TECHNICAL DATA

Terrawell Microstructural Characterization

Scanning electron microscopy and pore size distribution measurement

Specimen	Terrafuoco-109square (Pro), fracture surface
Curing method	Atmospheric curing
Date of analysis	18 August 2026
Magnification	×500 – ×110,000 (10 conditions)
Pore size distribution	Mercury intrusion porosimetry
Testing institute	Gifu Prefectural Ceramics Research Institute

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1.

Specimen and Measurement Conditions

1-1 Specimen

Product name	Terrafuoco-109square (Pro)
Category	Non-fired mineral building material
Curing method	Atmospheric curing (carbonation by carbon dioxide in ambient air)
Surface examined	Fracture surface

1-2 Scanning electron microscopy

Instrument	JEOL Ltd., field-emission scanning electron microscope JSM-7001GC
Specimen preparation	Carbon coating
Accelerating voltage	15.0 kV
Signal detected	Secondary electron image (SEI)
Working distance	10.0 – 10.1 mm
Magnifications	×500 / ×1,000 / ×2,000 / ×3,000 / ×5,000 / ×10,000 / ×20,000 / ×30,000 / ×50,000 / ×110,000
Date of analysis	18 August 2026
Testing institute	Gifu Prefectural Ceramics Research Institute

1-3 Pore size distribution measurement

Method	Mercury intrusion porosimetry
Instrument	Anton Paar POREMASTER 60
Specimen preparation	Dried at 40 °C for 24 h
Lower limit of measurement	Approx. 3.5 nm (determined by the maximum pressure of the instrument)
Testing institute	Gifu Prefectural Ceramics Research Institute

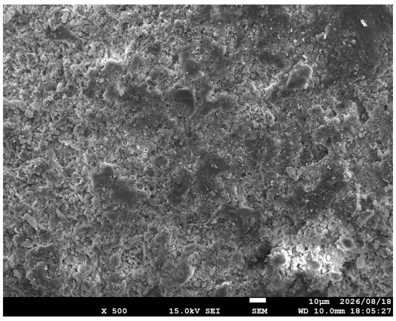
Scope of this document

- This document records the microstructure of the specimen. It does not state performance values.
- For performance characteristics, please refer to the separate performance test reports.
- The micrographs are unretouched original images; no additions or corrections have been made.

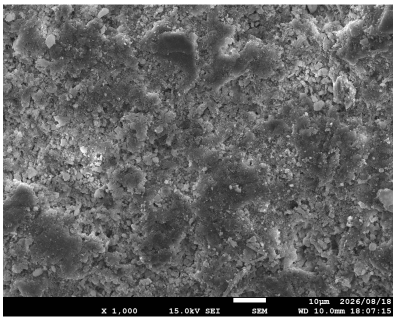
2.

Index of Magnifications

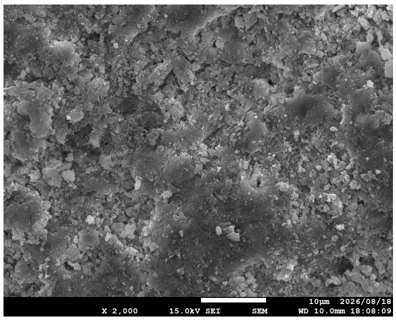
The fracture surface of a single specimen was examined continuously from ×500 to ×110,000. Each magnification is presented on the following pages.



