

The Technical Association of Refractories, Japan
 Certified Reference Material Series for X-ray Fluorescence Analysis of Refractories
 J R R M 6 0 1 (Zircon-Zirconia Refractory)
 Results of Analyses

Unit : mass%

Constituent	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	CaO	MgO	Na ₂ O	K ₂ O	P ₂ O ₅	Cr ₂ O ₃	ZrO ₂ (+HfO ₂)	HfO ₂	ZrO ₂ *3
Certified value	0.26 ₃	0.11 ₃	0.10 ₁	0.16 ₃	5.58 ₆	0.06 ₄	0.00 ₄	0.00 ₂	0.00 ₁	0.00 ₃	93.6 ₃	1.59 ₂	92.0 ₃
Laboratories													
L ₁	0.23 _{7 c}	0.10 _{6 v}	0.09 _{5 c}	0.16 _{6 c}	5.57 _{2 i}	0.06 _{2 i}	0.00 _{3 n}	0.00 _{5 n}	0.00 _{3 c}	0.00 _{4 i}	93.4 _{7 g}	1.57 _{1 s}	—
L ₂	0.26 _{2 c}	0.10 _{4 i}	0.09 _{2 c}	0.16 _{8 i}	5.55 _{4 i}	0.06 _{0 i}	0.00 _{3 n}	0.00 _{2 n}	0.00 _{3 c}	0.00 _{4 i}	93.4 _{5 g}	1.59 _{7 i}	—
L ₃	0.26 _{1 c}	0.13 _{3 i}	0.09 _{6 c}	0.16 _{8 i}	5.53 _{8 i}	0.05 _{2 i}	0.00 _{2 n}	0.00 _{3 n}	0.00 _{3 c}	0.00 _{2 i}	93.9 _{3 g}	1.60 _{1 i}	—
L ₄	0.27 _{0 c}	0.14 _{6 n}	0.10 _{6 c}	0.16 _{9 c}	5.59 _{6 n}	0.06 _{6 n}	0.00 _{4 n}	0.00 _{3 n}	0.00 _{3 c}	0.00 _{4 n}	93.6 _{1 g}	1.57 _{6 s}	—
L ₅	0.25 _{3 c}	0.10 _{1 i}	0.10 _{8 i}	0.17 _{0 i}	5.54 _{4 i}	0.07 _{0 i}	0.00 _{3 n}	0.00 _{1 n}	0.00 _{3 c}	0.00 _{4 i}	93.6 _{0 g}	1.57 _{3 i}	—
L ₆	0.27 _{8 c}	0.10 _{6 n}	0.10 _{1 c}	0.16 _{8 c}	5.57 _{7 n}	0.06 _{1 n}	0.00 _{4 n}	0.00 _{6 n}	0.00 _{3 c}	0.00 _{6 n}	93.7 _{1 g}	1.59 _{2 s}	—
L ₇	0.26 _{0 c}	0.12 _{3 i}	0.10 _{0 c}	0.16 _{8 c}	5.60 _{1 i}	0.06 _{2 i}	0.00 _{4 n}	0.00 _{6 n}	0.00 _{3 c}	0.00 _{2 n}	93.7 _{3 g}	1.61 _{8 i}	—
L ₈	0.25 _{3 c}	0.12 _{6 n}	0.11 _{3 c}	0.16 _{1 c}	5.75 _{8 n}	0.07 _{1 n}	0.00 _{2 n}	0.00 _{1 n}	0.00 _{3 c}	0.00 _{4 c}	93.5 _{3 g}	1.57 _{5 s}	—
L ₉	0.28 _{0 c}	0.12 _{4 n}	0.09 _{4 c}	0.16 _{7 c}	5.52 _{8 n}	0.06 _{5 n}	0.00 _{6 n}	0.00 _{6 n}	0.01 _{2 c}	0.00 _{4 n}	93.9 _{1 g}	1.62 _{1 s}	—
Average (\bar{x})	0.263 ₃	0.119 ₁	0.100 ₃	0.167 ₃	5.585 ₇	0.063 ₃	0.004 ₂	0.001 ₃	0.007 ₂	0.003 ₁	93.67 ₇	1.592 ₂	92.08 ₃
Standard deviation (Reproducibility) s_x	0.013 ₀	0.017 ₂	0.007 ₁	0.001 ₇	0.036 ₇	0.005 ₄	0.002 ₅	0.001 ₃	0.002 ₇	0.001 ₀	0.15 ₃	0.019 ₂	—
deviation (Reproducibility without laboratories) $s_{I(T)}^{*1}$	0.007 ₇	0.010 ₂	0.002 ₂	0.003 ₃	0.020 ₇	0.004 ₁	0.000 ₃	0.001 ₃	0.001 ₀	0.001 ₇	0.08 ₀	0.014 ₃	—
Uncertainty C (95%) *2	0.01 ₀	0.01 ₃	0.00 ₅	0.00 ₁	0.02 ₃	0.00 ₄	0.00 ₂	0.00 ₁	0.00 ₂	0.00 ₁	0.1 ₂	0.01 ₅	0.1 ₂ *4

(Note) * 1 $s_{I(T)}$ is intermediate precision without a time condition.* 2 The half-width confidence interval C (95%) = $t_{\ell-1,0.05} \times s_x / \sqrt{\ell}$ (ℓ = number of laboratories)* 3 $ZrO_2 = ZrO_2(+HfO_2) - HfO_2$ * 4 $s_{ZrO_2}^2 = \left(s_{ZrO_2(+HfO_2)}^2 \right)^2 + \left(s_{HfO_2}^2 \right)^2$

- (1) List of laboratories : Kurosaki Corporation, Kawasaki Refractories Co.,Ltd., The Industrial Technology Center of Okayama Prefecture, Yotai Refractories Co.,Ltd., Asahi Glass Co.,Ltd., Harima Ceramic Co.,Ltd., Shinagawa Refractories Co.,Ltd., Toshiba Ceramics Co.,Ltd., Toshiba Monofrax Co.,Ltd.
- (2) Analytical techniques : JIS R 2012(Method for chemical analysis of refractory containing zircon and/or zirconia) a: AAS, c:colorimetry, g:gravimetry, G:gravimetry and colorimetry, i:ICP-AES, v:chelatorimetry, x:XRF
- (3) Analytical values : Each value is the average of two values obtained by two measurements on different days. These analysis values are shown converted into LOI (Loss on ignition) component free values from the February 22, 2008 v20080222 version on.
- (4) Outlier tests were carried out by Grubbs test. The samples rejected by Grubbs tests were discussed in view of analytical techniques and it was determined whether the outliers should be adopted or not.
- (5) Date of preparation : March, 1995

Prepared, and Values given and certified by

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The Technical Association of Refractories, Japan

Certified Reference Material Series for X-ray Fluorescence Analysis of Refractories

J R R M 6 0 2 (Zircon-Zirconia Refractory)

