PERIODIC TODAY
CALIBRATION & REFERENCE STANDARDS FOR SEM

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GSR_C1

Test Sample Documentation

Technical description with example uses notes

Technical documentation for website download

17-June-2026

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1. Purpose and scope

GSR_C1 is a compact SEM/EDS reference sample intended for routine quality-control checks in gunshot-residue (GSR) particle analysis. The sample combines a compact single-field particle test matrix with supporting BSE, EDS and beam-current reference areas on one 1/2-inch aluminium pin stub.

The design is intended to support laboratories that perform positive-control checks before automated case-sample analysis. The notes in this document describe possible uses of the individual sample areas within a laboratory's own validated SEM/EDS method and software configuration.

Reference to ASTM E1588-25

ASTM E1588-25 Section 9.2 describes positive-control checks for automated analysis, including particles of known size range and composition or equivalent monitoring showing detection of 1 µm GSR particles. GSR_C1 was designed with this type of routine positive-control workflow in mind. Acceptance criteria, implementation and interpretation remain part of the laboratory method.

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2. Sample overview

The GSR_C1 assembly is embedded in a polished aluminum pin stub. The surface is polished for flat EDS analysis and carbon coated for conductivity.

Item	Description
Stub size	12.5 mm / 1/2-inch pin stub
Stub material	Aluminum Al6082
Surface finish	Polished to 0.5 µm
Conductive coating	10 nm carbon
Functional areas	Al/Ti/Mo BSE standard; Mn/Ni 88/12 alloy; Co; Al-Cu edge; 200 µm copper aperture / Faraday cup; compact single-field QM test matrix

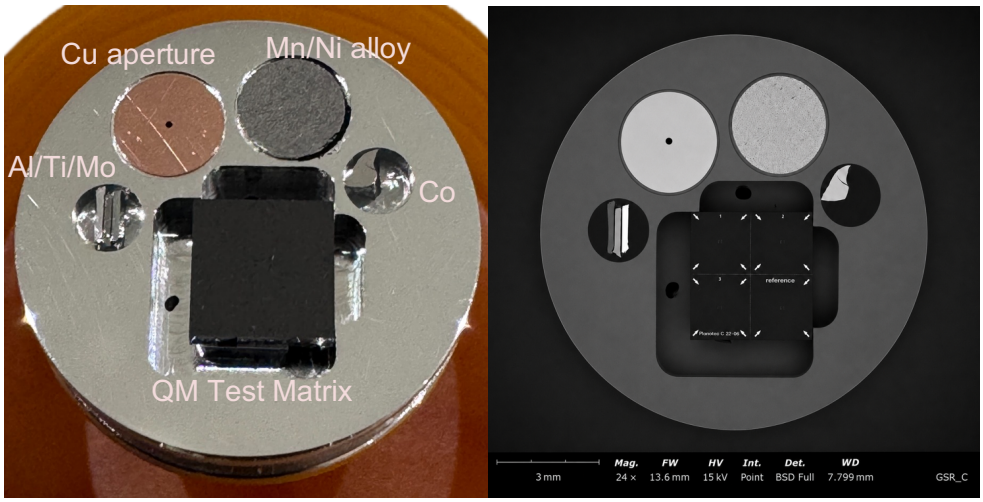

Figure 1. GSR_C1 sample layout on a 1/2-inch pin stub.

3. Functional areas on the GSR_C1 stub

Area	Intended function
Al/Ti/Mo BSE calibration standard	Three-material BSE contrast reference
Mn/Ni 88/12 alloy	EDS resolution reference material for monitoring the Mn Kα full width half maximum (FWHM)
Co	EDS energy-calibration material commonly used in automated GSR workflows
Al-Cu edge	Practical EDS energy-calibration for systems that use an Al-Cu calibration routine
200 µm copper aperture	Beam-current measurement point / Faraday cup.
Compact single-field QM test matrix	Labelled particle-size matrix for fast detection-sensitivity and classification checks

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4. Al/Ti/Mo BSE calibration standard

The Al/Ti/Mo area provides three materials with different atomic numbers (13, 22, and 42). In BSE imaging this produces a defined contrast range used for checking detector response and for setting SEM brightness/contrast before an automated GSR run. The chosen materials are relevant to both conventional and heavy-metal-free ammunition residue workflows.

The materials are placed close together so that a 512 µm field of view is sufficient to cover all three materials.

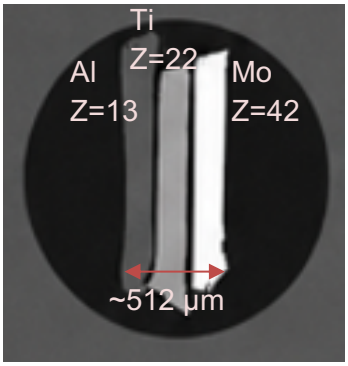

Figure 2. Al/Ti/Mo BSE calibration standard.