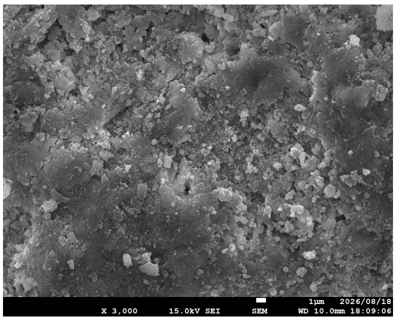
×500 bar 10 µm



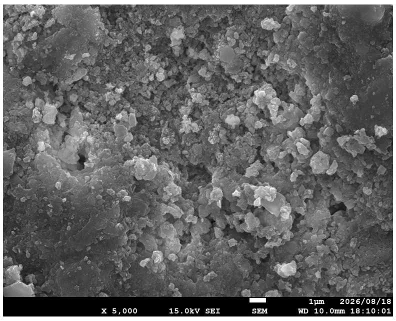
×1,000 bar 10 µm



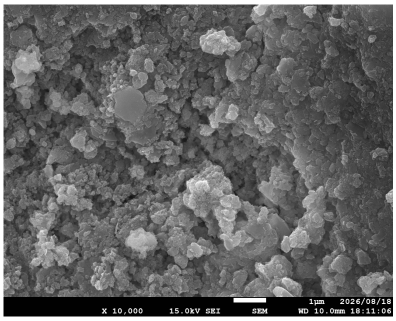
×2,000 bar 10 µm



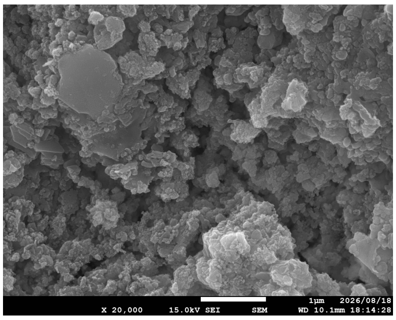
×3,000 bar 1 µm



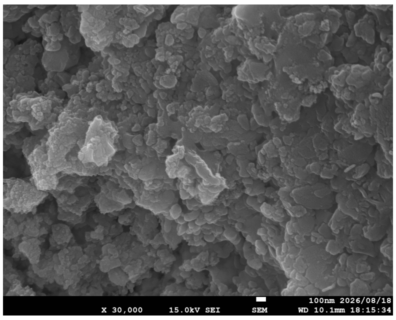
×5,000 bar 1 µm



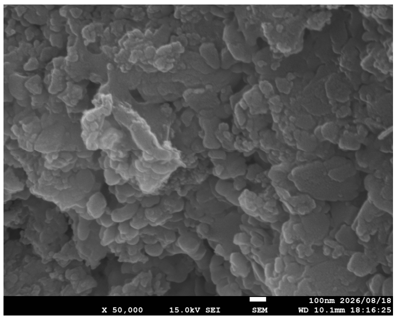
×10,000 bar 1 µm



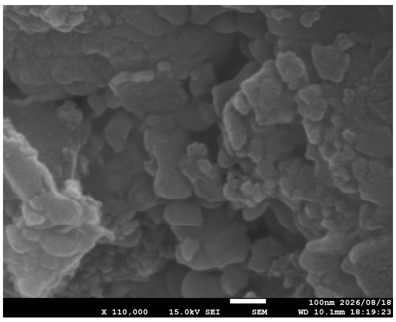
×20,000 bar 1 µm



×30,000 bar 100 nm



×50,000 bar 100 nm



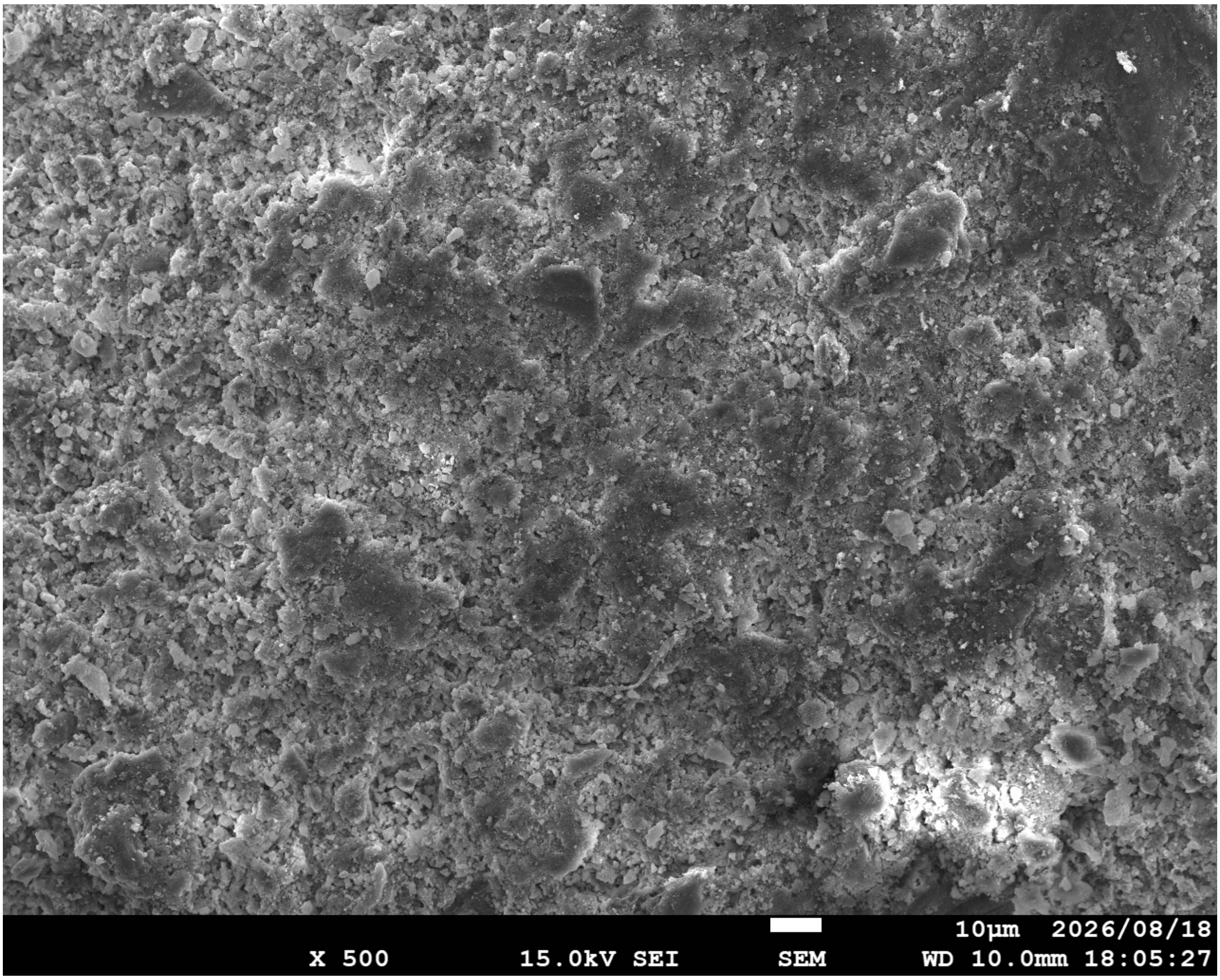
×110,000 bar 100 nm

3-1.

Scanning Electron Microscopy

Figure 1 Magnification ×500

Scale bar 10 µm



OBSERVATION

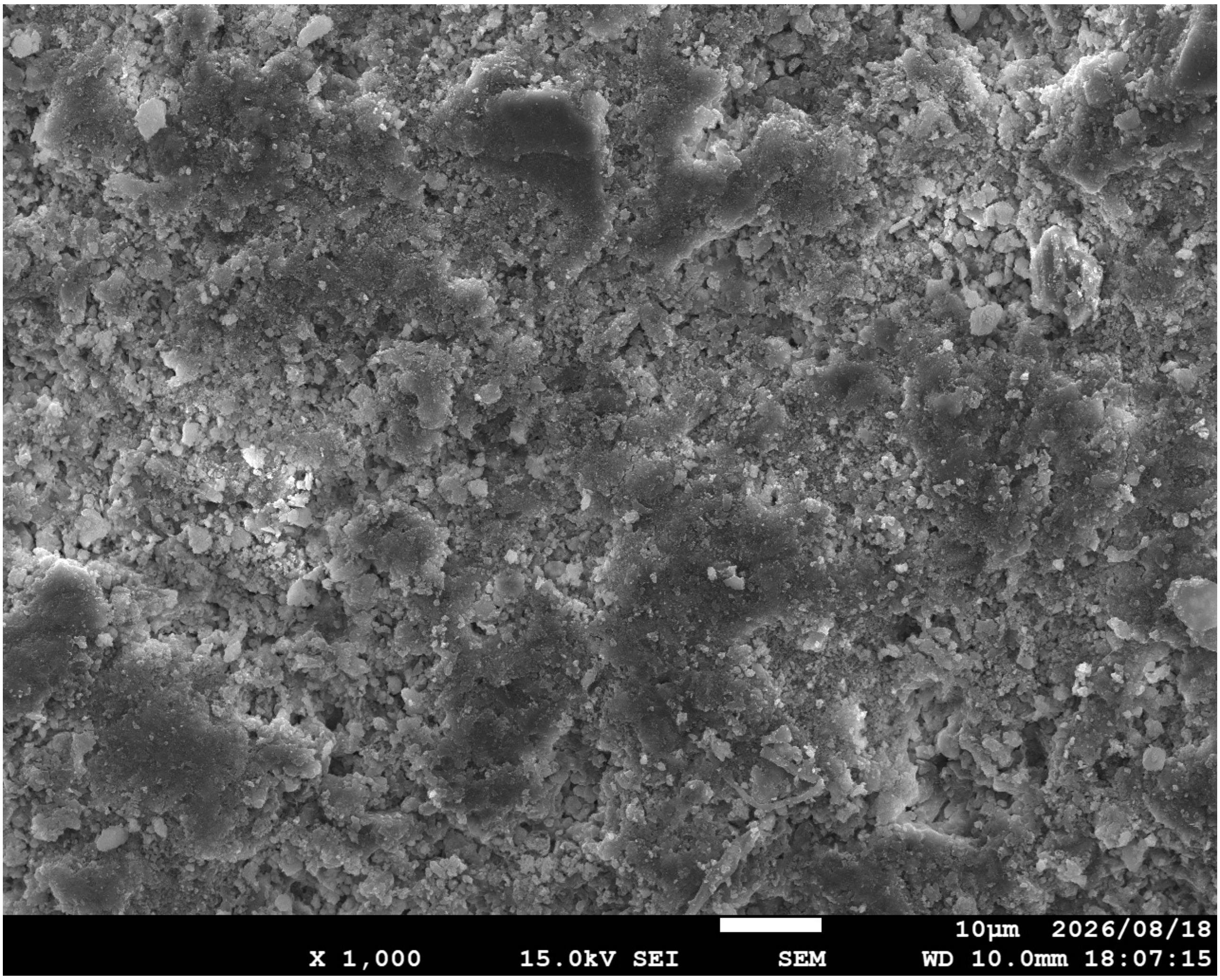
Overall view of the fracture surface. No macroscopic defects such as delamination or large voids are observed, and the structure within the field of view is broadly homogeneous.

