

JOINT RESEARCH CENTRE  
Directorate F – Health, Consumers and Reference Materials

# CERTIFICATE OF ANALYSIS

ERM<sup>®</sup> - FD066

CORUNDUM					
Volume-weighted equivalent diameter laser diffraction, Mie theory, wet dispersion			Number-weighted equivalent diameter Scanning Electron Microscopy (SEM)		
Diameter <sup>1)</sup>	Certified value <sup>2)</sup> [μm]	U <sup>3)</sup> [μm]	Diameter <sup>4)</sup>	Certified value <sup>2)</sup> [μm]	U <sup>3)</sup> [μm]
X <sub>5, 3</sub>	1.44	0.09	X <sub>5, 0</sub>	1.07	0.23
X <sub>10, 3</sub>	1.73	0.14	X <sub>10, 0</sub>	1.28	0.24
X <sub>25, 3</sub>	2.35	0.21	X <sub>25, 0</sub>	1.71	0.28
X <sub>50, 3</sub>	3.36	0.18	X <sub>50, 0</sub>	2.4	0.4
X <sub>75, 3</sub>	4.81	0.17	X <sub>75, 0</sub>	3.3	0.4
X <sub>90, 3</sub>	6.42	0.24	X <sub>90, 0</sub>	4.4	0.4
X <sub>95, 3</sub>	7.45	0.26	X <sub>95, 0</sub>	5.1	0.4

1) As defined by ISO 13320 applying the Mie theory and wet dispersion using a complex refractive index of 1.77 -0i.  
2) Certified values are values that fulfil the highest standards of accuracy. The given values represent the unweighted mean value of the means of accepted sets of data, each set being obtained in a different laboratory and/or with a different instrument. The certified value and its uncertainty are traceable to the International System of Units (SI).  
3) The uncertainty is the expanded uncertainty of the certified value with a coverage factor  $k = 2.57$  (laser diffraction, Mie theory) and  $k = 2.36$  (scanning electron microscopy), respectively, corresponding to a level of confidence of about 95 % estimated in accordance with ISO/IEC Guide 98-3, Guide to the Expression of Uncertainty in Measurement (GUM:1995), ISO, 2008.  
4) As obtained by scanning electron microscopy (SEM) and applying ISO 13322:2014.

This certificate is valid for five years after purchase.

Sales date:

The minimum amount of sample to be used is 70 mg (laser diffraction) or 5000 particles (SEM).

Geel, January 2018

Signed: 

Dr Doris Florian  
Head of Unit Reference Materials  
European Commission, Joint Research Centre  
Directorate F – Health, Consumers and Reference Materials  
Retieseweg 111  
B-2440 Geel, Belgium

## Additional Material Information

Volume-weighted equivalent diameter obtained by laser diffraction, Mie theory, dry dispersion		Volume-weighted equivalent diameter obtained by laser diffraction, Fraunhofer approximation, wet and dry dispersion		Number-weighted equivalent diameter obtained by laser diffraction, Mie Theory, wet and dry dispersion	
Diameter <sup>1)</sup>	Value <sup>1)</sup> [μm]	Diameter <sup>2)</sup>	Value <sup>2)</sup> [μm]	Diameter <sup>3)</sup>	Value <sup>3)</sup> [μm]
X <sub>5, 3</sub>	1.1 - 1.5	X <sub>5, 3</sub>	0.6 - 0.7	X <sub>5, 0</sub>	1.0
X <sub>10, 3</sub>	1.3 - 1.8	X <sub>10, 3</sub>	0.9 - 1.0	X <sub>10, 0</sub>	1.1
X <sub>25, 3</sub>	2.0 - 2.4	X <sub>25, 3</sub>	1.8 - 2.0	X <sub>25, 0</sub>	1.3
X <sub>50, 3</sub>	3.0 - 3.5	X <sub>50, 3</sub>	3.0 - 3.4	X <sub>50, 0</sub>	1.6
X <sub>75, 3</sub>	4.3 - 5.0	X <sub>75, 3</sub>	4.3 - 4.9	X <sub>75, 0</sub>	2.1
X <sub>90, 3</sub>	5.7 - 6.7	X <sub>90, 3</sub>	5.7 - 6.5	X <sub>90, 0</sub>	2.9
X <sub>95, 3</sub>	6.8 - 7.8	X <sub>95, 3</sub>	6.8 - 7.7	X <sub>95, 0</sub>	3.5
Volume weighted mean diameter					
	Obtained by laser diffraction, Mie theory, wet dispersion	Obtained by laser diffraction, Mie theory, dry dispersion		Obtained by laser diffraction, Fraunhofer approximation, wet and dry dispersion	
	Value <sup>4)</sup> [μm]	Value <sup>5)</sup> [μm]		Value <sup>6)</sup> [μm]	
$\bar{x}_{1,3}$	3.8	3.6		3.4	

These values refer to values that were obtained in the course of the study. They are stated without an uncertainty and give merely information about other material properties that may be of interest for the user.

1) As defined by ISO 13320 applying the Mie theory with dry dispersion using a complex refractive index of 1.77 -0i. The value is the unweighted mean of five sets of results obtained by different laboratories using instruments of two manufacturers. The values are traceable to the international system of Units (SI).

2) As defined by ISO 13320 applying the Fraunhofer approximation and wet or dry dispersion. The values represent the range of four sets (2 x wet dispersion, 2 x dry dispersion) of results obtained by two different laboratories using the same instrument model from one manufacturer. The values are traceable to the international system of Units (SI).