Results of Analyses

Unit : mass%

Constituent	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	CaO	MgO	Na ₂ O	K ₂ O	P ₂ O ₅	Cr ₂ O ₃	ZrO ₂ (+HfO ₂)	HfO ₂	ZrO ₂ *3
Certified value	0.33 _s	0.07 _s	1.62 _z	0.16 _z	0.22 _z	5.30 _z	0.76 _s	0.00 _z	1.34 _z	0.01 _s	90.0 _z	1.52 _z	88.4 _s
Laboratories													
L ₁	0.33 _{1 z}	0.08 _{1 i}	1.63 _{2 i}	0.15 _{1 i}	0.23 _{0 i}	5.33 _{5 i}	0.78 _{7 n}	0.00 _{1 n}	1.33 _{2 c}	0.01 _{1 i}	90.0 _{6 g}	1.51 _{4 x}	---
L ₂	0.34 _{1 i}	0.08 _{2 i}	1.63 _{3 c}	0.16 _{0 i}	0.21 _{0 i}	5.34 _{8 i}	0.76 _{0 n}	0.00 _{1 n}	1.33 _{3 c}	0.00 _{8 i}	89.5 _{6 g}	1.48 _{5 i}	---
L ₃	0.34 _{9 i}	0.06 _{0 i}	1.64 _{0 c}	0.16 _{9 i}	0.21 _{2 i}	5.27 _{0 i}	0.74 _{0 n}	0.00 _{1 n}	1.33 _{3 c}	0.01 _{3 i}	89.1 _{3 g}	1.52 _{5 x}	---
L ₄	0.31 _{1 z}	0.07 _{0 n}	1.60 _{2 c}	0.17 _{1 c}	0.23 _{9 n}	5.25 _{7 n}	0.76 _{5 n}	0.00 _{3 n}	1.33 _{2 c}	0.02 _{1 n}	89.9 _{3 g}	1.52 _{0 x}	---
L ₅	0.32 _{5 i}	0.04 _{1 i}	1.61 _{1 i}	0.15 _{8 i}	0.24 _{2 i}	5.28 _{0 i}	0.81 _{3 n}	0.00 _{0 n}	1.35 _{0 c}	0.00 _{1 i}	89.0 _{2 g}	1.52 _{0 x}	---
L ₆	0.34 _{2 x}	0.09 _{2 n}	1.60 _{1 c}	0.16 _{6 c}	0.19 _{6 n}	5.23 _{3 n}	0.71 _{8 n}	0.00 _{1 n}	1.34 _{5 c}	0.02 _{0 n}	89.1 _{5 g}	1.53 _{0 x}	---
L ₇	0.35 _{1 i}	0.08 _{1 i}	1.63 _{5 c}	0.16 _{6 c}	0.23 _{5 n}	5.34 _{0 i}	0.77 _{7 n}	0.00 _{1 n}	1.36 _{3 c}	0.02 _{0 i}	89.9 _{3 g}	1.54 _{0 i}	---
L ₈	0.33 _{1 z}	0.07 _{2 n}	1.61 _{7 c}	0.16 _{0 c}	0.20 _{1 n}	5.35 _{7 n}	0.77 _{1 n}	0.00 _{2 n}	1.35 _{1 c}	0.01 _{1 n}	89.2 _{2 g}	1.50 _{2 x}	---
L ₉	0.33 _{5 x}	0.09 _{1 n}	1.62 _{1 c}	0.16 _{0 c}	0.21 _{1 n}	5.29 _{7 n}	0.77 _{3 n}	0.00 _{1 n}	1.32 _{5 c}	0.01 _{5 n}	90.0 _{1 g}	1.57 _{0 x}	---
Average (\bar{X})	0.335 _z	0.077 _z	1.621 _z	0.164 _z	0.221 _z	5.303 _z	0.767 _z	0.003 _z	1.341 _z	0.015 _z	90.00 _z	1.525 _z	88.47 _z
Standard deviation (Reproducibility) $s_{\bar{x}}$	0.012 _s	0.015 _z	0.014 _s	0.005 _s	0.018 _s	0.044 _s	0.027 _z	0.001 _z	0.012 _s	0.006 _z	0.18 _z	0.025 _z	---
deviation (Reproducibility without laboratories) $s_{f(r)}^{*1}$	0.004 _z	0.004 _z	0.015 _s	0.004 _z	0.007 _z	0.026 _z	0.014 _z	0.000 _z	0.026 _s	0.002 _z	0.08 _z	0.011 _z	---
Uncertainty C (95%) ^{*2}	0.01 _z	0.01 _z	0.01 _z	0.00 _z	0.01 _z	0.03 _s	0.02 _z	0.00 _z	0.00 _z	0.00 _s	0.1 _z	0.02 _z	0.1 _z *4

(Note) * 1 $s_{f(r)}$ is intermediate precision without a time condition.* 2 The half-width confidence interval C (95%) = $t_{\ell-1,0.05} \times s_{\bar{x}} / \sqrt{\ell}$ (ℓ = number of laboratories)* 3 $ZrO_2 = ZrO_2 + HfO_2 - HfO_2$ * 4 $s_{\bar{x}_{ZrO_2}} = \sqrt{\left(s_{\bar{x}_{ZrO_2+HfO_2}}\right)^2 + \left(s_{\bar{x}_{HfO_2}}\right)^2}$

(1) List of laboratories : Kurosaki Corporation, Kawasaki Refractories Co.,Ltd., The Industrial Technology Center of Okayama Prefecture, Yotai Refractories Co.,Ltd., Asahi Glass Co.,Ltd., Harima Ceramic Co.,Ltd., Shinagawa Refractories Co.,Ltd., Toshiba Ceramics Co.,Ltd., Toshiba Monofrax Co.,Ltd.

(2) Analytical techniques : JIS R 2012(Method for chemical analysis of refractory containing zircon and/or zirconia) a: AAS, c:colorimetry, g:gravimetry, G:gravimetry and colorimetry, i:ICP-AES, v:chelatorimetry, x:XRFB

(3) Analytical values : Each value is the average of two values obtained by two measurements on different days. These analysis values are shown converted into LOI (Loss on ignition) component free values from the February 22, 2008 v20080222 version on.

(4) Outlier tests were carried out by Grubbs test. The samples rejected by Grubbs tests were discussed in view of analytical techniques and it was determined whether the outliers should be adopted or not.

(5) Date of preparation : March, 1995

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Certified Reference Material Series for X-ray Fluorescence Analysis of Refractories

J R R M 6 0 3 (Zircon-Zirconia Refractory)