3-2.

Scanning Electron Microscopy (continued)

Figure 2 Magnification ×1,000

Scale bar 10 µm



OBSERVATION

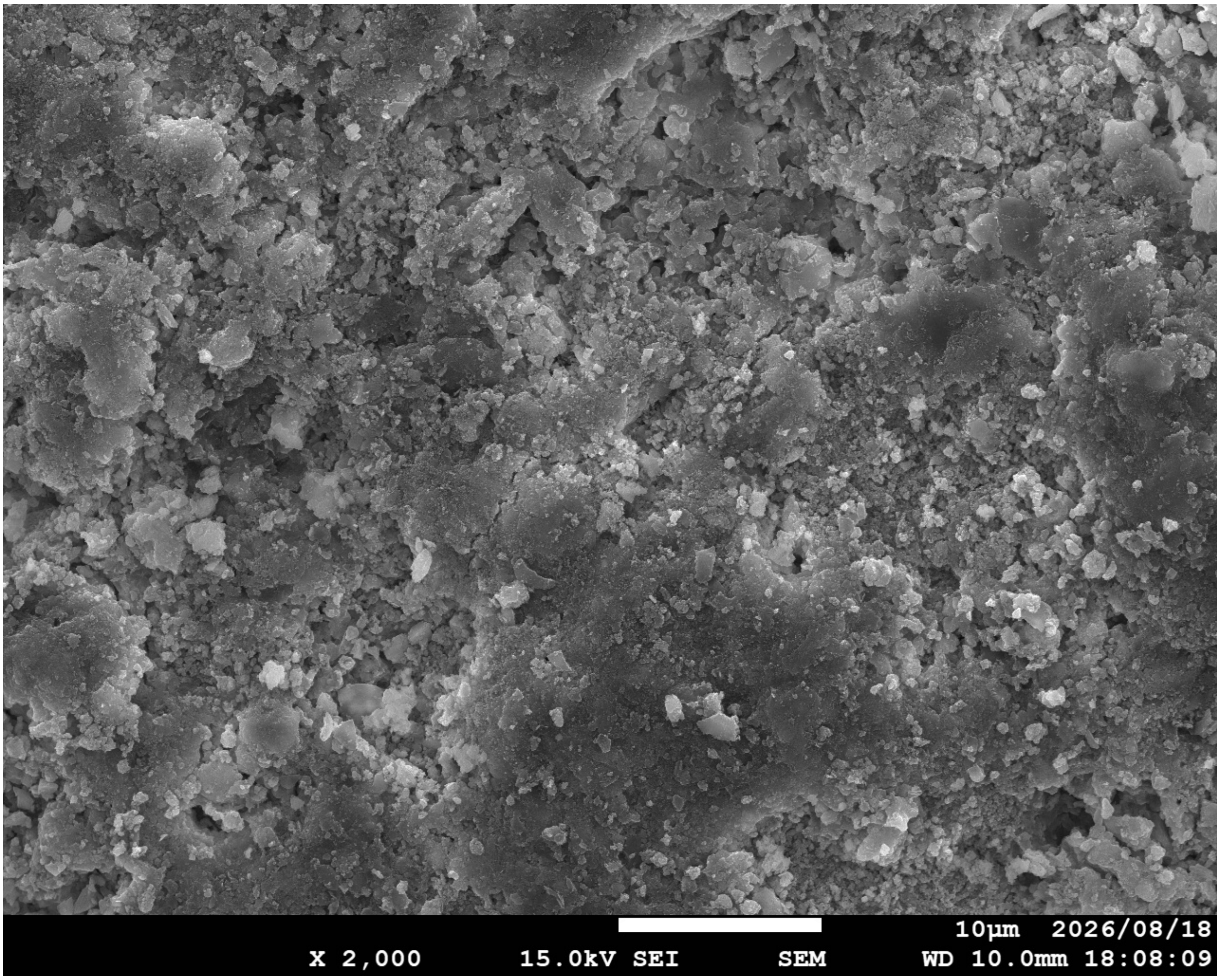
Particles on the order of a few micrometres are observed in a densely packed structure. The particles show no preferred orientation, and no layered structure along any particular direction is observed.

3-3.

Scanning Electron Microscopy (continued)

