

Porosity report from image analysis (polished cross-sections)

Demo · Sample DEMO · 2026-10-21

DEMO — the analysed cross-sections are synthetic, generated with a known porosity. The validation table compares the measurement with the truth.

Main results

Area porosity (mean of fields)	2.19 % ± 0.10 % (95 % CI)
Relative accuracy (%RA)	5 % over 5 images
Overall porosity (pore area / material area)	2.19 %
Material area analysed	1.390 mm² from 5 images (2 % of the field outside the material excluded)
Pores detected	117 (84 per mm²)
Grey-level threshold and sensitivity	0.42; 0.46 (Otsu) · porosity from 2.04 % to 2.36 % when the threshold moves by ± 0.03

Pore size (whole pores, number-based statistics)

Quantity	Mean	D10	D50	D90	Max
Equivalent diameter (µm)	15.32	5.70	11.03	30.68	44.32
Maximum Feret (µm)	34.30	6.47	12.28	99.53	152.74

Pore types (indicative, from shape)

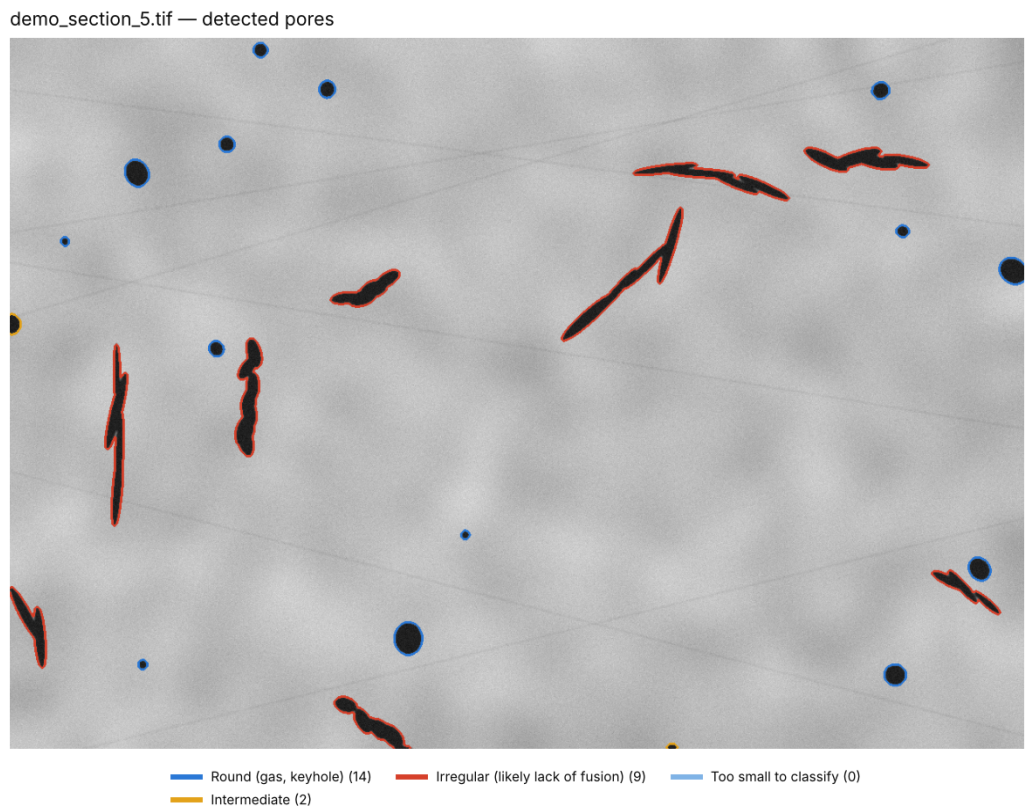
Type	Criterion (roundness)	Count	Share of porosity
Round (gas, keyhole)	≥ 0.70	71	22.1 %
Intermediate	0.45 to 0.70	0	0.0 %
Irregular (likely lack of fusion)	< 0.45	32	77.9 %
Too small to classify	< 30 px	1	0.0 %

Roundness = $4 \times \text{area} / (\pi \times \text{max Feret}^2)$. Thresholds depend on the alloy and process and can be adjusted. Classification on a 2D section is indicative.

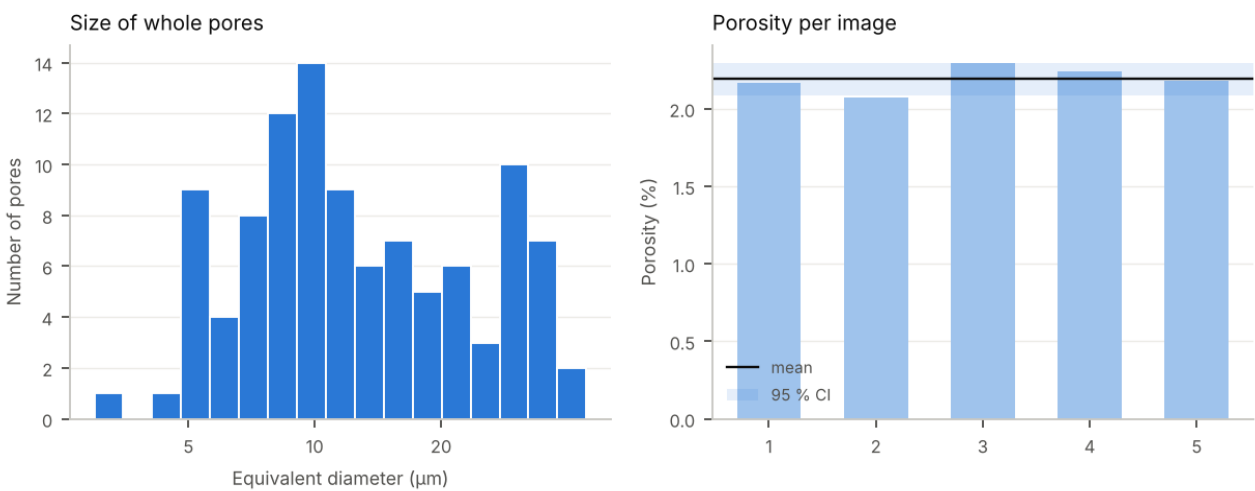
Largest pores (maximum Feret)

