



**Thermo Scientific ELEMENT GD PLUS**  
Glow Discharge Mass Spectrometer



# Defining quality standards for the analysis of solid samples

**Thermo**  
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# Redefine your quality standards for the elemental analysis of solid samples

The Thermo Scientific ELEMENT GD PLUS GD-MS redefines the analysis of advanced high purity materials directly from the solid. Extra low detection limits are provided with minimum calibration and sample preparation effort, making bulk metal analysis and depth profiling applications the domain for GD-MS.

Ceramics and other nonconductive powders are analysed by using a secondary electrode approach, providing the same level of sensitivity and data quality. This makes GD-MS the reliable standard method for metal analysis.



The ELEMENT™ GD PLUS GD-MS mass spectrometer is tailored to serve high purity material manufacturers and their customers in industries such as:

- Aerospace: nickel super alloys, depth profiling of coatings and diffusion layers
- Microelectronics: copper, alumina powder, sputter targets
- Renewable energy: silicon blocks, wafers, solar cells
- Medical/pharmaceutical/food: stainless steel, alloys
- Nuclear: uranium, nuclear fuel



# Incomparable

speed, sensitivity, accuracy

The ELEMENT GD PLUS GD-MS combines components with superior attributes into one instrument incomparable in speed, sensitivity and accuracy.

## Technology Overview

- Micro second pulsed, fast flow, high power glow discharge ion source
  - Short analysis time due to comparatively high sputter rates
  - Superior sensitivity
  - Low level of polyatomic interferences compared to static GD sources
  - Widely adjustable working range for pulsed mode operations
  - Uniform crater shape, flexible anode diameter
- 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
- Excellent abundance sensitivity
  - Minimum contribution of high matrix signals on neighboring analyte peaks
- State-of-the-art software suite for productivity and ease-of-use
  - Full computer control of all parameters
  - Fully automated analysis and data evaluation
  - LIMS connectivity with automatic data transfer
  - Control and diagnostic
  - Microsoft® Windows® 7 Operating System
- Quantitative multi-element analysis across the periodic table
- Resolution switching time <1 second.
- Less than 10 minutes sample turn-around for many applications
- Matrix to ultra-trace detection capabilities in a single scan
- Depth profiling from sub-ppm to 100% with nanometer depth resolution
- Minimum matrix effects for straightforward semiquantitative quantification



# High throughput and routine operation



The ELEMENT GD PLUS GD-MS ion source including its 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 switching time to a fraction of the time it used to be. The sample itself is placed in a vacuum chamber, eliminating any risk of leakage between the sample and the GD cell.

The sample can quickly and easily be removed from the ion source, simply unloaded and re-loaded, and repositioned for the next measurement. Opening and closing of the ion source manifold is fully automatic.



# Fast and easy sample to sample switching

## The Ion Source

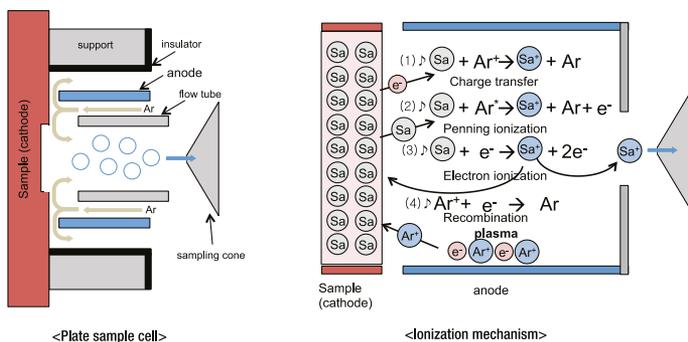
A glow discharge occurs when a potential difference is applied between two electrodes in a cell filled with gas at reduced pressure. In a configuration for elemental analysis the sample acts as the cathode, and its surface is sputtered by impacting gas ions. The sputtered particles, mostly neutral atoms, are ionized downstream in the plasma. Because the processes of sputtering and ionization are separated, especially in pulsed mode operation, 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.

