

CERTIFICATE OF ANALYSIS

ERM[®]-ED105

Yttrium Stabilized Zirconium Oxide		
Parameter	Mass fraction	
	Certified Value ¹⁾ in mg/kg	Uncertainty ²⁾ in mg/kg
Aluminium	660	15
Calcium	242	9
Iron	95	9
Magnesium	12.9	1.7
Silicon	195	40
Thorium	112	17
Titanium	497	11
Uranium	292	19
	Certified Value ¹⁾ in %	Uncertainty ²⁾ in %
Hafnium	1.535	0.024
Yttrium	6.11	0.09
Oxygen	25.2	0.4

1) The certified values are the means of 11-20 series of results (depending on the parameter) obtained by different laboratories. Up to 7 different analytical methods were used for the measurement of each parameter. The methods applied for determination of element mass fractions were calibrated using pure substances of definite stoichiometry or solutions prepared from them, thus achieving traceability to the International System of Units (SI).
2) The uncertainty of the certified value is the expanded uncertainty estimated in accordance with the Guide to the Expression of Uncertainty in Measurement (GUM) with a coverage factor $k = 2$. It includes contributions from sample inhomogeneity.

This certificate is valid until there is a revocation from the producer of the material.

Sample description

The reference material ERM[®]-ED105 consists of an yttrium stabilized zirconium oxide powder. The material is supplied in glass bottles containing 47 g each.

Note

European Reference Material ERM[®]-ED105 was produced and certified under the responsibility of Bundesanstalt für Materialforschung und -prüfung (BAM) in cooperation with the Committee of Chemists of the GDMB, Gesellschaft der Metallurgen und Bergleute e. V., according to the principles laid down in the technical guidelines of the European Reference Materials[®] co-operation agreement between BAM-LGC-IRMM. Information on these guidelines is available on the Internet (<http://www.erm-crm.org>).

Accepted as an ERM[®], 23.07.2015 (Revised 24.01.2024)



Dr. S. Richter
Committee for Certification

Dr. S. Recknagel
Project Coordinator

Parameter	Mass fraction ¹⁾ in mg/kg	Uncertainty ²⁾ in mg/kg
Nitrogen	912	140
Phosphorus	< 75	

1) Values were not certified, but given for information, when the number of accepted data sets was considered to be too low (< 5) or when the uncertainty from the inter-laboratory certification was considerably larger than the expected range.

2) The uncertainty of the certified value is the expanded uncertainty estimated in accordance with the Guide to the Expression of Uncertainty in Measurement (GUM) with a coverage factor $k = 2$. It includes contributions from sample inhomogeneity.

Parameter		Mass fraction in %
Phase ³⁾	monoclinic	1.94
Particle size distribution ⁴⁾	Particle size in μm	
	d ₁₀	18.9
	d ₅₀	33.3
	d ₉₀	55.4

3) The measurements were carried out by X-ray powder diffraction using Rietveld method for evaluation.

4) The particle size distribution was determined by laser light diffraction method.

Participating laboratories (2015)

Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin, Germany
 Bruker AXS GmbH, Germany
 BCRC, Mons, Belgium
 ESK Ceramics GmbH & Co. KG, Kempten, Germany
 Forschungsinstitut für anorganische Werkstoffe - Glas/Keramik GmbH, Höhr-Grenzhausen, Germany
 Forschungszentrum Jülich, Jülich, Germany
 GfE Fremat GmbH, Freiberg, Germany
 H. C. Starck GmbH & Co. KG, Werk Goslar, Goslar, Germany
 H. C. Starck GmbH & Co. KG, Werk Laufenburg, Laufenburg, Germany
 Institute Jozef Stefan, Ljubljana, Slovenia
 Karlsruher Institut für Technologie, Karlsruhe, Germany
 Leibniz Institut für Kristallzüchtung, Berlin, Germany
 Max-Planck-Institut für intelligente Systeme, Stuttgart, Germany
 Osram AG, Augsburg, Germany
 Plansee SE, Reutte, Austria
 Revierlabor GmbH, Essen, Germany
 Treibacher Industrie AG, Treibach-Althofen, Austria
 Umicore AG & Co. KG, Hanau, Germany
 Wolfram Bergbau und Hütten AG, St. Martin i.S., Austria