Figure 3 Magnification ×2,000

Scale bar 10 µm



OBSERVATION

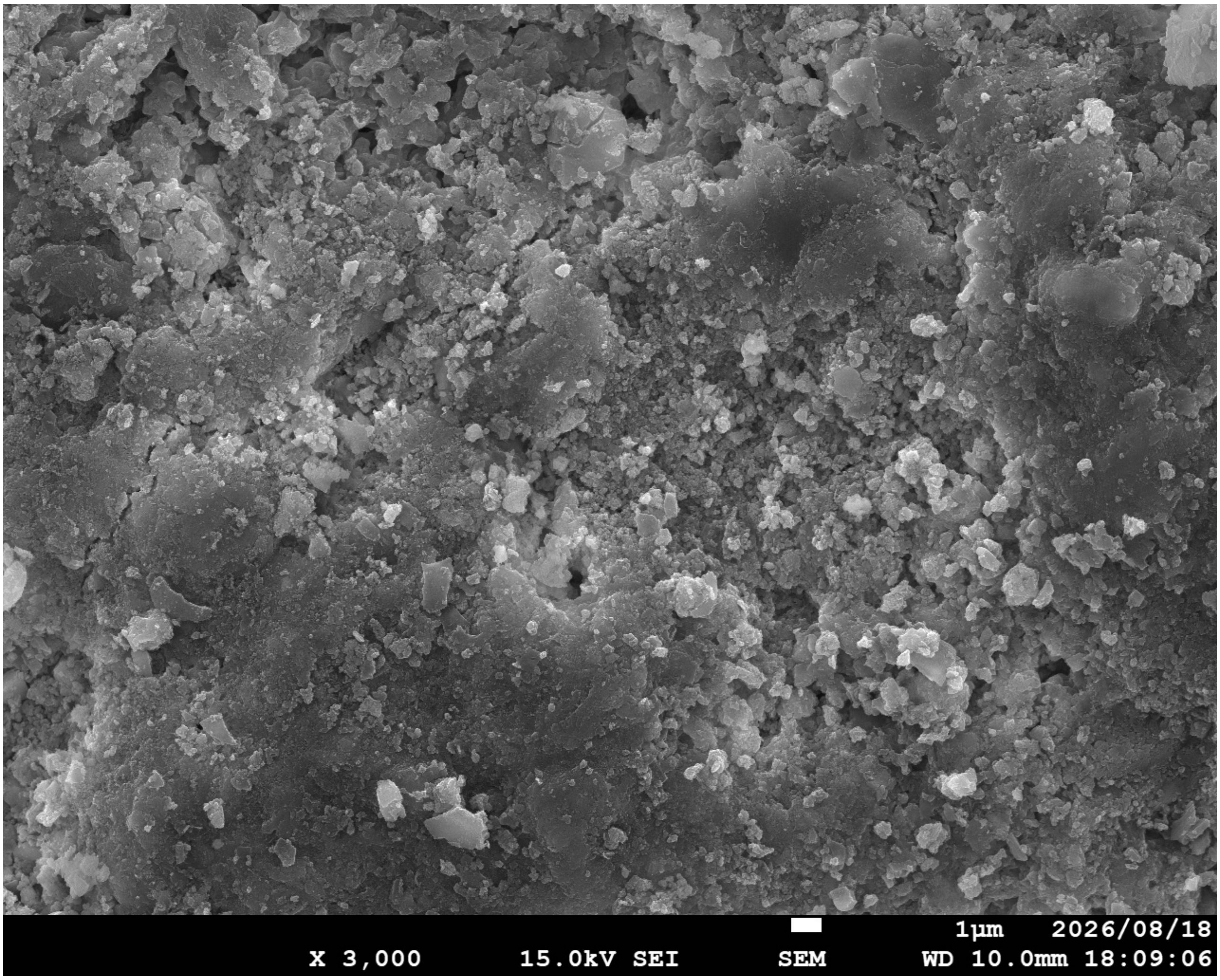
Voids can be seen between the particles. Individual pores are approximately 1 µm or smaller and are scattered throughout the field of view.

3-4.

Scanning Electron Microscopy (continued)

Figure 4 Magnification ×3,000

Scale bar 1 μm



OBSERVATION

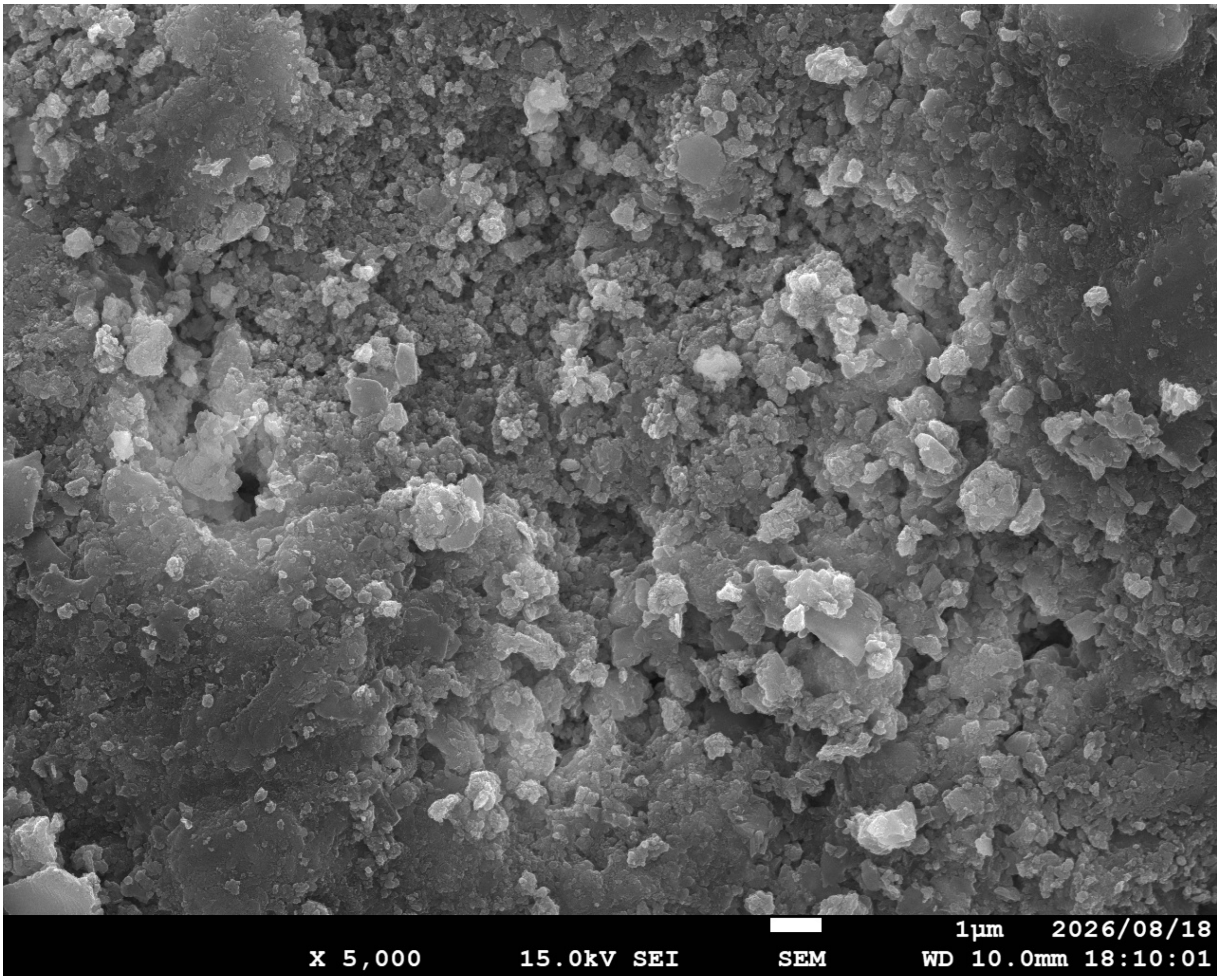
Pores ranging from several hundred nanometres to approximately 1 μm are distributed throughout the field of view. Pores are found both in regions where particles are in close contact and in regions where they are loosely stacked.