## Typical Discharge Parameters

Discharge gas flow (typically): 300 - 500 mL/min

Voltage: 500 - 1400 V

Current: 5 - 75 mA



The ELEMENT GD PLUS GD-MS ion source offers generally high, although widely adjustable sputter rates and a simple and fast sample change-over, providing routine operation and high throughput without any compromise in performance. Pulsed mode operation results in significantly higher ionization efficiency at lower sputter rates, reducing the amount of deposits in the source.

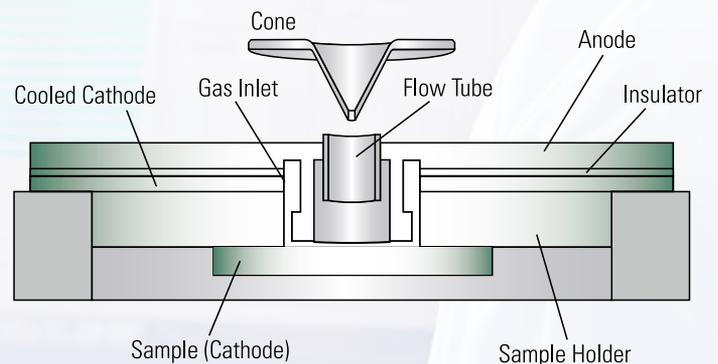
High throughput is additionally supported by electronic (Peltier) sample cooling (or heating), eliminating the need for cooling with cryogenic gases as required in other GD-MS instruments. There is a much reduced requirement for perfectly flat samples because the sample is not used as a vacuum seal.



## Characteristics of the

### Glow Discharge Source

- High sensitivity for short analysis times
- Fast and simple sample to sample switching
- Low level of polyatomic interferences without the need for cryo-cooling
- Complete set of consumables for ultra-high purity and medium purity analysis
- Flexible cell for flat samples, pressed powders and pin samples (optional sample holder)
- Plug-in cone and anode parts for quick exchange eliminates the risk of cross contamination
- Sputter rates widely adjustable for bulk analysis or depth profiling
- Large sputtered sample area for representative surface sampling, minimizing inhomogeneities in the material
- Flexible anode diameter for advanced depth profiling applications