Image	Max Feret (µm)	Eq. diameter (µm)	Roundness	Type	Position (x; y µm)
demo_section_29.tif	152.7	44.3	0.08	Irregular	289.4; 276.6
demo_section_29.tif	137.0	30.2	0.05	Irregular	607.8; 100.8
demo_section_43.tif	130.9	30.2	0.05	Irregular	192.6; 126.8
demo_section_43.tif	121.7	28.9	0.06	Irregular	109.6; 352.7
demo_section_43.tif	121.2	32.6	0.07	Irregular	338.7; 281.6

Detection check (image 1)



Distribution and porosity per image



Results per image

Image	Porosity (%)	Pores	Material (mm ²)	Threshold	Sensitivity (± %)
demo_section_5.tif	2.17	25	0.285	0.46	2.6
demo_section_17.tif	2.07	32	0.285	0.46	2.4
demo_section_29.tif	2.30	19	0.285	0.46	2.6
demo_section_43.tif	2.24	17	0.285	0.46	2.6
demo_section_61.tif	2.18	24	0.251	0.42	2.7

Validation against ground truth (synthetic cross-sections)

Quantity	Truth	Measured	Difference
Overall porosity (%)	2.17	2.19	+0.02 pt
Share of “irregular” porosity (%)	77.7	77.9	+0.20 pt
Largest whole pore (µm)	152.8	152.7	−0.06 µm
Whole pores	104	104	

The synthetic sections have a porosity known to the pixel, so this table measures the error of the whole chain (blur, noise, scratches, thresholding).

Method

Pixel size read from the microscope metadata (Zeiss or Thermo Fisher TIFF), measured on the scale bar of the data band, or given. Uneven illumination is corrected (background estimated at large scale on the material only). Gaussian smoothing ($\sigma = 1$ px). Threshold: the lower of the Otsu threshold and the material noise limit (median − 6 robust standard deviations), so that grain contrast and scratches are not counted as pores when porosity is low. Morphological opening (1 px radius); objects below 9 px are ignored. Large dark regions touching the field border (at least 5 % of the field: mounting resin, empty space) are excluded from the material. Field porosity = pore area / material area. Mean, standard deviation, 95 % confidence interval (Student $t \times SD / \sqrt{n}$) and relative accuracy %RA = CI / mean, as in quantitative metallography. Pores cut by the border count in the porosity but not in the size distribution. The approach is close to the automatic image analysis method (Method B) of ASTM E2109 for thermal sprayed coatings.

Quality checks

Automatic check	Value	Status
Scale consistent (images, metadata, scale bar)	spread 0.0 %	pass
Fields analysed	5	pass
Relative accuracy of porosity (%RA)	5 %	pass
Threshold sensitivity (± 0.03 grey level)	± 3 %	pass
Pore / material contrast (contrast-to-noise ratio)	24	pass
Pores too small to classify	1 %	pass
Saturated bright pixels	0.0 %	pass
Share of the field outside the material	2 %	pass
Visual review by an analyst	—	not done (automated run)

Delivered files

This report (PDF) · pores.csv (one row per pore: type, area, diameters, Feret, roundness, position) · a control image per field · summary.json.

Traceability

Item	Value
Analysis engine version	1.0.0
Parameters	correction_eclairage = True, lissage_px = 1.0, aire_min_px = 9, aire_min_classe_px = 30, bruit_k = 6.0, exterieur_min_frac = 0.05, rondeur_rond = 0.7, rondeur_irreguliere = 0.45, delta_seuil = 0.03, tuiles = 4, ra_cible_pct = 10.0
SHA-256 fingerprint of demo_section_5.tif	d5625a73642e431d...
SHA-256 fingerprint of demo_section_17.tif	692753c6bb2edf75...
SHA-256 fingerprint of demo_section_29.tif	35eda515d4860ba2...
SHA-256 fingerprint of demo_section_43.tif	9a2463fb19db445b...
SHA-256 fingerprint of demo_section_61.tif	b3b020c6545ecb86...

The same images, parameters and engine version always give exactly the same results.

Limitations

Automated image analysis: preparation (polishing, pull-outs, smearing), acquisition and the representativeness of the fields are the user's responsibility. Oxides, inclusions or dark phases are counted as pores when they are as dark as pores. A 2D section does not measure volume porosity or the true 3D size of pores (use CT or the Archimedes method for that). Not an accredited (ISO/IEC 17025) measurement: for R&D and internal quality control.

Analysis: Automated analysis