Participating laboratories (2023, determination of O and N)

Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin, Germany
 Bruker AXS GmbH, Germany
 Eltra GmbH, Haan, Germany
 Horn & Co Analytics, Wenden-Hünsborn, Germany
 IFW Dresden e.V., Dresden (Germany)
 Karlsruher Institut für Technologie (KIT), Karlsruhe, Germany
 LECO Instrumente GmbH, Berlin, Germany
 Plansee SE, Reutte, Austria
 revierlabor, Essen, Germany

Laboratory means

line no.	Al [mg/kg]	Ca [mg/kg]	Fe [mg/kg]	Mg [mg/kg]	Si [mg/kg]	Th [mg/kg]	Ti [mg/kg]	U [mg/kg]	Hf [%]	Y [%]	O [%]	<i>P</i> [mg/kg]	<i>N</i> [mg/kg]	<i>ZrO₂</i> (monoclinic) [%]
1	614.3	---	71.8	9.5	80.8	60.3	---	235.7	1.469	5.780	---	< 4	667	1.8
2	627.5	219.3	73.3	9.5	97.8	90.5	454.0	251.8	1.474	5.984	24.89	< 10	728	2.0
3	635.0	223.8	79.5	9.7	132.3	91.3	463.0	280.5	1.481	5.992	25.01	< 20	814	2.01
4	638.3	230.3	80.9	10.0	150.3	95.3	473.7	283.6	1.482	5.998	25.05	48.3	838	
5	641.7	231.7	82.4	10.2	151.7	112.6	474.0	295.3	1.485	6.020	25.23	71.9	920	
6	648.3	235.0	82.7	10.9	152.2	114.7	485.0	297.2	1.497	6.024	25.24		955	
7	649.0	236.7	83.3	11.3	186.8	117.8	494.7	298.2	1.518	6.092	25.35		1160	
8	653.5	238.3	83.3	11.3	192.0	121.5	497.9	300.8	1.537	6.093	25.44		1215	
9	655.5	239.8	83.6	11.4	202.8	130.0	498.3	301.7	1.539	6.098	25.50			
10	656.7	240.7	85.8	12.0	204.1	131.0	499.8	333.3	1.540	6.118				
11	660.2	241.2	89.4	12.5	206.2	166.7	500.2	335.8	1.543	6.125				
12	665.0	243.7	89.7	12.7	206.3		501.7		1.554	6.127				
13	671.2	244.7	95.5	13.2	254.3		506.7		1.558	6.148				
14	676.6	246.7	103.3	13.3	272.5		508.3		1.560	6.155				
15	695.0	271.6	107.3	16.0	299.0		516.0		1.564	6.207				
16	704.3	280.0	111.7	18.3	326.7		525.0		1.567	6.237				
17	726.3	---	117.3	20.0	---		526.7		1.625	6.360				
18	---		119.8	20.2			530.0		1.630	6.368				
19			131.7						---	---				
20			137.5											
<i>M:</i>	659.9	241.6	95.5	12.9	194.8	112.0	497.3	292.2	1.535	6.107	25.21	< 75	912	1.94
<i>SM:</i>	28.5	15.9	19.3	3.5	68.5	27.7	21.9	29.8	0.048	0.139	0.21		20	

Note: The „ --- “ indicates that an outlying value has been detected by a statistical test and was withdrawn or removed
Values given in *italic type* are for information only.