5. Mn/Ni 88/12 alloy for EDS resolution check

The Mn/Ni 88/12 alloy area is included as an EDS resolution reference. EDS resolution is commonly expressed as the full width at half maximum (FWHM) of the Mn Kα peak at approximately 5.9 keV. The Mn-Ni alloy provides Mn for this measurement while avoiding the practical handling disadvantages of pure manganese.

An EDS spectrum should be acquired for long enough to obtain a smooth Mn Kα peak. After subtracting the local background, the peak width is determined at half of the peak height. This FWHM value can be monitored as an indicator of EDS energy resolution under the selected system conditions.

The evaluation can be performed manually or with suitable spectrum-analysis software. Amongst others, DTSA-II from NIST can be useful for spectrum processing and peak measurements, provided the laboratory applies consistent settings and records the evaluation method.

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6. EDS energy-calibration materials: Co and Al-Cu

The Co area is included for EDS energy calibration. Cobalt is commonly used in automated GSR software workflows, including Oxford-based systems.

The Al-Cu check is available at the interface between the copper aperture and the aluminium stub. This provides a practical Al-Cu calibration location for systems that use an Al-Cu energy-calibration routine, for example Phenom-based workflows.

The automated GSR software or EDS platform can use the relevant Co or Al-Cu location to calibrate EDS spectrum gain and offset. The exact acquisition settings and acceptance limits should follow the laboratory's software configuration and method.

7. Copper aperture / Faraday cup area

The 200 µm copper aperture can be used as a beam-current measurement point, depending on the SEM configuration. The aperture is mounted to provide a clear opening for current measurement and a geometry to minimize any electrons escaping to make an accurate measurement.

The beam can be positioned on the aperture opening and measured using the microscope's current-measurement function or an external picoamp meter setup, where available. The result can be monitored as part of routine beam-current or beam-stability checks.

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8. Compact single-field QM test matrix

The compact single-field QM test matrix is the main feature of the GSR_C1 sample. It contains labelled particle-size rows from 3.0 µm down to 0.6 µm. The relevant particle structures are placed in a single field of view, so the complete matrix can be measured without scanning a large search area.

The central test matrix is approximately 100 x 130 µm and is located in a larger open area of approximately 1.3 x 1.3 mm. This gives practical positioning tolerance: after removing and replacing the stub, small changes in stage position normally do not bring unrelated structures into the image field. Arrow structures at the edges help the user quickly find the correct quadrant and centre the matrix.

The matrix contains eight particles per labelled size row. The 2.0 µm and 3.0 µm columns act as robust reference rows and visual row markers; these larger particles are normally detected under routine conditions and help confirm orientation and row alignment. The smaller rows provide a practical way to compare detection and classification performance around the 1 µm region.

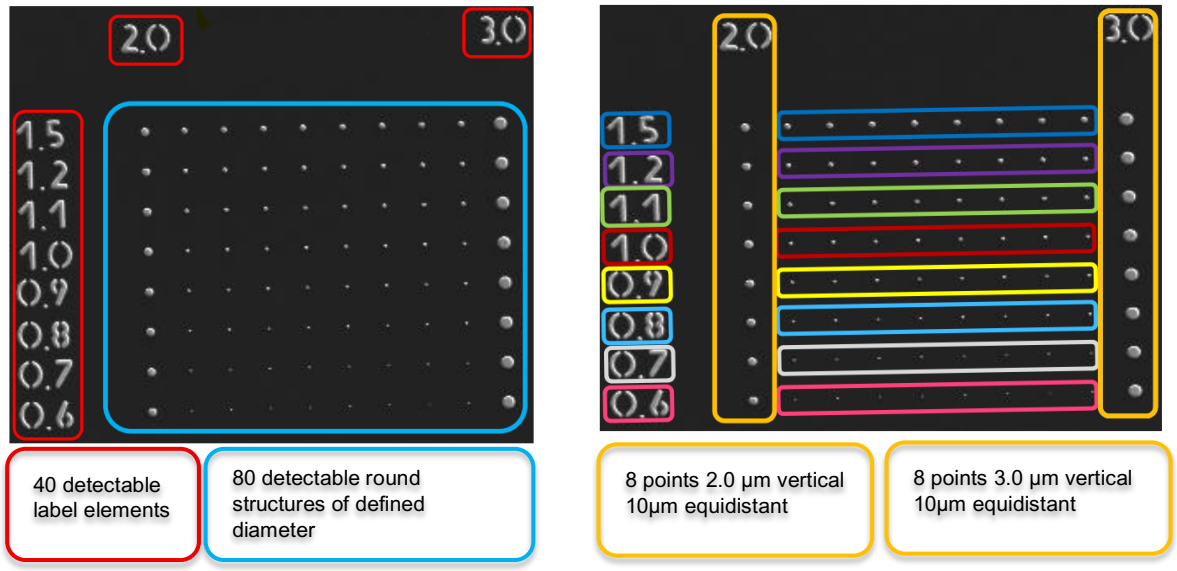

Figure 3. Labelled particle-size rows and compact single-field layout.