3-5.

Scanning Electron Microscopy (continued)

Figure 5 Magnification ×5,000

Scale bar 1 µm



OBSERVATION

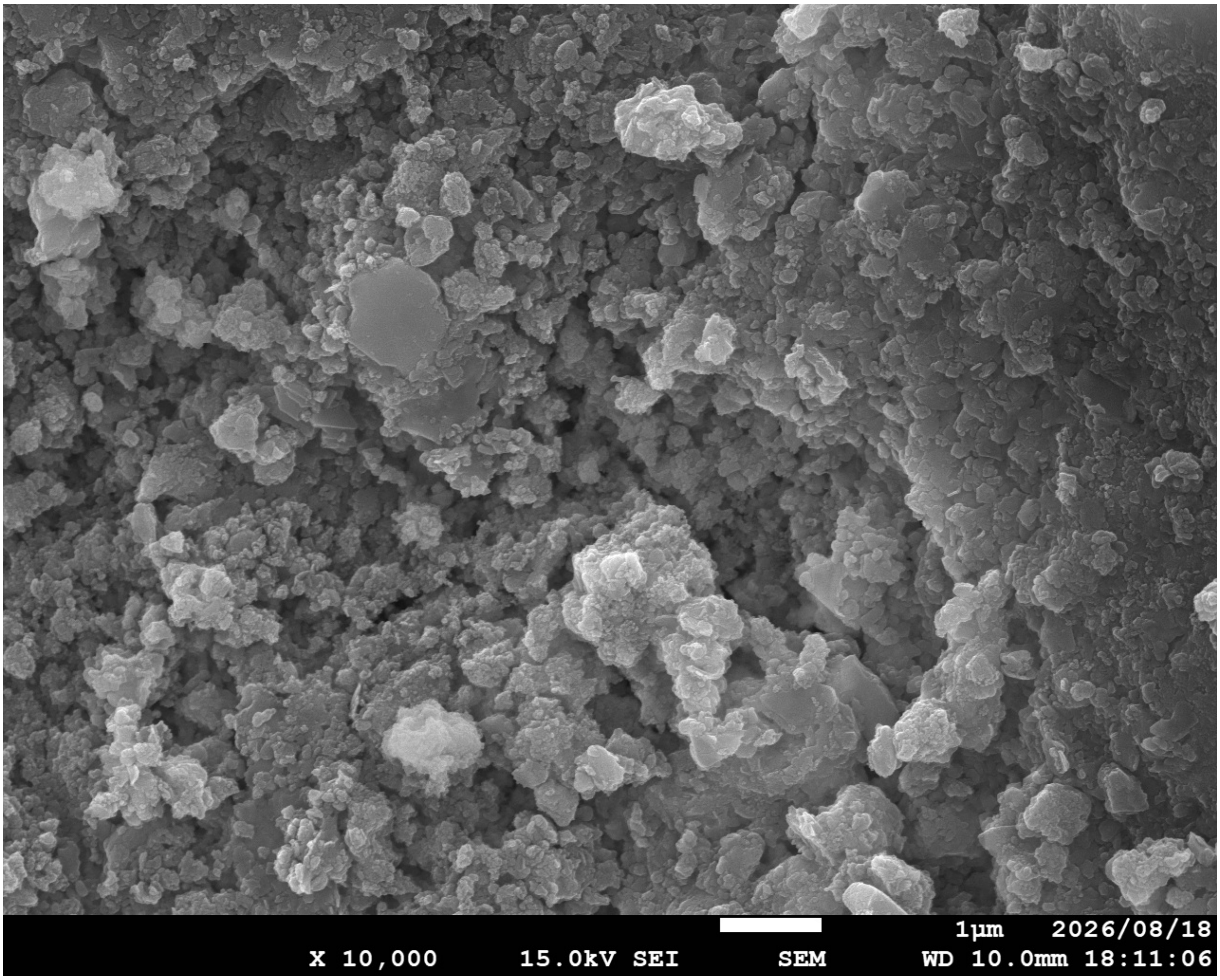
An interlocking structure of fine particles. The gaps between the particles remain directly as pores, showing that the manner in which the particles pack determines the shape of the pores.

3-6.

Scanning Electron Microscopy (continued)

Figure 6 Magnification ×10,000

Scale bar 1 µm



OBSERVATION

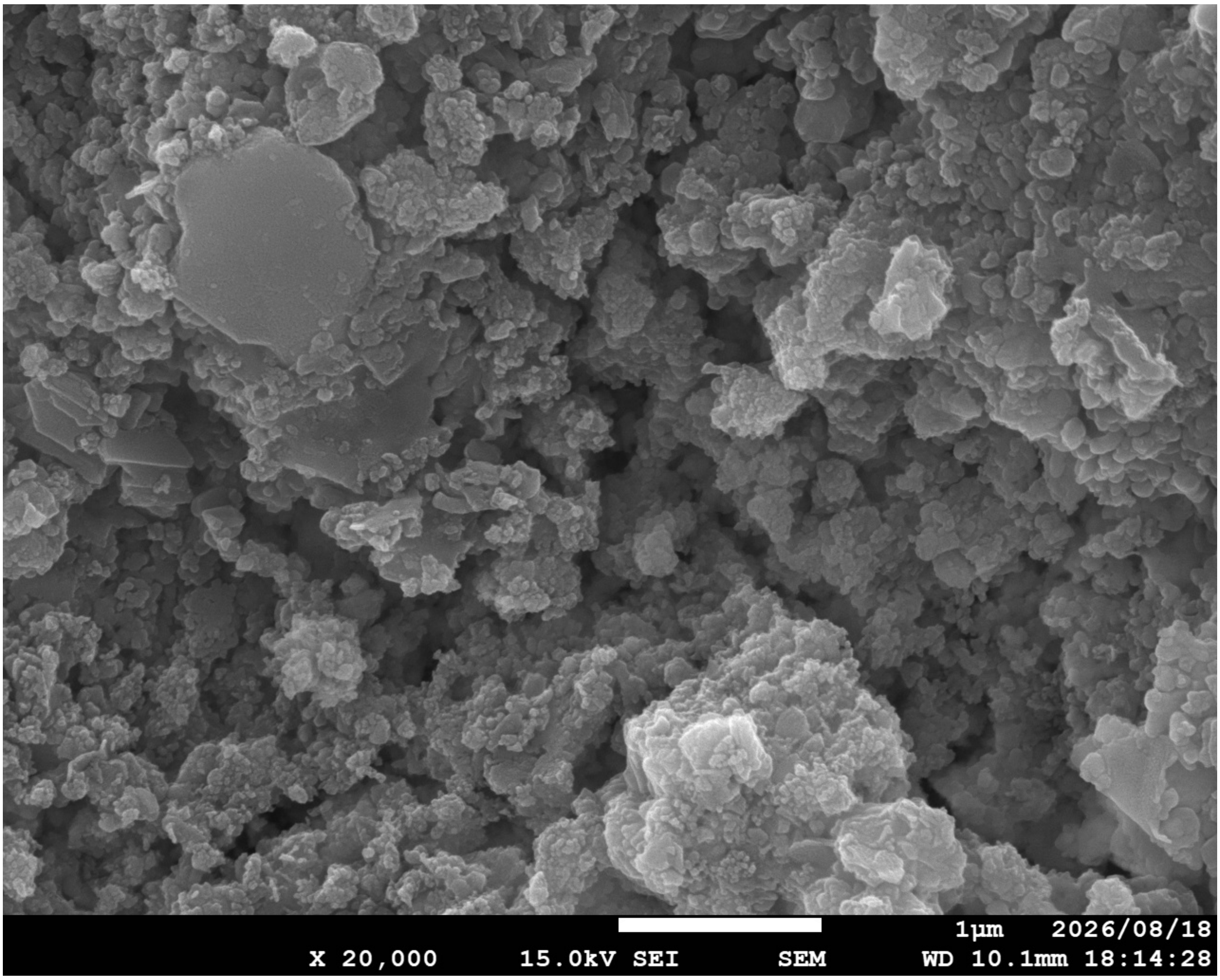
Aggregates of particles, and the pores formed in the interstices between them. The pores are not concentrated in any particular location but are scattered across the field of view. Individual pores are irregular in shape.