Results of Analyses

Unit : mass%

Constituent	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	CaO	MgO	Na ₂ O	K ₂ O	P ₂ O ₅	Cr ₂ O ₃	ZrO ₂ (+HfO ₂)	HfO ₂	ZrO ₂ *3
Certified value	0.96 ₇	5.29 ₉	2.86 ₁	0.93 ₄	0.95 ₄	0.96 ₈	0.18 ₇	0.65 ₃	0.83 ₄	0.02 ₈	86.2 ₈	1.45 ₄	84.8 ₀
Laboratories													
L ₁	0.96 ₇ x	5.40 ₁ i	2.85 ₅ i	0.90 ₂ i	0.96 ₀ i	0.98 ₅ i	0.18 ₄ a	0.65 ₄ a	0.82 ₅ c	0.03 ₂ i	86.5 ₀ g	1.44 ₆ x	—
L ₂	0.96 ₉ i	5.40 ₁ i	2.87 ₀ c	0.93 ₃ i	0.93 ₀ i	0.94 ₇ i	0.19 ₂ a	0.63 ₇ a	0.85 ₁ c	0.01 ₈ i	86.0 ₀ g	1.45 ₂ x	—
L ₃	0.98 ₅ i	5.23 ₁ i	2.92 ₁ c	0.93 ₆ i	0.95 ₈ i	0.98 ₀ i	0.18 ₀ a	0.63 ₇ a	0.81 ₁ c	0.04 ₆ i	86.1 ₀ g	1.45 ₈ x	—
L ₄	0.97 ₁ x	5.27 ₀ a	2.86 ₅ c	0.95 ₃ c	0.96 ₈ a	0.94 ₃ a	0.19 ₀ a	0.66 ₃ a	0.85 ₂ c	0.03 ₁ a	86.2 ₁ g	1.44 ₆ x	—
L ₅	0.95 ₆ i	5.29 ₁ i	2.81 ₃ i	0.93 ₃ i	0.94 ₀ i	0.96 ₇ i	0.20 ₄ a	0.66 ₇ a	0.84 ₆ c	0.01 ₈ i	86.4 ₃ g	1.43 ₆ i	—
L ₆	0.95 ₅ x	5.24 ₁ a	2.88 ₂ c	0.95 ₄ c	0.92 ₅ a	0.95 ₅ a	0.18 ₃ a	0.65 ₇ a	0.84 ₃ c	0.01 ₆ a	86.4 ₂ g	1.46 ₅ x	—
L ₇	0.98 ₁ i	5.34 ₃ v	2.85 ₅ c	0.94 ₆ c	0.96 ₃ i	0.97 ₁ i	0.18 ₂ a	0.66 ₂ a	0.83 ₇ c	0.03 ₄ i	85.9 ₇ g	1.46 ₄ x	—
L ₈	0.95 ₆ x	5.27 ₀ a	2.82 ₇ c	0.92 ₀ c	0.96 ₅ a	0.98 ₀ a	0.18 ₅ a	0.64 ₃ a	0.84 ₇ c	0.04 ₁ a	86.3 ₁ g	1.43 ₂ x	—
L ₉	0.96 ₄ x	5.22 ₇ a	2.86 ₂ c	0.92 ₂ c	0.94 ₇ a	0.97 ₅ a	0.18 ₃ a	0.65 ₉ a	0.83 ₃ c	0.02 ₂ a	86.3 ₅ g	1.48 ₈ x	—
Average (\bar{x})	0.967 ₁	5.299 ₃	2.861 ₄	0.933 ₅	0.953 ₇	0.968 ₁	0.187 ₃	0.653 ₂	0.838 ₄	0.028 ₇	86.25 ₈	1.454 ₄	84.80 ₄
Standard deviation (Reproducibility) s_x	0.010 ₅	0.069 ₉	0.030 ₆	0.017 ₂	0.015 ₈	0.016 ₄	0.007 ₂	0.011 ₅	0.012 ₀	0.010 ₅	0.19 ₅	0.017 ₁	—
deviation (Reproducibility without laboratories) $s_{I(T)}$ *1	0.005 ₂	0.047 ₂	0.023 ₀	0.008 ₈	0.007 ₈	0.013 ₃	0.003 ₄	0.012 ₆	0.008 ₁	0.002 ₃	0.11 ₁	0.003 ₄	—
Uncertainty C (95%) *2	0.00 ₈	0.05 ₄	0.02 ₄	0.01 ₃	0.01 ₂	0.01 ₃	0.00 ₅	0.00 ₉	0.00 ₆	0.00 ₈	0.1 ₅	0.01 ₃	0.1 ₅ *4

(Note) * 1 $s_{I(T)}$ is intermediate precision without a time condition.* 2 The half-width confidence interval $C (95\%) = t_{\ell-1, 0.05} \times s_x / \sqrt{\ell}$ (ℓ = number of laboratories)* 3 $ZrO_2 = ZrO_2(+HfO_2) - HfO_2$ * 4 $s_{x, ZrO_2} = \sqrt{\left(s_{x, ZrO_2(+HfO_2)}\right)^2 + \left(s_{x, HfO_2}\right)^2}$

(1) List of laboratories : Kurosaki Corporation, Kawasaki Refractories Co., Ltd., The Industrial Technology Center of Okayama Prefecture, Yotai Refractories Co., Ltd., Asahi Glass Co., Ltd., Harima Ceramic Co., Ltd., Shinagawa Refractories Co., Ltd., Toshiba Ceramics Co., Ltd., Toshiba Monofrax Co., Ltd.

(2) Analytical techniques : JIS R 1012 (Method for chemical analysis of refractory containing zircon and/or zirconia) a) AAS, c) colorimetry, g) gravimetry, G) gravimetry and colorimetry, i) ICP-AES, v) chelatometry, x) XRF

(3) Analytical values : Each value is the average of two values obtained by two measurements on different days. These analysis values are shown converted into LOI (Loss on ignition) component free values from the February 22, 2008 v20080222 version on.

(4) Outlier tests were carried out by Grubbs test. The samples rejected by Grubbs tests were discussed in view of analytical techniques and it was determined whether the outliers should be adopted or not.

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J R R M 6 0 4 (Zircon-Zirconia Refractory)

Results of Analyses

Unit : mass%

Constituent	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	CaO	MgO	Na ₂ O	K ₂ O	P ₂ O ₅	Cr ₂ O ₃	ZrO ₂ (+HfO ₂)	HfO ₂	ZrO ₂ *3
Certified value	3.05 ₂	6.93 ₃	0.43 ₆	0.13 ₄	0.09 ₄	0.01 ₇	1.09 ₆	1.94 ₂	1.99 ₇	3.06 ₉	80.8 ₁	1.35 ₉	79.4 ₅
Laboratories													
L ₁	3.04 ₁ x	7.00 ₁ i	0.43 ₁ i	0.13 ₂ i	0.09 ₅ i	0.01 ₅ i	1.10 ₇ a	1.98 ₃ a	1.99 ₁ c	3.07 ₇ i	80.8 ₇ g	1.37 ₀ x	—
L ₂	3.02 ₇ i	6.98 ₅ i	0.41 ₉ c	0.13 ₁ i	0.09 ₂ i	0.01 ₆ i	1.05 ₀ a	1.91 ₁ a	2.04 ₁ c	3.02 ₁ i	80.7 ₁ g	1.36 ₇ x	—
L ₃	3.04 ₅ i	6.98 ₂ i	0.43 ₇ c	0.13 ₆ i	0.11 ₆ i	0.01 ₇ i	1.06 ₇ a	1.90 ₂ a	1.95 ₁ c	3.11 ₂ i	80.7 ₇ g	1.34 ₁ i	—
L ₄	3.09 ₅ x	6.87 ₄ a	0.42 ₅ a	0.13 ₄ c	0.08 ₉ a	0.01 ₅ a	1.10 ₄ a	1.92 ₃ a	1.98 ₂ c	3.07 ₁ a	80.7 ₃ g	1.36 ₁ x	—
L ₅	2.99 ₅ i	6.85 ₁ i	0.42 ₅ i	0.12 ₅ i	0.10 ₁ i	0.02 ₀ i	1.13 ₀ a	1.94 ₇ a	2.05 ₁ c	3.04 ₁ i	80.9 ₅ g	1.29 ₄ i	—
L ₆	3.07 ₀ x	6.95 ₅ a	0.43 ₂ c	0.13 ₂ c	0.08 ₀ a	0.01 ₂ a	1.07 ₂ a	1.96 ₂ a	1.99 ₄ c	3.07 ₂ a	80.5 ₅ g	1.38 ₃ x	—
L ₇	3.07 ₄ i	6.96 ₀ v	0.42 ₅ c	0.13 ₇ c	0.09 ₅ i	0.01 ₆ i	1.04 ₄ a	1.97 ₂ a	2.00 ₂ c	3.05 ₂ i	80.9 ₃ g	1.36 ₇ x	—
L ₈	3.04 ₃ x	6.95 ₁ a	0.42 ₅ c	0.13 ₄ c	0.08 ₅ a	0.01 ₀ a	1.12 ₃ a	1.93 ₇ a	1.97 ₅ c	3.08 ₅ a	80.9 ₀ g	1.34 ₅ x	—
L ₉	3.05 ₉ x	6.82 ₂ a	0.43 ₃ c	0.13 ₅ c	0.09 ₀ a	0.01 ₅ a	1.10 ₅ a	1.93 ₀ a	1.98 ₅ c	3.08 ₂ a	80.7 ₁ g	1.40 ₅ x	—
Average (\bar{x})	3.051 ₇	6.933 ₁	0.429 ₅	0.133 ₅	0.094 ₆	0.016 ₇	1.090 ₁	1.941 ₅	1.997 ₂	3.068 ₅	80.80 ₅	1.359 ₂	79.44 ₅
Standard deviation (Reproducibility) s_x	0.029 ₂	0.066 ₄	0.004 ₇	0.003 ₅	0.010 ₁	0.002 ₄	0.032 ₅	0.027 ₀	0.030 ₅	0.026 ₅	0.13 ₂	0.030 ₅	—
deviation (Reproducibility without laboratories) $s_{I(T)}$ *1	0.023 ₅	0.036 ₅	0.004 ₅	0.002 ₅	0.012 ₅	0.002 ₇	0.022 ₇	0.019 ₂	0.018 ₅	0.022 ₀	0.07 ₇	0.010 ₄	—
Uncertainty C (95%) *2	0.02 ₂	0.05 ₁	0.00 ₄	0.00 ₂	0.00 ₅	0.00 ₂	0.02 ₅	0.02 ₁	0.02 ₄	0.02 ₁	0.1 ₅	0.02 ₄	0.1 ₀ *4