# Measure 50 elements

## at low ppb within 5 minutes

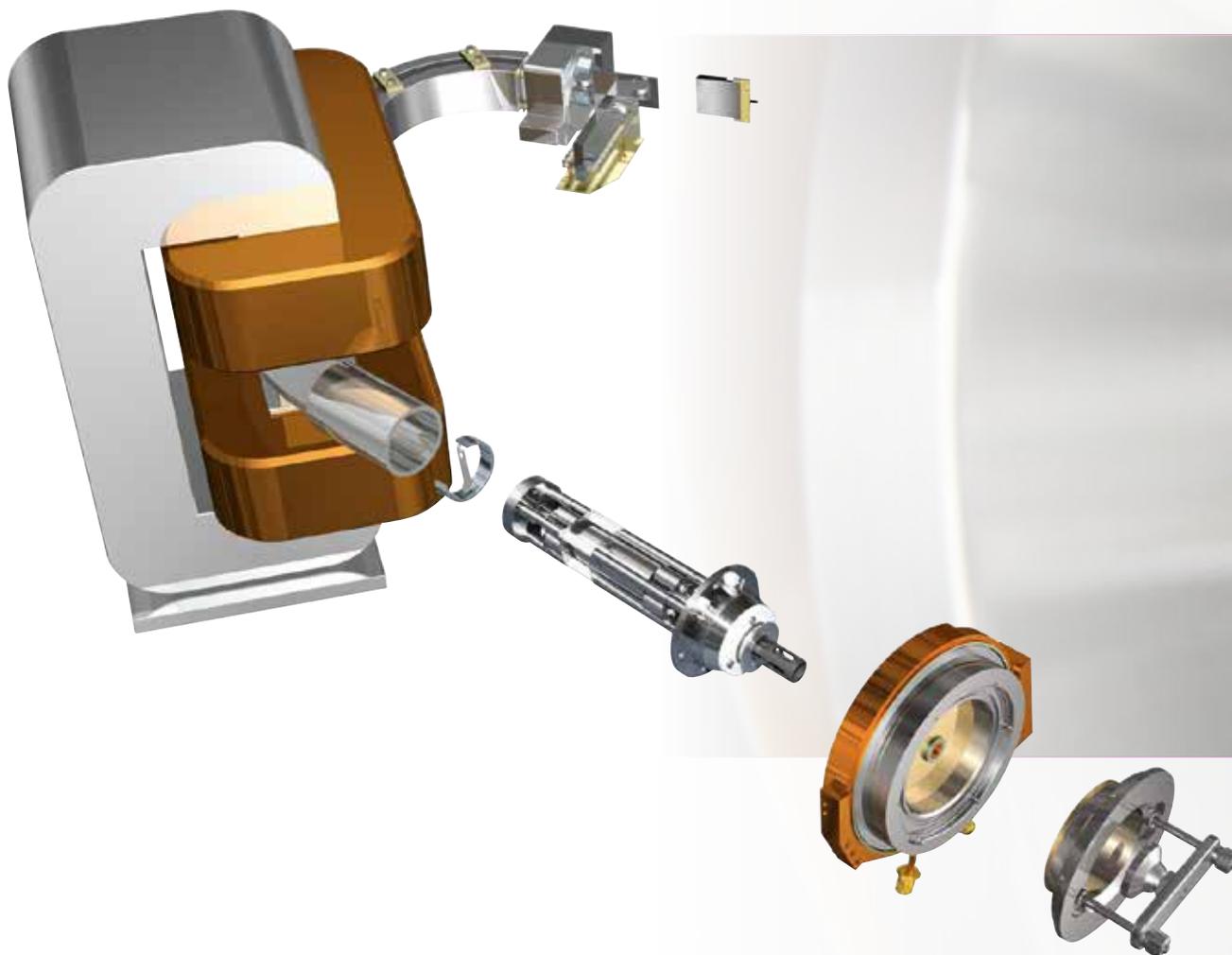
### The Mass Spectrometer

The ELEMENT GD PLUS GD-MS 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 mass spectrometer of the ELEMENT GD PLUS GD-MS 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 reverse Nier-Johnson sector geometry ensures excellent abundance sensitivity of < 10 ppb in copper matrix, determined as the background signal on m-1 (mass 62 vs. mass 63). The analyzer is optimized for speed and mass stability. The magnet is designed for the mass range 1-260 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, resulting in minimum magnet switching and settling times.



High precision and accuracy of the mass calibration is vital for short analysis times, allowing precise peak top jumping. Due to the fully automatic mass locking process, mass calibration is no longer a regular procedure.

#### **Key features of the ELEMENT GD PLUS GD-MS**

Sensitivity (peak height, total ion current):  $> 1 \times 10^{10}$  cps, ( $1.6 \times 10^{-9}$  A) for copper in medium resolution ( $R \geq 4000$ )

Resolution: LR  $\geq 300$ , MR  $\geq 4000$ , HR  $\geq 10000$  switchable within  $< 1$  s

Mass stability:  $< 25$  ppm / 8 hour

Abundance sensitivity:  $< 10$  ppb (determined as m-1/m in copper, medium resolution)