3-7.

Scanning Electron Microscopy (continued)

Figure 7   Magnification ×20,000

Scale bar 1 µm



OBSERVATION

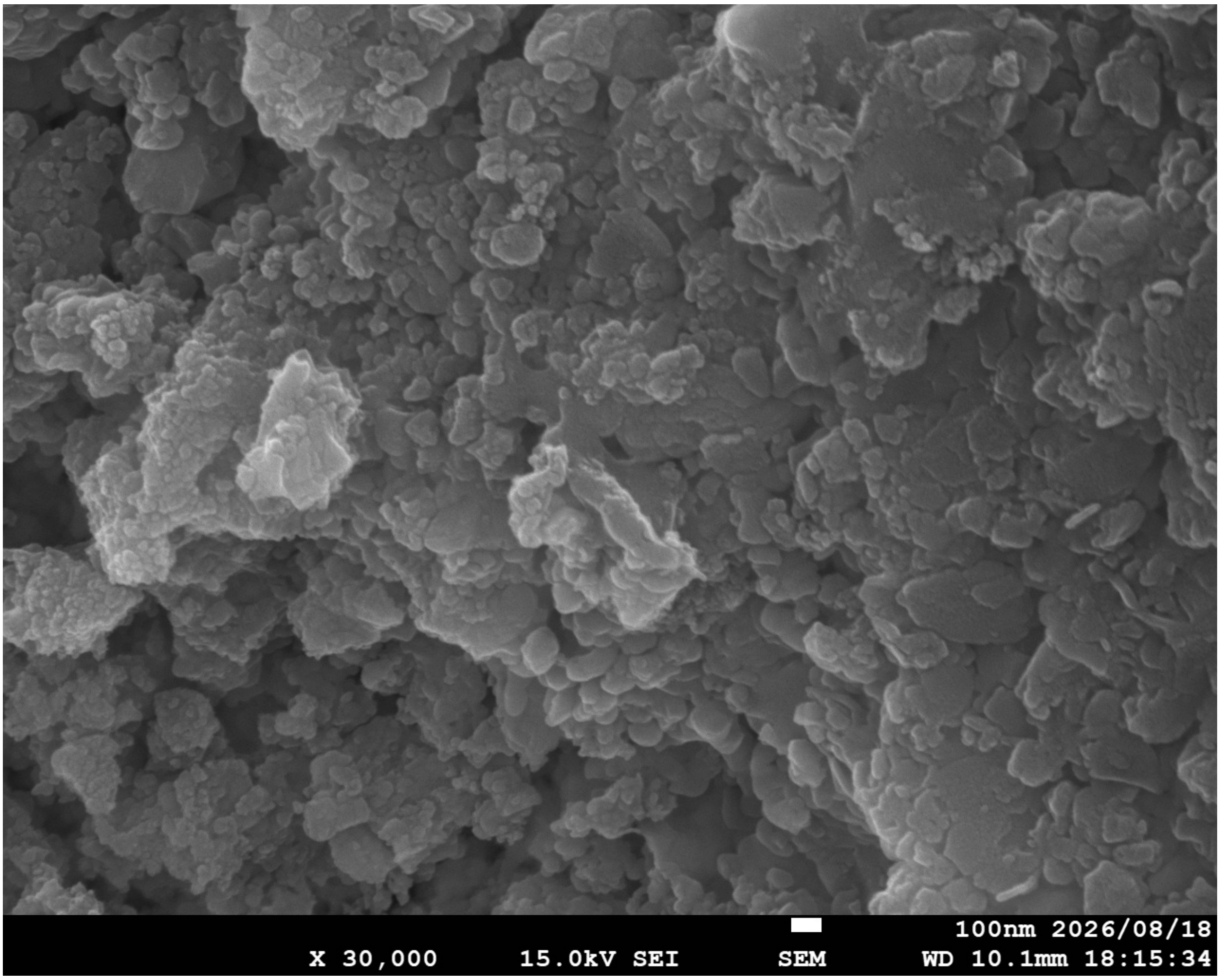
Numerous pores of approximately 100 nm are observed. The particles are in contact at both points and faces, and pores remain around the areas of contact.

3-8.