(Note) * 1 $s_{I(T)}$ is intermediate precision without a time condition.* 2 The half-width confidence interval C (95%) = $t_{\ell-1,0.05} \times s_x / \sqrt{\ell}$ (ℓ = number of laboratories)* 3 $ZrO_2 = ZrO_2(+HfO_2) - HfO_2$ * 4 $s_{x_{ZrO_2}} = \sqrt{\left(s_{x_{ZrO_2(HfO_2)}}\right)^2 + \left(s_{x_{HfO_2}}\right)^2}$

(1) List of laboratories : Kurosaki Corporation, Kawasaki Refractories Co.,Ltd., The Industrial Technology Center of Okayama Prefecture, Yotai Refractories Co.,Ltd., Asahi Glass Co.,Ltd., Harima Ceramic Co.,Ltd., Shinagawa Refractories Co.,Ltd., Toshiba Ceramics Co.,Ltd., Toshiba Monofrax Co.,Ltd.

(2) Analytical techniques : JIS R 2012(Method for chemical analysis of refractory containing zircon and/or zirconia) a: AAS, c:colorimetry, g:gravimetry, G:gravimetry and colorimetry, i:ICP-AES, v:chelometry, x:XRF

(3) Analytical values : Each value is the average of two values obtained by two measurements on different days. These analysis values are shown converted into LOI (Loss on ignition) component free values from the February 22, 2008 v20080222 version on.

(4) Outlier tests were carried out by Grubbs test. The samples rejected by Grubbs tests were discussed in view of analytical techniques and it was determined whether the outliers should be adopted or not.

(5) Date of preparation : March, 1995

Prepared, and Values given and certified by

The Technical Association of Refractories, Japan

New Ginza Bldg., 3-13, Ginza 7-chome, Chuo-ku, Tokyo 104-0061, Japan

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Certified Reference Material Series for X-ray Fluorescence Analysis of Refractories

J R R M 6 0 5 (Zircon-Zirconia Refractory)

Results of Analyses

Unit : mass%

Constituent	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	CaO	MgO	Na ₂ O	K ₂ O	P ₂ O ₅	Cr ₂ O ₃	ZrO ₂ (+HfO ₂)	HfO ₂	ZrO ₂ *3
Certified value	10.8 ₂	4.84 ₇	0.17 ₇	0.12 ₇	1.94 ₅	1.99 ₉	0.45 ₈	0.54 ₃	0.35 ₄	1.55 ₂	76.9 ₁	1.31 ₈	75.5 ₉
Laboratories													
L ₁	10.7 ₇ g	4.93 ₉ i	0.17 ₉ i	0.12 ₈ i	1.94 ₈ i	1.98 ₄ i	0.46 ₀ a	0.55 ₄ a	0.36 ₁ c	1.57 ₃ i	76.9 ₅ g	1.30 ₇ x	—
L ₂	10.8 ₁ g	4.89 ₂ i	0.17 ₉ c	0.12 ₈ i	1.95 ₉ i	1.99 ₂ i	0.47 ₁ a	0.54 ₂ a	0.34 ₁ c	1.55 ₅ i	76.7 ₆ g	1.38 ₆ i	—
L ₃	10.9 ₀ g	4.83 ₃ i	0.17 ₈ c	0.12 ₅ i	1.93 ₈ i	1.94 ₃ i	0.44 ₃ a	0.53 ₁ a	0.34 ₅ c	1.51 ₉ i	76.7 ₅ g	1.28 ₅ i	—
L ₄	10.7 ₈ g	4.80 ₁ a	0.17 ₈ c	0.12 ₉ c	1.95 ₁ a	1.99 ₅ a	0.45 ₃ a	0.52 ₇ a	0.35 ₈ c	1.56 ₁ a	76.9 ₃ g	1.29 ₁ x	—
L ₅	10.9 ₁ g	4.90 ₈ i	0.18 ₂ i	0.12 ₉ i	1.93 ₈ i	2.04 ₆ i	0.48 ₇ a	0.56 ₇ a	0.35 ₁ c	1.57 ₄ i	77.0 ₂ g	1.28 ₈ i	—
L ₆	10.8 ₃ g	4.83 ₁ a	0.17 ₄ a	0.12 ₆ c	1.94 ₀ a	1.99 ₃ a	0.45 ₁ a	0.53 ₃ a	0.35 ₃ c	1.52 ₆ a	76.7 ₈ g	1.31 ₅ x	—
L ₇	10.6 ₆ g	4.87 ₁ i	0.17 ₆ c	0.12 ₈ c	1.95 ₆ i	1.99 ₈ i	0.44 ₆ a	0.54 ₈ a	0.35 ₇ c	1.54 ₇ i	77.1 ₉ g	1.31 ₉ x	—
L ₈	10.7 ₄ g	4.78 ₁ a	0.17 ₉ c	0.12 ₈ c	1.96 ₉ a	2.01 ₅ a	0.47 ₁ a	0.54 ₂ a	0.35 ₃ c	1.53 ₅ a	76.8 ₂ g	1.33 ₃ i	—
L ₉	10.9 ₄ g	4.76 ₈ a	0.17 ₁ c	0.12 ₁ c	1.90 ₇ a	2.02 ₈ a	0.43 ₁ a	0.53 ₈ a	0.36 ₇ c	1.58 ₃ a	77.0 ₆ g	1.34 ₅ x	—
Average (\bar{x})	10.81 ₈	4.847 ₄	0.176 ₉	0.127 ₃	1.945 ₃	1.999 ₂	0.458 ₃	0.542 ₆	0.354 ₃	1.552 ₆	76.91 ₁	1.317 ₆	75.59 ₃
Standard deviation (s_x)	0.09 ₂	0.059 ₄	0.003 ₃	0.001 ₇	0.018 ₄	0.028 ₃	0.016 ₂	0.012 ₂	0.007 ₅	0.022 ₃	0.14 ₉	0.032 ₈	—
deviation ($s_{I(T)}$) *1	0.05 ₅	0.035 ₂	0.006 ₀	0.002 ₀	0.017 ₈	0.012 ₅	0.005 ₆	0.013 ₄	0.010 ₅	0.017 ₀	0.12 ₈	0.013 ₄	—
Uncertainty C (95%) *2	0.0 ₇	0.04 ₃	0.00 ₃	0.00 ₁	0.01 ₄	0.02 ₂	0.01 ₃	0.00 ₉	0.00 ₆	0.01 ₇	0.1 ₁	0.02 ₅	0.1 ₂ *4

(Note) * 1 $s_{I(T)}$ is intermediate precision without a time condition.* 2 The half-width confidence interval C (95%) = $t_{\ell-1,0.05} \times s_x / \sqrt{\ell}$ (ℓ = number of laboratories)* 3 $ZrO_2 = ZrO_2(+HfO_2) - HfO_2$ * 4 $s_{x-ZrO_2} = \sqrt{\left(s_{x-ZrO_2(HfO_2)}\right)^2 + \left(s_{x-HfO_2}\right)^2}$

(1) List of laboratories : Kurosaki Corporation, Kawasaki Refractories Co.,Ltd., The Industrial Technology Center of Okayama Prefecture, Yotai Refractories Co.,Ltd., Asahi Glass Co.,Ltd., Harima Ceramic Co.,Ltd., Shinagawa Refractories Co.,Ltd., Toshiba Ceramics Co.,Ltd., Toshiba Monofrax Co.,Ltd.