3) As defined by ISO 13320 applying the Mie theory and wet or dry dispersion using a refractive index of 1.77 -0i. The values represent the range of 7 sets (4 x wet dispersion, 3 x dry dispersion) of results obtained by four different laboratories using instruments from two manufacturers and applying the internal conversion algorithm. The values are traceable to the international system of Units (SI).

4) As defined by ISO 13320 applying the Mie theory with wet dispersion using a complex refractive index of 1.77 -0i. The value is the unweighted mean of three sets of results obtained by different laboratories using instruments of two manufacturers. The values are traceable to the international system of Units (SI).

5) As defined by ISO 13320 applying the Mie theory with wet dispersion using a complex refractive index of 1.77 -0i. The value is the unweighted mean of three sets of results obtained by different laboratories using instruments of two manufacturers. The values are traceable to the international system of Units (SI).

6) As defined by ISO 13320 applying the Fraunhofer approximation and wet or dry dispersion. The values represent the range of four sets (2 x wet dispersion, 2 x dry dispersion) of results obtained by two different laboratories using the same instrument model from one manufacturer. The values are traceable to the international system of Units (SI).

## DESCRIPTION OF THE MATERIAL

The material consists of approximately 20 g corundum powder with a top particle size of 10 μm. It is packed in amber glass bottles with glass inserts to facilitate mixing.

## **ANALYTICAL METHODS USED FOR CERTIFICATION**

Laser diffraction according to ISO 13320:2009 applying the Mie theory and wet dispersion

Scanning electron microscopy with image analysis according to ISO 13322:2014

## **PARTICIPANTS**

Agfa-Gevaert, Research and Development Materials, Mortsel, BE

Aokin AG, Berlin. DE

Delft Solids Solutions B.V, Barendrecht, NL

Escubed Ltd., Leeds, UK

(measurements under the scope of ISO/IEC 17025 accreditation UKAS 8467)

Evonik Technology and Infrastructure GmbH, Essen, DE

European Commission, Joint Research Centre, Directorate F – Health, Consumers and Reference Materials, Geel, BE

(measurements under the scope of ISO/IEC 17025 accreditation BELAC No. 268-TEST)

Industrial Technology Research Institute (ITRI), Shinchu, TW

MVA Scientific Consultants, Duluth, US

(measurements under the scope of ISO/IEC 17025 accreditation A2LA 2096.01)

National Institute of Metrology (NIM), Beijing, CN

National Institute of Standards and Technology (NIST), Gaithersburg, US

National Measurement Institute Australia (NMIA), Lindfield, AU

National Physical Laboratory (NPL), Teddington, UK

Solvias AG, Kaiseraugst, CH

Sympatec GmbH, Clausthal-Zellerfeld, DE

University of Namur, Namur, BE

Umicore, Analytical Competence Center, Olen, BE

(measurements under the scope of ISO/IEC 17025 accreditation BELAC No. 401-TEST)

## **SAFETY INFORMATION**

The usual laboratory safety precautions apply.

## **INSTRUCTIONS FOR USE AND INTENDED USE**

### **Preparation of the material**

Before opening a bottle, the bottle must be gently inverted several times to ensure the homogeneity of the powder. Take several sub-samples at different depths, typically top, middle and bottom of the bottle, using spatula or special sampling device (using rotating/spinning riffler).

Suspensions are prepared preferably with deionised water (with or without surfactant) or isopropanol.

### **Use of the certified values**

The main purpose of this material is to assess method performance, i.e. for checking accuracy of analytical results/calibration.

### Comparing an analytical result with the certified value

A result is unbiased if the combined standard uncertainty of measurement and certified value covers the difference between the certified value and the measurement result (see also ERM Application Note 1, <https://crm.jrc.ec.europa.eu/>).

When assessing the method performance, the measured values of the CRMs are compared with the certified values. The procedure is summarised here:

- Calculate the absolute difference between mean measured value and the certified value ( $\Delta_{\text{meas}}$ ).
- Combine the measurement uncertainty ( $u_{\text{meas}}$ ) with the uncertainty of the certified value ( $u_{\text{CRM}}$ ):  
$$u_{\Delta} = \sqrt{u_{\text{meas}}^2 + u_{\text{CRM}}^2}$$
- Calculate the expanded uncertainty ( $U_{\Delta}$ ) from the combined uncertainty ( $u_{\Delta}$ ) using an appropriate coverage factor, corresponding to a level of confidence of approximately 95 %
- If  $\Delta_{\text{meas}} \leq U_{\Delta}$  then no significant difference exists between the measurement result and the certified value, at a confidence level of approximately 95 %.

### Use in quality control charts

The materials can be used for quality control charts. Using CRMs for quality control charts has the added value that a trueness assessment is built into the chart.

## **STORAGE**

The material should be stored at  $(18 \pm 5) ^\circ\text{C}$ .

However, the European Commission cannot be held responsible for changes that happen during storage of the material at the customer's premises, especially of opened samples.

## **LEGAL NOTICE**

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## **NOTE**

A detailed certification report is available at <https://crm.jrc.ec.europa.eu/>.

A paper copy is obtainable from the Joint Research Centre, Directorate F – Health, Consumers and Reference Materials on request.



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European Commission – Joint Research Centre  
Directorate F – Health, Consumers and Reference Materials  
Retieseweg 111, B - 2440 Geel (Belgium)  
Telephone: +32-(0)14-571.705 - Fax: +32-(0)14-590.406  
[jrc-rm-distribution@ec.europa.eu](mailto:jrc-rm-distribution@ec.europa.eu)