Scanning Electron Microscopy (continued)

Figure 8 Magnification ×30,000

Scale bar 100 nm



OBSERVATION

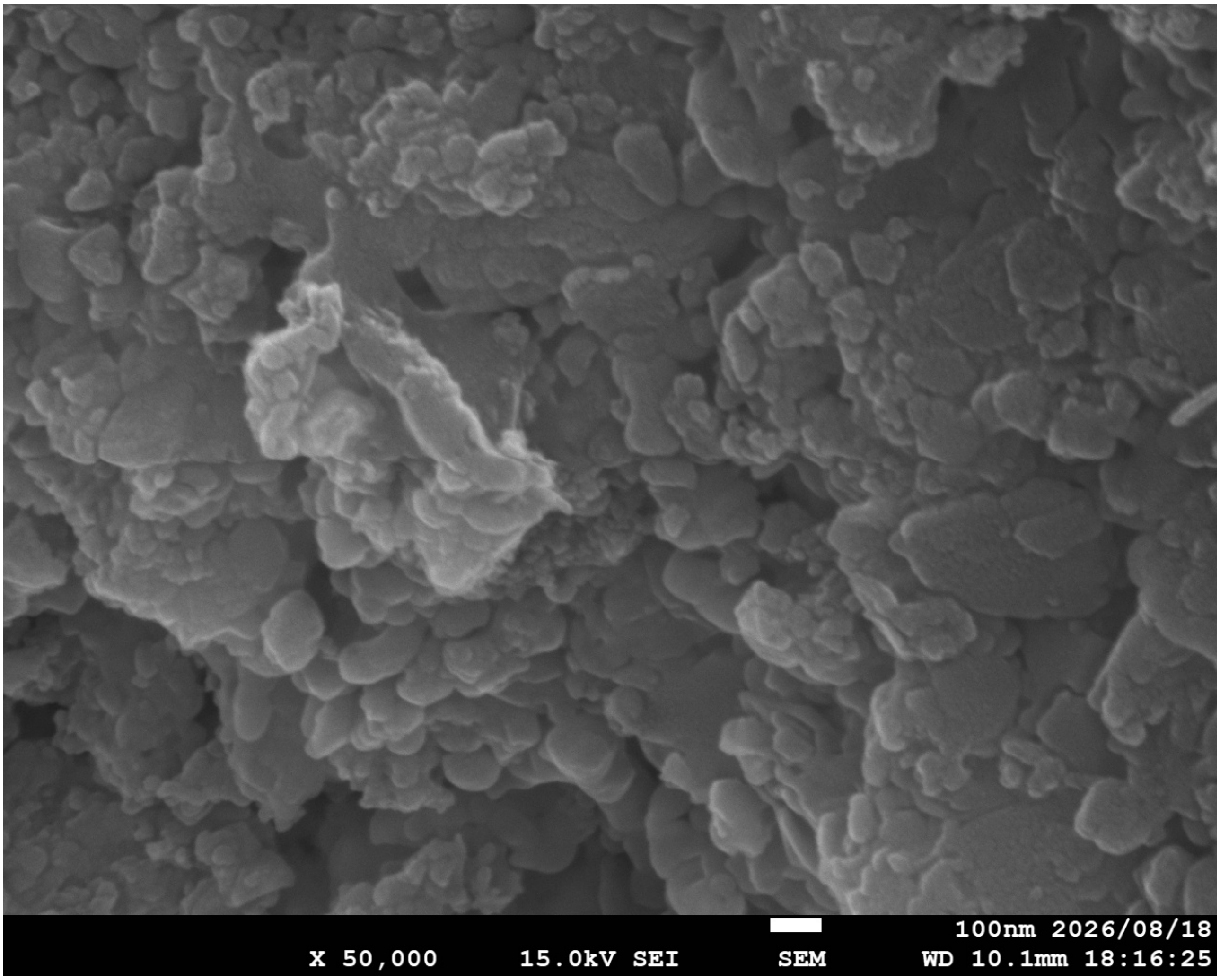
Surface irregularities of the particles, and the pores remaining between them. In places the pores appear to run into one another, suggesting that they may be interconnected within the body.

3-9.

Scanning Electron Microscopy (continued)

Figure 9 Magnification ×50,000

Scale bar 100 nm



OBSERVATION

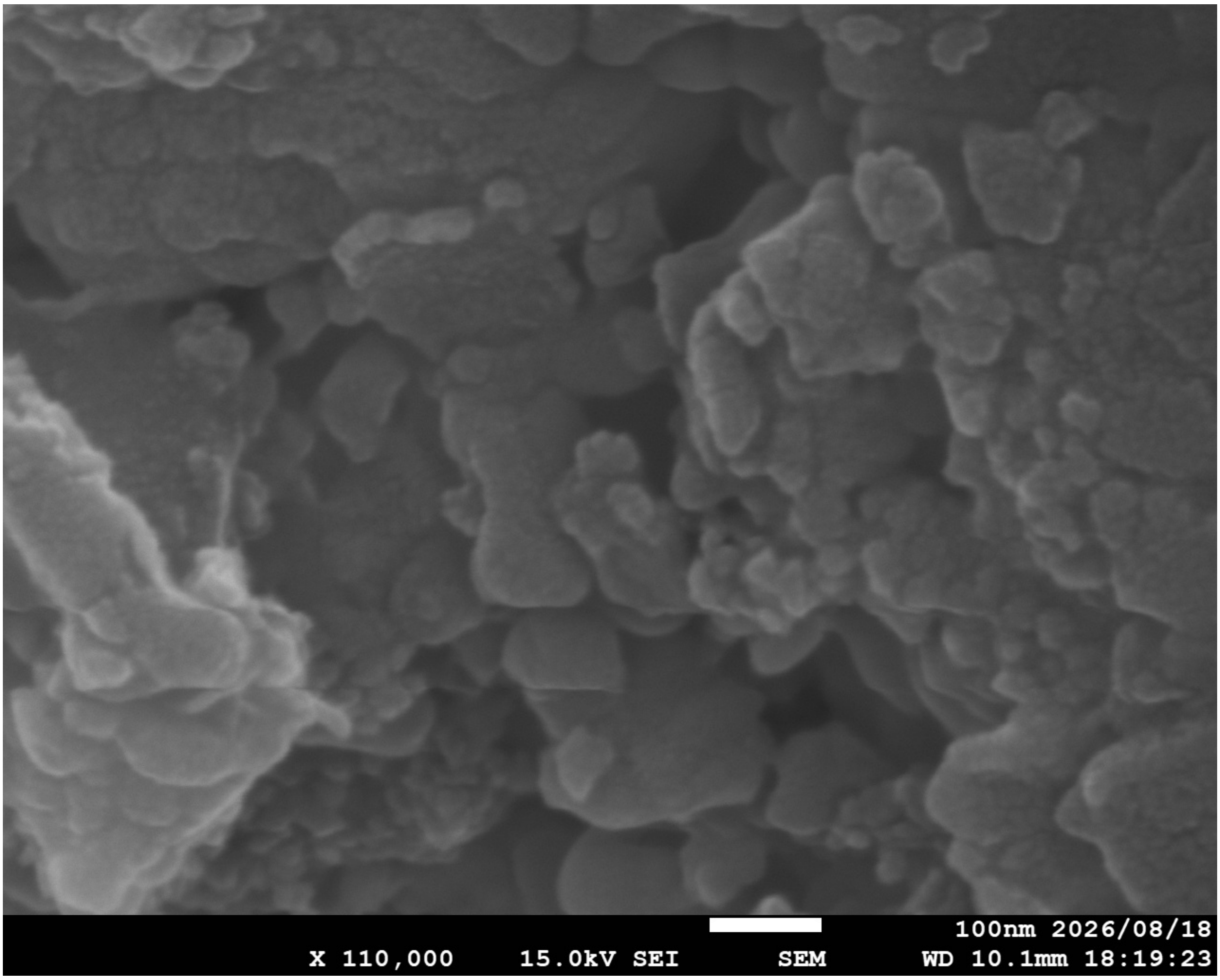
Pores ranging from several tens of nanometres to approximately 100 nm are clearly visible. Pores of this size are also distributed around the larger pores.