(2) Analytical techniques : JIS R 1202(Method for chemical analysis of refractory containing zircon and/or zirconia) a: AAS, c:colorimetry, g:gravimetry, G:gravimetry and colorimetry, i:ICP-AES, v:chelatorimetry, x:XRF

(3) Analytical values : Each value is the average of two values obtained by two measurements on different days. These analysis values are shown converted into LOI (Loss on ignition) component free values from the February 22, 2008 v20080222 version on.

(4) Outlier tests were carried out by Grubbs test. The samples rejected by Grubbs tests were discussed in view of analytical techniques and it was determined whether the outliers should be adopted or not.

(5) Date of preparation : March, 1995

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 J R R M 6 0 6 (Zircon-Zirconia Refractory)
 Results of Analyses

Unit : mass%

Constituent		SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	CaO	MgO	Na ₂ O	K ₂ O	P ₂ O ₅	Cr ₂ O ₃	ZrO ₂ (+HfO ₂)	HfO ₂	ZrO ₂ *3
Certified value		22.1 ₀	0.53 ₄	0.93 ₆	0.11 ₇	0.02 ₁	0.32 ₁	2.03 ₄	0.01 ₄	0.01 ₈	0.00 ₈	73.8 ₈	1.26 ₉	72.5 ₉
Laboratories	L ₁	22.0 ₃ c	0.52 ₆ i	0.94 ₇ i	0.12 ₀ i	0.02 ₀ i	0.33 ₀ i	1.99 ₃ a	0.01 ₀ a	0.01 ₈ c	0.01 ₀ i	73.8 ₅ g	1.26 ₂ s	—
	L ₂	22.1 ₀ c	0.53 ₂ i	0.93 ₆ c	0.11 ₈ i	0.02 ₀ i	0.30 ₀ i	2.05 ₅ a	0.01 ₈ a	0.02 ₀ c	0.00 ₉ i	73.8 ₂ g	1.29 ₁ i	—
	L ₃	22.0 ₅ c	0.53 ₄ i	0.93 ₂ c	0.11 ₈ c	0.01 ₈ i	0.30 ₃ i	2.04 ₂ a	0.01 ₂ a	0.01 ₈ c	0.01 ₀ i	73.8 ₈ g	1.22 ₅ i	—
	L ₄	22.1 ₂ c	0.54 ₄ a	0.92 ₇ c	0.12 ₁ c	0.02 ₀ a	0.31 ₀ a	2.01 ₉ a	0.01 ₂ a	0.02 ₁ c	0.01 ₂ a	73.8 ₂ g	1.23 ₂ s	—
	L ₅	21.9 ₃ c	0.52 ₈ i	0.94 ₇ i	0.11 ₉ i	0.02 ₀ i	0.34 ₁ i	2.03 ₀ a	0.01 ₀ a	0.02 ₀ c	0.00 ₉ i	73.8 ₇ g	1.25 ₃ i	—
	L ₆	22.3 ₄ c	0.53 ₀ a	0.92 ₁ c	0.11 ₁ c	0.02 ₂ a	0.31 ₀ a	2.03 ₀ a	0.01 ₀ a	0.01 ₈ c	0.01 ₁ a	73.8 ₀ g	1.27 ₃ s	—
	L ₇	22.0 ₁ c	0.54 ₄ v	0.92 ₈ c	0.11 ₈ c	0.02 ₀ i	0.31 ₀ i	2.05 ₃ a	0.01 ₂ a	0.01 ₈ c	0.00 ₈ i	73.7 ₇ g	1.30 ₁ i	—
	L ₈	22.2 ₁ c	0.51 ₂ a	0.93 ₅ c	0.11 ₈ c	0.01 ₆ a	0.32 ₀ a	2.05 ₁ a	0.01 ₂ a	0.02 ₀ c	0.00 ₈ a	73.7 ₁ g	1.28 ₇ i	—
	L ₉	22.0 ₀ c	0.54 ₅ a	0.94 ₈ c	0.11 ₄ c	0.02 ₁ a	0.31 ₅ a	2.02 ₉ a	0.01 ₀ a	0.02 ₀ c	0.00 ₇ a	74.0 ₀ g	1.29 ₆ s	—
Average (\bar{X})		22.09 ₉	0.533 ₇	0.935 ₅	0.117 ₄	0.020 ₉	0.321 ₄	2.034 ₂	0.013 ₈	0.019 ₂	0.008 ₁	73.85 ₉	1.269 ₁	72.59 ₉
Standard deviation	(Reproducibility) s_x (without laboratories) $s_{I(T)}$ *1	0.13 ₀ 0.05 ₁	0.011 ₀ 0.011 ₁	0.009 ₂ 0.009 ₈	0.003 ₁ 0.002 ₄	0.003 ₆ 0.001 ₇	0.012 ₈ 0.006 ₄	0.019 ₈ 0.014 ₂	0.003 ₅ 0.002 ₀	0.001 ₁ 0.001 ₂	0.003 ₃ 0.001 ₄	0.09 ₇ 0.08 ₈	0.028 ₁ 0.008 ₃	— —
Uncertainty C (95%) *2		0.1 ₀	0.00 ₈	0.00 ₇	0.00 ₂	0.00 ₃	0.01 ₀	0.01 ₅	0.00 ₃	0.00 ₁	0.00 ₃	0.0 ₇	0.02 ₂	0.0 ₈ *4

(Note) *1 $s_{I(T)}$ is intermediate precision without a time condition.*2 The half-width confidence interval C (95%) = $t_{1-0.05} \times s_x / \sqrt{\ell}$ (ℓ = number of laboratories)*3 $\text{ZrO}_2 = \text{ZrO}_2(+\text{HfO}_2) - \text{HfO}_2$ *4 $s_{x, \text{ZrO}_2} = \sqrt{\left(s_{x, \text{ZrO}_2(+\text{HfO}_2)}\right)^2 + \left(s_{x, \text{HfO}_2}\right)^2}$

(1) List of laboratories : Kurosaki Corporation, Kawasaki Refractories Co., Ltd., The Industrial Technology Center of Okayama Prefecture, Yotai Refractories Co., Ltd., Asahi Glass Co., Ltd., Harima Ceramic Co., Ltd., Shinagawa Refractories Co., Ltd., Toshiba Ceramics Co., Ltd., Toshiba Monofrax Co., Ltd.

(2) Analytical techniques : JIS R 2012(Method for chemical analysis of refractory containing zircon and/or zirconia) a: AAS, c:colorimetry, g:gravimetry, G:gravimetry and colorimetry, i:ICP-AES, v:chelatorimetry, x:XRF

(3) Analytical values : Each value is the average of two values obtained by two measurements on different days. These analysis values are shown converted into LOI (Loss on ignition) component free values from the February 22, 2008 v20080222 version on.