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8.1 Four-quadrant design and reference field

The chip contains four equivalent particle fields. Fields 1, 2 and 3 are intended as daily-use areas. The fourth field is marked as a reference area and has the same design but is intended for less frequent use.

During repeated electron-beam exposure, the measured BSE brightness of the particle structures will gradually decrease as carbon contamination builds up on the surface. This is a normal wear mechanism for a daily-use SEM reference area, especially in instruments or methods with longer dwell times or higher beam exposure.

The reference field provides a practical way to separate sample wear from instrument or setup effects. If a daily-use field starts to give weaker detection results, the reference field can be measured under the same conditions. If the reference field performs as expected, the daily-use field is likely degraded and the next daily-use field can be selected. If both the daily-use field and the reference field perform poorly, the cause is more likely related to the SEM/EDS setup, software settings, contamination, focus, astigmatism, detector response or another part of the measurement configuration.

A practical routine check may compare the number of detected and correctly classified particles per size row against the laboratory's own acceptance limits. The single-field layout keeps the image-acquisition part short; the total analysis time is mainly determined by the EDS acquisition time selected for each detected object.

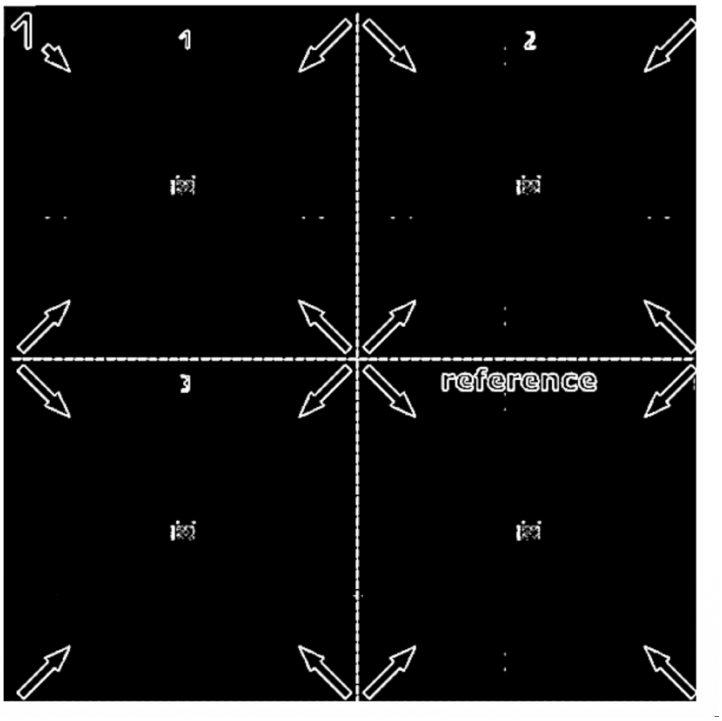

Figure 4: Four quadrant QM test matrix overview

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8.2 Indicative measurement time

Because the matrix is measured in one field of view and contains a limited number of objects, the image-acquisition time is typically only seconds. The EDS acquisition time is approximately proportional to the selected live time per object and the number of detected objects.

EDS time per object	Approx. number of objects	Approx. EDS time
0.5 s	120	~1 min
1 s	120	~2 min
2 s	120	~4 min
5 s	120	~10 min

In practice, total measurement time is commonly in the range of 2 to 10 minutes, depending on image settings, EDS live time, number of detected objects and the configuration of the automated GSR software.

9. Handling, storage and lifetime

Handle the sample only with clean tweezers and avoid touching the polished surface. For best lifetime, store the sample in a clean dry environment or under vacuum. If loose particles are present, they may be gently removed using clean dry compressed air or nitrogen. Do not brush, wipe or rub the sample surface.

During prolonged use, carbon deposition from cracked hydrocarbons in the SEM chamber can gradually darken exposed structures and reduce BSE contrast. This effect is the reason for separating daily-use fields from the reference field in the compact QM matrix.

