer as well as remote control and diagnostic. The software is based upon that used in the Finnigan ELEMENT High Resolution ICP-MS, proven in more than 300 installations worldwide.

The Finnigan ELEMENT GD software is a state-of-the-art, simple to use software suite.

- Effortless autotuning of instrument parameters
- Intuitive and easy creation of methods and analysis sequences
- Real time display of spectra, time resolved data and results
- Automatic data export to LIMS systems
- Microsoft Windows XP OS
Software for a high level of transparency

The Element software suite controls and monitors all instrument functions for GD-MS analysis and data evaluation. Real-time display of mass spectra, time-resolved data, calibration curves and comprehensive reports guarantee a high level of transparency and therefore easily traceable results. Full and flexible support for LIMS connectivity ensures convenient, automatic and safe data management.

Figure 12: Real time display of calibration curves, spectra and results

The Element software package offers full quantitative analysis using Relative Sensitivity Factors (RSF) obtained from standard materials or semi-quantitative analysis using Ion Beam Ratios (IBR). Since the Finnigan ELEMENT GD detection system is capable of measuring traces and the matrix within one analysis, the ratio between the analyte and the matrix (100 %) is be used for quantification.

Figure 13: Glow Discharge ion source software control

- Intelligent and straightforward quantification strategies
- User definable report configuration
- Traceable data management
- Remote control & diagnostic

Proven in > 300 Element High Resolution ICP-MS installations worldwide
Laboratory Solutions Backed by Worldwide Service and Support

Tap our expertise throughout the life of your instrument. As an industry leader in analytical instruments, Thermo's support extends throughout our worldwide network of Thermo-trained and certified engineers who are experts in laboratory technologies and applications. Put our team of experts to work for you in a range of disciplines, from system installation, training and technical support, to complete asset management and regulatory compliance consulting. Improve your productivity and lower the cost of instrument ownership through our product support services. Maximize uptime while eliminating the uncontrollable cost of unplanned maintenance and repairs. When it’s time to enhance your systems, Thermo also offers certified parts and a range of accessories and consumables suited to your application.

To learn more about our products and comprehensive service offerings, visit our Web site at www.Thermo.com.