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 J R R M 6 0 7 (Zircon-Zirconia Refractory)
 Results of Analyses

Unit : mass%

Constituent	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	CaO	MgO	Na ₂ O	K ₂ O	P ₂ O ₅	Cr ₂ O ₃	ZrO ₂ (+HfO ₂)	HfO ₂	ZrO ₂ *3
Certified value	32.9 ₄	3.53 ₉	0.12 ₁	0.13 ₇	0.04 ₈	0.03 ₁	0.02 ₈	0.04 ₃	0.08 ₆	0.00 ₂	62.8 ₈	1.21 ₈	61.6 ₈
Laboratories													
L ₁	33.0 ₂ g	3.50 ₈ i	0.11 ₆ i	0.14 ₄ c	0.04 ₈ i	0.02 ₀ i	0.03 ₁ a	0.04 ₆ a	0.08 ₃ c	0.00 ₀ i	62.6 ₁ g	1.20 ₈ s	—
L ₂	32.9 ₇ g	3.55 ₁ i	0.11 ₂ c	0.13 ₇ i	0.04 ₆ i	0.02 ₆ i	0.02 ₈ a	0.04 ₆ a	0.08 ₀ c	0.00 ₀ i	62.6 ₈ g	1.23 ₀ i	—
L ₃	33.0 ₀ g	3.53 ₉ i	0.12 ₁ c	0.13 ₇ i	0.04 ₆ i	0.02 ₆ i	0.03 ₀ a	0.04 ₆ a	0.08 ₂ c	0.00 ₁ i	63.0 ₀ g	1.20 ₀ i	—
L ₄	32.9 ₁ g	3.50 ₈ a	0.12 ₇ c	0.13 ₈ c	0.05 ₀ a	0.03 ₆ a	0.02 ₇ a	0.04 ₄ a	0.08 ₃ c	0.00 ₂ a	62.7 ₈ g	1.19 ₆ s	—
L ₅	32.9 ₄ g	3.53 ₁ i	0.12 ₁ i	0.13 ₈ i	0.04 ₁ i	0.03 ₆ i	0.02 ₈ a	0.04 ₅ a	0.08 ₂ c	0.00 ₃ i	62.7 ₇ g	1.22 ₃ i	—
L ₆	32.9 ₇ g	3.56 ₀ v	0.12 ₈ c	0.13 ₈ c	0.05 ₀ a	0.02 ₈ a	0.02 ₃ a	0.04 ₀ a	0.09 ₀ c	0.00 ₀ a	62.1 ₀ g	1.22 ₀ s	—
L ₇	32.8 ₁ g	3.56 ₈ v	0.11 ₆ c	0.13 ₂ c	0.04 ₆ i	0.03 ₈ i	0.02 ₆ a	0.04 ₁ a	0.08 ₄ c	0.00 ₂ a	63.0 ₀ g	1.21 ₂ i	—
L ₈	32.8 ₁ g	3.54 ₅ a	0.12 ₇ c	0.13 ₇ c	0.05 ₀ a	0.03 ₀ a	0.02 ₀ a	0.04 ₁ a	0.08 ₇ c	0.00 ₈ a	62.8 ₀ g	1.23 ₁ i	—
L ₉	33.0 ₃ g	3.53 ₀ a	0.12 ₁ c	0.13 ₂ c	0.05 ₄ a	0.03 ₁ a	0.02 ₃ a	0.04 ₂ a	0.09 ₁ c	0.00 ₁ a	63.1 ₁ g	1.24 ₁ s	—
Average (\bar{X})	32.94 ₀	3.538 ₈	0.121 ₁	0.136 ₇	0.048 ₄	0.031 ₀	0.026 ₂	0.043 ₁	0.085 ₇	0.001 ₈	62.88 ₂	1.218 ₂	61.66 ₄
Standard deviation (Reproducibility) $s_{\bar{x}}$	0.07 ₇	0.022 ₀	0.005 ₈	0.003 ₃	0.003 ₁	0.004 ₃	0.003 ₅	0.002 ₆	0.003 ₈	0.001 ₈	0.19 ₃	0.015 ₇	—
deviation (Reproducibility without laboratories) $s_{t(7)}$ *1	0.04 ₇	0.048 ₃	0.003 ₀	0.001 ₈	0.001 ₈	0.003 ₇	0.002 ₃	0.003 ₅	0.002 ₁	0.001 ₁	0.10 ₇	0.013 ₆	—
Uncertainty C (95%) *2	0.0 ₁	0.01 ₇	0.00 ₄	0.00 ₃	0.00 ₂	0.00 ₂	0.00 ₂	0.00 ₂	0.00 ₃	0.00 ₁	0.1 ₅	0.01 ₂	0.1 ₈ *4

(Note) *1 $s_{t(7)}$ is intermediate precision without a time condition.*2 The half-width confidence interval C (95%) = $t_{\alpha/2, \ell-1} \times s_{\bar{x}} / \sqrt{\ell}$ (ℓ = number of laboratories)*3 $\text{ZrO}_2 = \text{ZrO}_2(+\text{HfO}_2) - \text{HfO}_2$ *4 $s_{\bar{x}_{\text{ZrO}_2}} = \sqrt{\left(s_{\bar{x}_{\text{ZrO}_2(+\text{HfO}_2)}}\right)^2 + \left(s_{\bar{x}_{\text{HfO}_2}}\right)^2}$

(1) List of laboratories : Kurosaki Corporation, Kawasaki Refractories Co., Ltd., The Industrial Technology Center of Okayama Prefecture, Yotai Refractories Co., Ltd., Asahi Glass Co., Ltd., Harima Ceramic Co., Ltd., Shinagawa Refractories Co., Ltd., Toshiba Ceramics Co., Ltd., Toshiba Monofrax Co., Ltd.

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J R R M 6 0 8 (Zircon-Zirconia Refractory)