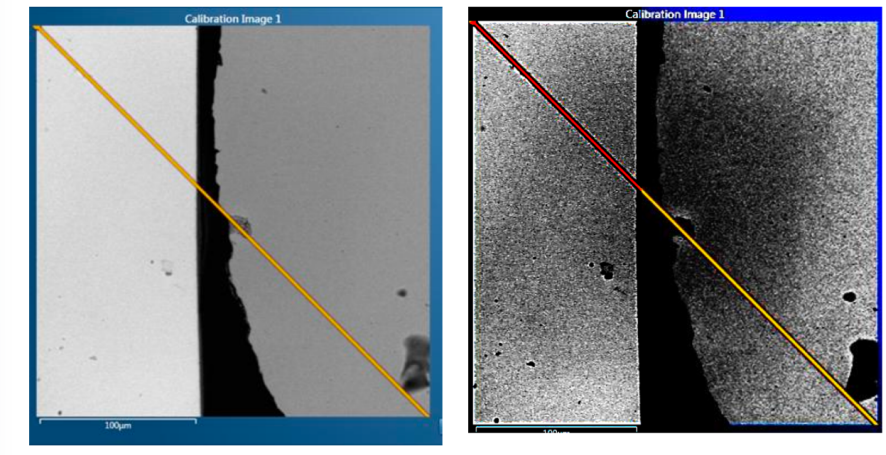

Figure 5. Example of beam-exposure related contamination on a BSE reference area.

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10. Notes on interpretation

GSR_C1 is a calibration sample and should be used within the laboratory's own SEM/EDS method, software configuration and acceptance criteria. The notes in this document describe possible checks for the included sample areas; they are not a substitute for method validation, instrument qualification or laboratory-specific quality procedures.

Other system-validation standards remain useful for qualifying and validating the wider SEM/EDS system for GSR applications. GSR_C1 is intended to complement such standards by providing a compact daily-use reference sample on the same 1/2-inch stub as supporting BSE, EDS and beam-current reference areas.

Appendix: source material information

The following supplier information is included for traceability of source materials used in the reference areas. Batch-specific certificates may differ by production lot.

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Element technical data sheet: Manganese/Nickel Foil 88/12

Certificate of Typical Analysis

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Our Reference: 0007SO-07-0006860
Your Order Number: 39000001276
SKU Number / Batch: 1000132250/500034088

Product Detail
Manganese/Nickel Foil
Mn88/Ni12
Condition: As Rolled
Thickness: 0.125mm
Size: 50mm x 50mm

Element	Result
Mn	88%
Ni	12%

All impurities in wt% unless otherwise stated.
The analysis was performed on this batch either in the final form or at an earlier stage of manufacture.

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Element technical data sheet: Cobalt (Co)

CERTIFICATE OF ANALYSIS

Our reference : LS590160
Your order number : Q1056392
Item number : CO00-LP-000110 / CO006110 / 5

Cobalt	:	Matrix
Aluminium	:	0.33
Chromium	:	1.1
Copper	:	3
Gallium	:	0.28
Iron	:	13
Manganese	:	0.62
Molybdenum	:	0.16
Nickel	:	37
Tantalum	:	1
Titanium	:	0.43

All impurities in ppm unless otherwise stated.
The analysis was performed on this batch either in the final form or at an earlier stage of manufacture.

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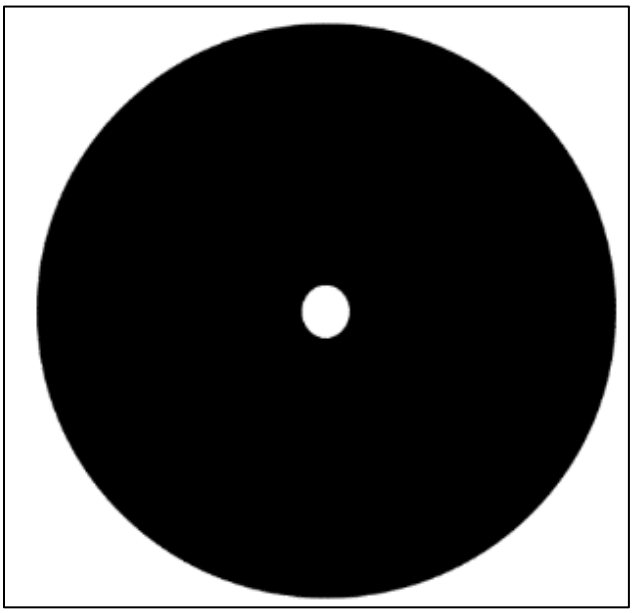
Element technical data sheet: 200µm copper aperture



GA200

Mesh Specifications	
Mesh (lines/inch)	**N/A**
Pitch (um)	**N/A**
Bar Width (*um*)	**N/A**
Hole Width (*um*)	**200**

Rim Specifications	
Rim width (mm)	**N/A**
Centre Mark	**N/A**
Rim Mark	No

Availability	
Gold per Vial	**50**
Other per Vial	**100**
2.3mm	**No**