3-10.

Scanning Electron Microscopy (continued)

Figure 10 Magnification ×110,000

Scale bar 100 nm



OBSERVATION

Highest magnification. The outlines of individual particles, and the pores left between them, are observed. The particle surfaces are not smooth but carry fine irregularities.

4.

Pore Size Distribution Measurement

The pore size distribution measured by mercury intrusion porosimetry is shown in Figure 11. Filled circles indicate the differential pore volume (left axis); open circles indicate the cumulative pore volume (right axis).

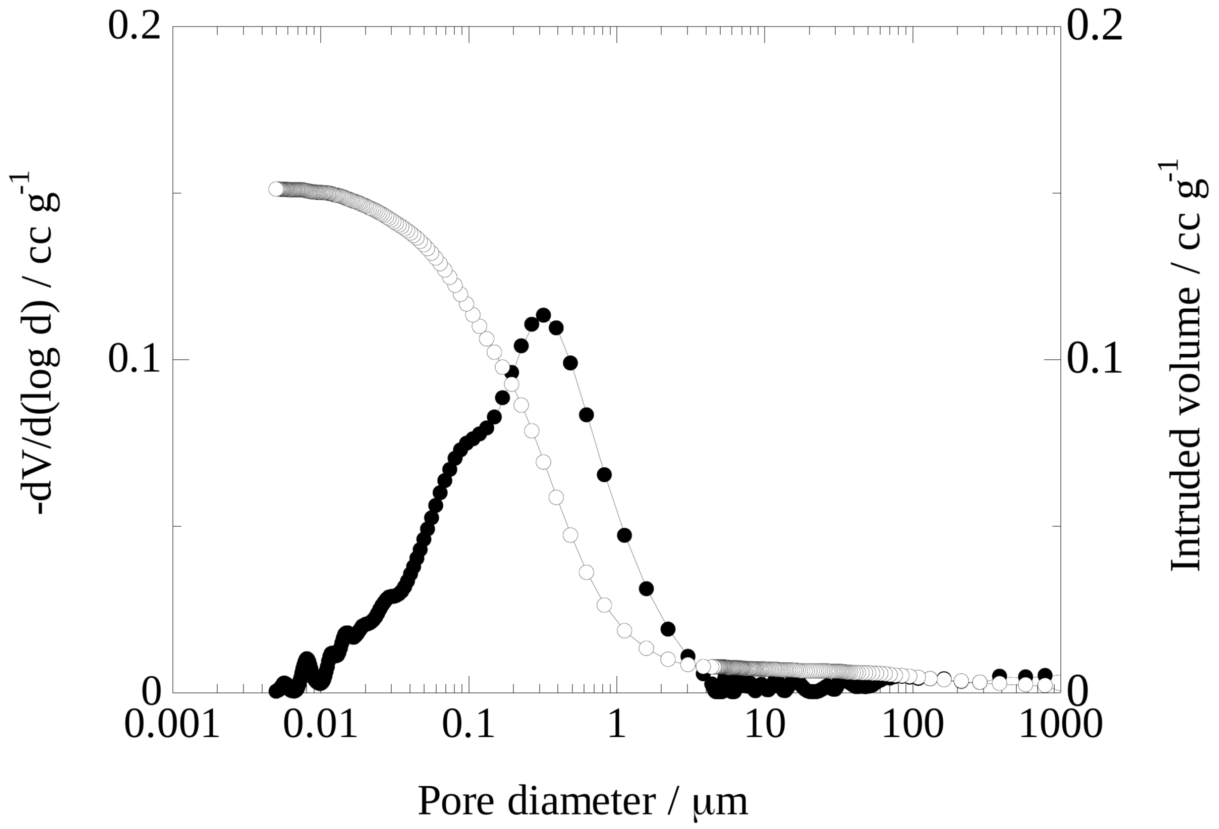


Figure 11 Pore size distribution (mercury intrusion porosimetry)

Principal features of the distribution

— The pore size distribution has a peak in the region of 0.1 – 1 µm. Under the IUPAC classification this region corresponds to macropores (larger than 50 nm).

— The distribution extends continuously into the region below 0.1 µm; pores are present down to the lower limit of measurement (approx. 3.5 nm).

— The contribution of coarse voids larger than 10 µm is small.

— The cumulative pore volume is approximately 0.15 cm^3/g (read from the distribution curve).

5.

Summary of Results

Scanning electron microscopy

The fracture surface of Terrafuoco-109square (Pro) was examined from ×500 to ×110,000. At the macroscopic scale the structure is homogeneous; at the microscopic scale it consists of fine particles densely stacked together. The interstices between the particles remain as pores, and pores ranging from several tens of nanometres to approximately 1 µm were confirmed to be distributed throughout the interior of the specimen.

Pore size distribution measurement

The pore size distribution obtained by mercury intrusion porosimetry has a peak in the region of 0.1 – 1 µm, and under the IUPAC classification this region corresponds to macropores. The distribution extends continuously into the smaller region down to the lower limit of measurement, and the contribution of coarse voids larger than 10 µm is small. The cumulative pore volume is approximately 0.15 cm^3/g.

* Under the IUPAC classification, pores are divided into micropores (less than 2 nm in diameter), mesopores (2 – 50 nm) and macropores (larger than 50 nm). The principal region observed in this measurement is that of macropores. The region of mesopores and below requires evaluation by methods other than the one used here.

Consistency between the two methods

The pore sizes observed by electron microscopy correspond to the peak region of the pore size distribution obtained by mercury intrusion porosimetry. Both methods examined the fracture surface, that is, the interior of the specimen; they capture the same internal structure by different means.

Notes on measurement

* The lower limit of measurement by mercury intrusion porosimetry is approximately 3.5 nm, determined by the maximum pressure of the instrument. Pores smaller than this are outside the scope of this measurement.
* The drying conditions used in specimen preparation (40 °C, 24 h) were set conservatively in order to avoid affecting the hardened phases. The volume of fine pores may therefore be underestimated.
* All observations and measurements presented in this document were carried out at the Gifu Prefectural Ceramics Research Institute.
* This document presents the results for a single specimen and does not state representative values for the product as a whole.
* The cumulative pore volume is an approximate value read from the distribution curve.
* The electron micrographs presented are unretouched original images; no additions or corrections have been made.

Enquiries
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