M: Arithmetic mean of the laboratory means
SM: Standard deviation of the laboratory means

Analytical methods used for determination

Element	Line No.	Analytical method used
Al	1, 2, 4, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17	ICP-OES
	3	XRF
	5	F AAS
	11	DC Arc OES
Ca	2, 3, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16	ICP-OES
	4	F AAS
	12	XRF
Fe	1, 2, 5, 7, 8, 10, 11, 12, 13, 14, 15, 16, 19, 20	ICP-OES
	3	XRF
	4	ETV-ICP-OES
	6	ICP-MS
	9, 18	F AAS
	17	DC Arc OES
Mg	1, 2, 3, 6, 7, 8, 9, 11, 12, 13, 14, 16, 17	ICP-OES
	4	ETV-ICP-OES
	5	ICP-MS
	10, 18	F AAS
	15	DC Arc OES
Si	1, 2, 3, 4, 7, 9, 10, 11, 12, 14	ICP-OES
	5	Photometry
	6	ETV-ICP-OES
	8	ET AAS
	13	SS ET AAS
	15	XRF
	16	DC Arc OES
Th	1, 3, 9	ICP-OES
	2, 4, 5, 7, 10	ICP-MS
	6	k ₀ -INAA
	8	ETV-ICP-OES
	11	XRF
Ti	2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 14, 16, 17, 18	ICP-OES
	4	ETV-ICP-OES
	13, 15	XRF
U	1, 2, 4, 5, 11	ICP-MS
	3, 6, 9	ICP-OES
	7	ETV-ICP-OES
	8	k ₀ -INAA
	10	XRF
Hf	1, 2, 4, 6, 7, 8, 9, 10, 11, 14, 15, 17, 18	ICP-OES
	3, 12, 13, 16	XRF
	5	k ₀ -INAA
Y	1, 2, 3, 4, 6, 7, 8, 9, 10, 12, 14, 15, 17, 18	ICP-OES
	5, 11, 13, 16	XRF
O	2, 3, 4, 5, 6, 7, 8, 9	CGHE
P	1, 2, 3, 4, 5	ICP-OES
N	1, 2, 3, 4, 5, 6, 7, 8	CGHE

The measurements of the monoclinic phase of yttrium stabilized zirconium oxide were carried out by X-ray powder diffraction using Rietveld method for evaluation. The tetragonal and cubic phases could not be determined due to signal overlapping.

List of abbreviations

CGHE	Carrier gas hot extraction
DC Arc OES	Direct current arc optical emission spectrometry
ET AAS	Electrothermal atomic absorption spectrometry
ETV-ICP-OES	Inductively coupled plasma optical emission spectrometry with electrothermal vaporisation
F AAS	Flame atomic absorption spectrometry
k ₀ -INAA	k ₀ -Instrumental neutron activation analysis
ICP-MS	Inductively coupled plasma mass spectrometry
ICP-OES	Inductively coupled plasma optical emission spectrometry
SS ET AAS	Solid sampling electrothermal atomic absorption spectrometry
XRF	X-ray fluorescence spectrometry

Recommendations for Correct Sampling and Sample Preparation

To ensure representative sub-sampling for the analysis the CRM bottle should be shaken in different directions for about two minutes before taking the sub-sample. According to the sub-sample mass used for the homogeneity testing the minimum sample intake for analysis is 200 mg. It is not required to dehydrate the sample before starting measurements.

Intended Use and Recommendations for Correct Storage

This reference material is intended for the calibration of analytical instruments and to validate or verify analytical methods suitable for the analysis of zirconium oxide materials. The sample should be stored in a dust-free and dry environment at room temperature (20 °C).

Certificate revision history

January 2024 (addition of oxygen and nitrogen)
July 2015 (original certificate issue)

This Reference Material is offered by:

Bundesanstalt für Materialforschung und -prüfung (BAM)
Richard-Willstätter-Str. 11, D-12489 Berlin

Phone: +49 30 8104 2061
Fax: +49 30 8104 72061

Email: sales.crm@bam.de
Internet: www.webshop.bam.de