Results of Analyses

Unit : mass%

Constituent		SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	CaO	MgO	Na ₂ O	K ₂ O	P ₂ O ₅	Cr ₂ O ₃	ZrO ₂ (+HfO ₂)	HfO ₂	ZrO ₂ *3
Certified value		34.6 _s	0.70 ₇	0.09 ₂	0.10 ₂	0.52 ₁	3.12 ₇	0.03 ₁	0.01 ₉	0.11 ₇	0.49 ₇	60.1 ₅	1.21 ₇	58.8 _s
Laboratories	L ₁	34.6 ₁ g	0.75 ₂ i	0.10 ₄ i	0.10 ₂ i	0.54 ₂ i	3.13 ₉ i	0.03 ₂ a	0.01 ₅ a	0.10 ₅ c	0.50 ₄ i	59.9 ₇ g	1.21 ₆ s	—
	L ₂	34.6 ₈ g	0.66 ₇ i	0.08 ₂ c	0.10 ₀ i	0.51 ₂ i	3.11 ₈ i	0.03 ₄ a	0.02 ₂ a	0.12 ₄ c	0.47 ₂ i	60.0 ₇ g	1.20 ₇ s	—
	L ₃	34.7 ₃ g	0.71 ₃ i	0.09 ₁ c	0.10 ₆ c	0.51 ₀ i	3.11 ₆ i	0.03 ₂ a	0.01 ₅ a	0.11 ₆ c	0.48 ₇ i	59.8 ₂ g	1.19 ₅ i	—
	L ₄	34.6 ₀ g	0.70 ₈ a	0.09 ₅ c	0.10 ₄ c	0.52 ₇ a	3.10 ₈ a	0.03 ₃ a	0.02 ₂ a	0.11 ₂ c	0.49 ₁ a	60.2 ₅ g	1.19 ₁ s	—
	L ₅	34.6 ₅ g	0.67 ₃ a	0.09 ₁ c	0.10 ₀ c	0.51 ₂ i	3.14 ₈ i	0.03 ₆ a	0.02 ₁ a	0.11 ₇ c	0.49 ₆ i	60.2 ₅ g	1.21 ₇ i	—
	L ₆	34.7 ₁ g	0.74 ₁ a	0.09 ₀ c	0.10 ₆ c	0.51 ₈ a	3.10 ₈ a	0.02 ₈ a	0.01 ₅ a	0.12 ₄ c	0.51 ₀ a	60.1 ₅ g	1.21 ₄ s	—
	L ₇	34.5 ₂ g	0.69 ₅ i	0.08 ₅ c	0.10 ₅ c	0.53 ₅ i	3.13 ₅ i	0.03 ₁ a	0.02 ₀ a	0.12 ₅ c	0.51 ₆ i	60.1 ₅ g	1.25 ₅ i	—
	L ₈	34.4 ₈ g	0.72 ₄ a	0.08 ₈ c	0.10 ₂ c	0.51 ₂ a	3.11 ₂ a	0.02 ₅ a	0.01 ₈ a	0.11 ₃ c	0.49 ₁ a	60.0 ₅ g	1.22 ₇ i	—
	L ₉	34.8 ₂ g	0.68 ₇ a	0.09 ₂ c	0.10 ₅ c	0.51 ₂ a	3.17 ₁ a	0.02 ₆ a	0.01 ₆ a	0.12 ₅ c	0.49 ₅ a	60.1 ₅ g	1.23 ₁ s	—
Average (X̄)		34.64 _s	0.707 ₁	0.091 _s	0.102 ₄	0.520 _s	3.127 ₃	0.030 _s	0.019 ₅	0.117 ₄	0.496 _s	60.10 ₁	1.217 ₄	58.88 ₄
Standard deviation	(Reproducibility) s _x (Reproducibility without laboratories) s _{I(T)} *1	0.09 ₉ 0.06 ₅	0.029 ₉ 0.009 ₇	0.006 ₈ 0.006 ₁	0.003 ₂ 0.003 ₄	0.011 ₂ 0.009 ₅	0.021 _s 0.018 ₇	0.003 ₇ 0.002 ₄	0.003 ₄ 0.002 ₅	0.006 ₇ 0.004 _s	0.012 _s 0.016 _s	0.15 ₂ 0.07 ₂	0.020 _s 0.012 ₅	— —
Uncertainty C (95%) *2		0.0 _s	0.02 ₃	0.00 _s	0.00 ₂	0.00 _s	0.01 ₇	0.00 ₃	0.00 ₃	0.00 ₅	0.01 ₅	0.1 ₂	0.01 ₅	0.1 ₂ *4

(Note) * 1 $s_{I(T)}$ is intermediate precision without a time condition.

* 2 The half-width confidence interval C (95%) = $t_{\ell-1,0.05} \times s_x / \sqrt{\ell}$ (ℓ = number of laboratories)

* 3 $\text{ZrO}_2 = \text{ZrO}_2(+\text{HfO}_2) - \text{HfO}_2$

* 4 $s_{x_{\text{ZrO}_2}} = \sqrt{\left(s_{x_{\text{ZrO}_2(+\text{HfO}_2)}}\right)^2 + \left(s_{x_{\text{HfO}_2}}\right)^2}$

(1) List of laboratories : Kurosaki Corporation, Kawasaki Refractories Co.,Ltd., The Industrial Technology Center of Okayama Prefecture, Yotai Refractories Co.,Ltd., Asahi Glass Co.,Ltd., Harima Ceramic Co.,Ltd., Shinagawa Refractories Co.,Ltd., Toshiba Ceramics Co.,Ltd., Toshiba Monofrax Co.,Ltd.

(2) Analytical techniques : JIS R 2012(Method for chemical analysis of refractory containing zircon and/or zirconia) a: AAS, c:colorimetry, g:gravimetry, G:gravimetry and colorimetry, i:ICP-AES, v:chelatorimetry, x:XRF

(3) Analytical values : Each value is the average of two values obtained by two measurements on different days. These analysis values are shown converted into LOI (Loss on ignition) component free values from the February 22, 2008 v20080222 version on.

(4) Outlier tests were carried out by Grubbs test. The samples rejected by Grubbs tests were discussed in view of analytical techniques and it was determined whether the outliers should be adopted or not.

(5) Date of preparation : March, 1995

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The Technical Association of Refractories, Japan

Certified Reference Material Series for X-ray Fluorescence Analysis of Refractories

J R R M 6 0 9 (Zircon-Zirconia Refractory)

Results of Analyses

Unit : mass%

Constituent	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	CaO	MgO	Na ₂ O	K ₂ O	P ₂ O ₅	Cr ₂ O ₃	ZrO ₂ (+HfO ₂)	HfO ₂	ZrO ₂ *3
Certified value	40.5 _s	0.88 ₇	0.15 _a	0.15 ₃	0.30 _o	0.15 _o	0.94 _a	0.02 _a	0.08 _i	0.01 ₂	56.7 _s	1.12 ₄	55.6 ₂
Laboratories													
L ₁	40.4 _a g	0.88 ₁ i	0.15 ₅ i	0.15 ₃ i	0.31 ₁ i	0.15 ₂ i	0.94 ₃ a	0.02 ₅ a	0.08 _o c	0.01 ₂ i	56.5 ₉ g	1.12 ₁ s	—
L ₂	40.6 _a g	0.88 ₁ i	0.14 ₆ c	0.15 ₁ i	0.31 ₀ i	0.14 ₈ i	0.95 ₇ a	0.03 ₈ a	0.08 ₁ c	0.01 ₂ i	56.6 ₈ g	1.13 ₇ i	—
L ₃	40.5 _a g	0.90 ₀ i	0.14 ₆ c	0.15 ₂ c	0.29 ₂ i	0.14 ₅ i	0.93 ₉ a	0.02 ₆ a	0.07 ₈ c	0.01 ₁ i	56.6 ₇ g	1.09 ₂ i	—
L ₄	40.6 ₁ g	0.88 ₈ a	0.14 ₄ c	0.15 ₆ c	0.30 ₀ a	0.14 ₀ a	0.94 ₁ a	0.03 ₀ a	0.08 _o c	0.01 ₀ a	56.7 ₁ g	1.08 ₉ s	—
L ₅	40.6 ₁ g	0.88 ₈ i	0.15 ₃ i	0.15 ₁ i	0.29 ₁ i	0.15 ₁ i	0.93 ₈ a	0.03 ₂ a	0.08 ₁ c	0.00 ₆ i	56.6 ₅ g	1.12 ₃ i	—
L ₆	40.4 ₀ g	0.89 ₀ a	0.14 ₆ c	0.15 ₅ c	0.29 ₁ a	0.15 ₀ a	0.93 ₃ a	0.02 ₂ a	0.08 ₁ c	0.01 ₈ a	56.8 ₀ g	1.12 ₁ s	—
L ₇	40.3 ₀ g	0.87 ₈ i	0.14 ₆ c	0.15 ₅ c	0.30 ₂ i	0.14 ₀ i	0.93 ₁ a	0.02 ₅ a	0.07 ₀ c	0.01 ₂ i	56.7 ₀ g	1.17 ₁ i	—
L ₈	40.4 ₈ g	0.87 ₇ a	0.15 ₂ c	0.15 ₂ c	0.30 ₂ a	0.15 ₀ a	0.95 ₅ a	0.02 ₀ a	0.08 _o c	0.01 ₀ a	57.0 ₀ g	1.13 ₁ i	—
L ₉	40.7 ₇ g	0.89 ₁ a	0.15 ₃ c	0.15 ₀ c	0.29 ₀ a	0.14 ₇ a	0.94 ₉ a	0.02 ₈ a	0.08 ₂ c	0.00 ₀ a	56.7 ₁ g	1.12 ₈ s	—
Average (\bar{x})	40.55 ₁	0.886 ₇	0.149 ₇	0.153 ₁	0.300 ₄	0.149 ₇	0.942 ₃	0.028 ₄	0.080 ₁	0.011 ₈	56.74 ₈	1.123 ₇	55.62 ₄
Standard deviation (Reproducibility) $s_{\bar{x}}$	0.11 ₂	0.006 ₇	0.004 ₂	0.002 ₀	0.007 ₇	0.004 ₂	0.009 ₁	0.004 ₅	0.002 ₁	0.003 ₄	0.13 ₂	0.024 ₄	—
deviation (Reproducibility without laboratories) $s_{1(T)}$ *1	0.04 ₅	0.009 ₂	0.004 ₂	0.003 ₀	0.006 ₂	0.003 ₀	0.007 ₁	0.002 ₃	0.001 ₄	0.002 ₀	0.11 ₅	0.005 ₅	—
Uncertainty C (95%) *2	0.0 ₈	0.00 ₅	0.00 ₃	0.00 ₂	0.00 ₈	0.00 ₃	0.00 ₇	0.00 ₃	0.00 ₂	0.00 ₃	0.1 ₀	0.01 ₉	0.1 ₀ *4