Scan speed:  $< 150$  ms from  $m/z$  7 to 238 to 7



# Dynamic

## beyond limits

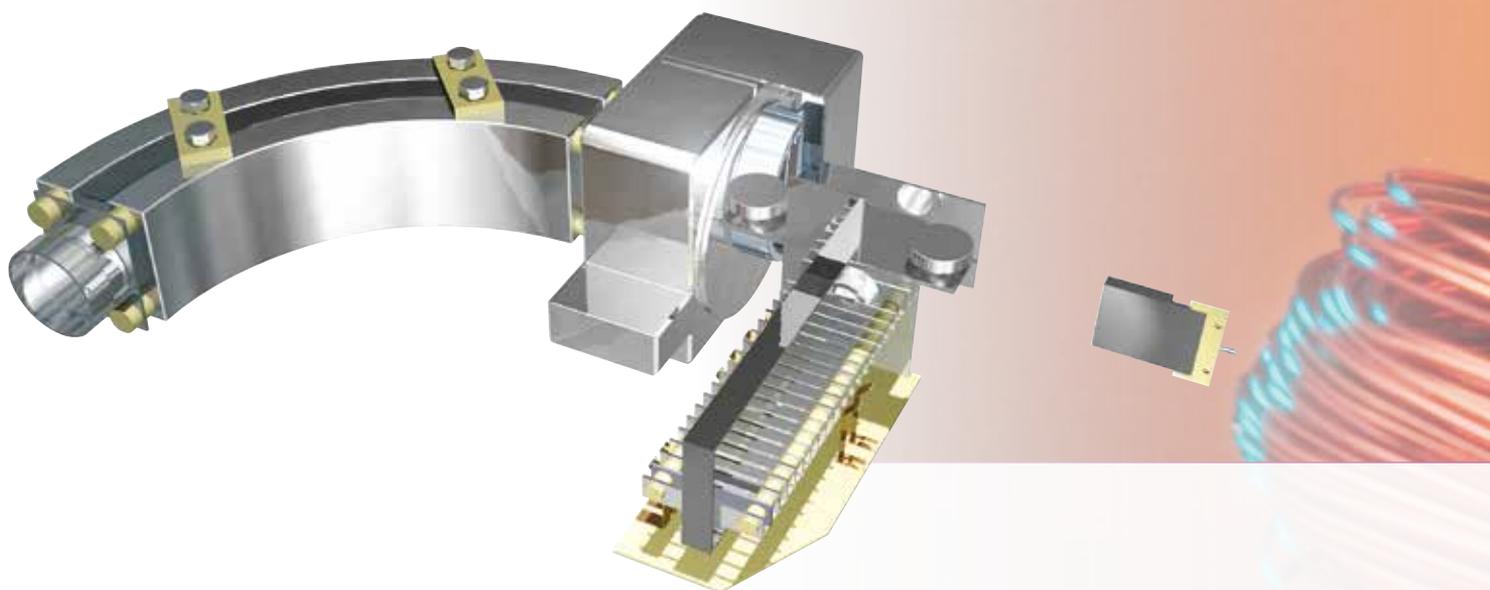
A sophisticated detection system completes the refined design of the ELEMENT GD PLUS GD-MS mass spectrometer.

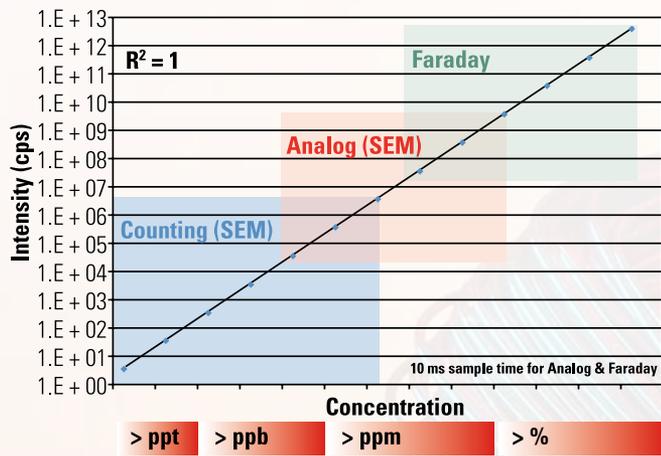
### Detection System

Typical applications involve the simultaneous analysis of matrix elements (%), traces (ppm) and ultra-traces (ppb). To achieve this, the detection system offers:

- Wide dynamic range: 0.5 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 ELEMENT GD PLUS GD-MS instrument this is achieved through the use of a unique and patented\* combination of a dual mode (dark noise  $< 0.5$  cps) secondary electron multiplier (SEM) and a Faraday collector (maximum current  $> 10^{12}$  cps). The Faraday detector is no longer a slow collector requiring long analysis time: due to its fast detection electronics it does not suffer decay or response times and allows integration times down to 1 ms.





Detector ranges for the ELEMENT GD mass spectrometer



# Our complete portfolio

## for surface and bulk metal analysis.

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