(Note) * 1 $s_{1(T)}$ is intermediate precision without a time condition.* 3 $ZrO_2 = ZrO_2 + HfO_2 - HfO_2$ * 2 The half-width confidence interval C (95%) = $t_{\ell-1,0.05} \times s_{\bar{x}} / \sqrt{\ell}$ (ℓ = number of laboratories)* 4 $s_{\bar{x}_{ZrO_2}} = \sqrt{\left(s_{\bar{x}_{ZrO_2 + HfO_2}}\right)^2 + \left(s_{\bar{x}_{HfO_2}}\right)^2}$

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 Certified Reference Material Series for X-ray Fluorescence Analysis of Refractories
 J R R M 6 1 0 (Zircon-Zirconia Refractory)
 Results of Analyses

Unit : mass%

Constituent	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	CaO	MgO	Na ₂ O	K ₂ O	P ₂ O ₅	Cr ₂ O ₃	ZrO ₂ (+HfO ₂)	HfO ₂	ZrO ₂ *3
Certified value	45.7 ₆	0.45 ₁	0.30 ₆	0.09 ₉	3.07 ₈	0.54 ₈	0.04 ₃	0.01 ₆	0.11 ₃	0.00 ₉	49.7 ₂	0.98 ₇	48.7 ₄
Laboratories													
L ₁	45.6 ₉ g	0.47 ₆ i	0.31 ₃ i	0.09 ₈ i	3.12 ₃ i	0.55 ₂ i	0.04 ₀ a	0.00 ₉ a	0.10 ₅ c	0.01 ₀ i	49.6 ₃ g	0.98 ₂ x	—
L ₂	45.6 ₇ g	0.44 ₈ i	0.30 ₆ c	0.09 ₈ i	3.11 ₂ i	0.53 ₈ i	0.04 ₁ a	0.01 ₆ a	0.11 ₀ c	0.00 ₉ i	49.7 ₀ g	1.01 ₃ i	—
L ₃	45.6 ₈ g	0.44 ₈ i	0.29 ₇ c	0.09 ₈ c	3.05 ₁ i	0.53 ₇ i	0.04 ₆ a	0.01 ₀ a	0.11 ₁ c	0.00 ₉ i	49.5 ₂ g	0.95 ₂ i	—
L ₄	45.7 ₁ g	0.44 ₇ a	0.30 ₆ c	0.10 ₁ c	3.10 ₈ a	0.53 ₀ a	0.04 ₃ a	0.00 ₇ a	0.10 ₈ c	0.00 ₇ a	49.6 ₇ g	0.96 ₁ x	—
L ₅	45.7 ₃ g	0.43 ₂ i	0.31 ₄ i	0.10 ₀ i	3.06 ₀ i	0.56 ₀ i	0.04 ₇ a	0.01 ₂ a	0.11 ₇ c	0.00 ₈ i	49.7 ₁ g	0.98 ₇ i	—
L ₆	45.7 ₀ g	0.46 ₁ u	0.30 ₇ c	0.10 ₀ c	3.09 ₇ a	0.54 ₄ a	0.04 ₂ a	0.01 ₀ a	0.11 ₈ c	0.00 ₈ a	49.7 ₄ g	0.97 ₇ x	—
L ₇	45.6 ₃ g	0.45 ₆ i	0.30 ₇ c	0.09 ₇ c	3.05 ₃ i	0.54 ₅ i	0.04 ₀ a	0.00 ₈ a	0.10 ₈ c	0.01 ₀ i	49.8 ₁ g	1.02 ₇ i	—
L ₈	45.6 ₇ g	0.44 ₂ a	0.31 ₄ c	0.09 ₈ c	3.05 ₈ a	0.55 ₂ a	0.04 ₂ a	0.00 ₈ a	0.11 ₈ c	0.01 ₀ a	49.7 ₄ g	0.99 ₀ i	—
L ₉	45.8 ₃ g	0.44 ₆ a	0.31 ₁ c	0.10 ₀ c	3.03 ₅ a	0.56 ₁ u	0.04 ₂ a	0.00 ₈ a	0.12 ₀ c	0.00 ₈ a	49.9 ₀ g	0.98 ₃ x	—
Average (\bar{x})	45.69 ₈	0.450 ₇	0.307 ₇	0.098 ₇	3.077 ₈	0.547 ₆	0.042 ₅	0.009 ₆	0.113 ₃	0.008 ₈	49.72 ₄	0.986 ₈	48.73 ₇
Standard deviation (Reproducibility) $s_{\bar{x}}$	0.06 ₃	0.012 ₈	0.006 ₁	0.001 ₇	0.032 ₇	0.009 ₂	0.002 ₆	0.002 ₃	0.005 ₈	0.001 ₃	0.13 ₈	0.023 ₈	—
deviation (Reproducibility without laboratories) $s_{I(T)}$ *1	0.06 ₈	0.008 ₂	0.004 ₉	0.001 ₇	0.014 ₃	0.009 ₈	0.002 ₈	0.001 ₄	0.002 ₈	0.001 ₀	0.08 ₇	0.007 ₃	—
Uncertainty C (95%) *2	0.0 ₅	0.01 ₀	0.00 ₅	0.00 ₁	0.02 ₅	0.00 ₇	0.00 ₂	0.00 ₂	0.00 ₅	0.00 ₁	0.1 ₀	0.01 ₈	0.1 ₁ *4

(Note) *1 $s_{I(T)}$ is intermediate precision without a time condition.*2 The half-width confidence interval C (95%) = $t_{\ell-1,0.05} \times s_{\bar{x}} / \sqrt{\ell}$ (ℓ = number of laboratories)*3 $ZrO_2 = ZrO_2(HfO_2) - HfO_2$ *4 $s_{\bar{x}ZrO_2} = \sqrt{\left(s_{\bar{x}ZrO_2(HfO_2)}\right)^2 + \left(s_{\bar{x}HfO_2}\right)^2}$

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