






GRANULITE



## GRANULITE LAB TEST SUMMARY

Granulite 160 grade has been tested by DIFK German Institute for Refractory and Ceramics, accredited testing laboratory, according to DIN EN ISO standards (see the Summary Table below). Complete copies of test reports are available for your review attached.

	PROPERTY	RESULT	TEST
<b>CHEMICAL ANALYSIS XRF</b>			
	SiO <sub>2</sub>	59,54 %	DIN EN ISO 12677
	Al <sub>2</sub> O <sub>3</sub>	35,54 %	DIN EN ISO 12677
	Fe <sub>2</sub> O <sub>3</sub>	1,27 %	DIN EN ISO 12677
	TiO <sub>2</sub>	1,07 %	DIN EN ISO 12677
	CaO	0,68 %	DIN EN ISO 12677
	<b>PHYSICAL PROPERTIES</b>		
	Loss on ignition (1025 °C)	0,15 %	DIN EN ISO 12677
	True density	0,825 g/cm <sup>3</sup>	DIN 66137-2
	Loose bulk density	0,402 Mg/m <sup>3</sup>	DIN EN 1097-3
	Melting Temperature	1748 °C	DIN 51730
	Moisture	0,09 %	INTERNAL TEST METOD
<b>PARTICLE SIZE</b>			
	0-63 µm	5,13 %	DIN 66165 PART 1+2
	63-125 µm	29,19 %	DIN 66165 PART 1+2
	125-250 µm	65,68 %	DIN 66165 PART 1+2
	250-500 µm	0 %	DIN 66165 PART 1+2

### Determination of humidity content

*Date of testing:* August 10, 2017

The results are related to delivered material

<b>Sample</b>	<b>Humidity [wt-%]</b>
<b>Granulite-160</b>	<b>0,09</b>
<b>Granulite-300</b>	<b>0,07</b>



**Chemical analysis of refractory products by XRF**

fused cast bead method  
determined according DIN EN ISO 12677\*

Date of testing: August 10, 2017

The results are normalized to 100 wt.-% and related to ignited material

	<b>Granulite-160</b>	<b>Granulite-300</b>
<b>Al<sub>2</sub>O<sub>3</sub></b>	35,54	36,31
<b>SiO<sub>2</sub></b>	59,54	58,48
<b>Fe<sub>2</sub>O<sub>3</sub></b>	1,27	1,45
<b>TiO<sub>2</sub></b>	1,07	1,11
<b>CaO</b>	0,68	0,72
<b>MgO</b>	0,32	0,42
<b>K<sub>2</sub>O</b>	0,66	0,61
<b>Na<sub>2</sub>O</b>	0,38	0,34
<b>Mn<sub>3</sub>O<sub>4</sub></b>	<0,01	<0,01
<b>Cr<sub>2</sub>O<sub>3</sub></b>	<0,01	<0,01
<b>P<sub>2</sub>O<sub>5</sub></b>	0,31	0,35
<b>ZrO<sub>2</sub></b>	0,03	0,03
<b>SrO</b>	0,05	0,05
<b>BaO</b>	0,15	0,14
<b>change in weight by ignition (1025 °C)</b>	-0,15	-0,12

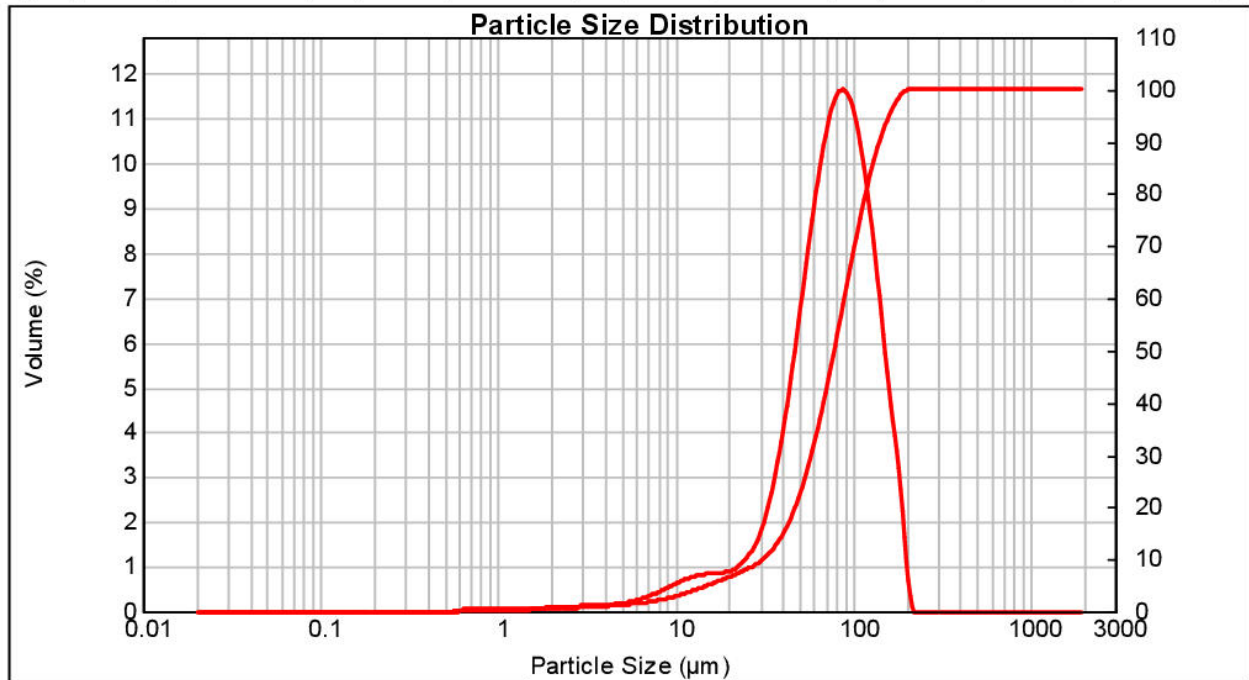
**Determination of particle size distribution**

Date of testing: August 09, 2017

Determination of grain size with Malvern Mastersizer 2000

	<b>Granulite-160</b>
<b>D10 – value [µm]</b>	<b>30,74</b>
<b>D25 – value [µm]</b>	<b>52,60</b>
<b>D50 – value [µm]</b>	<b>78,10</b>
<b>D75 – value [µm]</b>	<b>109,24</b>
<b>D90 – value [µm]</b>	<b>141,13</b>

D(0.10) : 30.74 µm      D(0.25) : 52.60 µm      D(0.50) : 78.10 µm      D(0.75) : 109.24 µm      D(0.90) : 141.13 µm



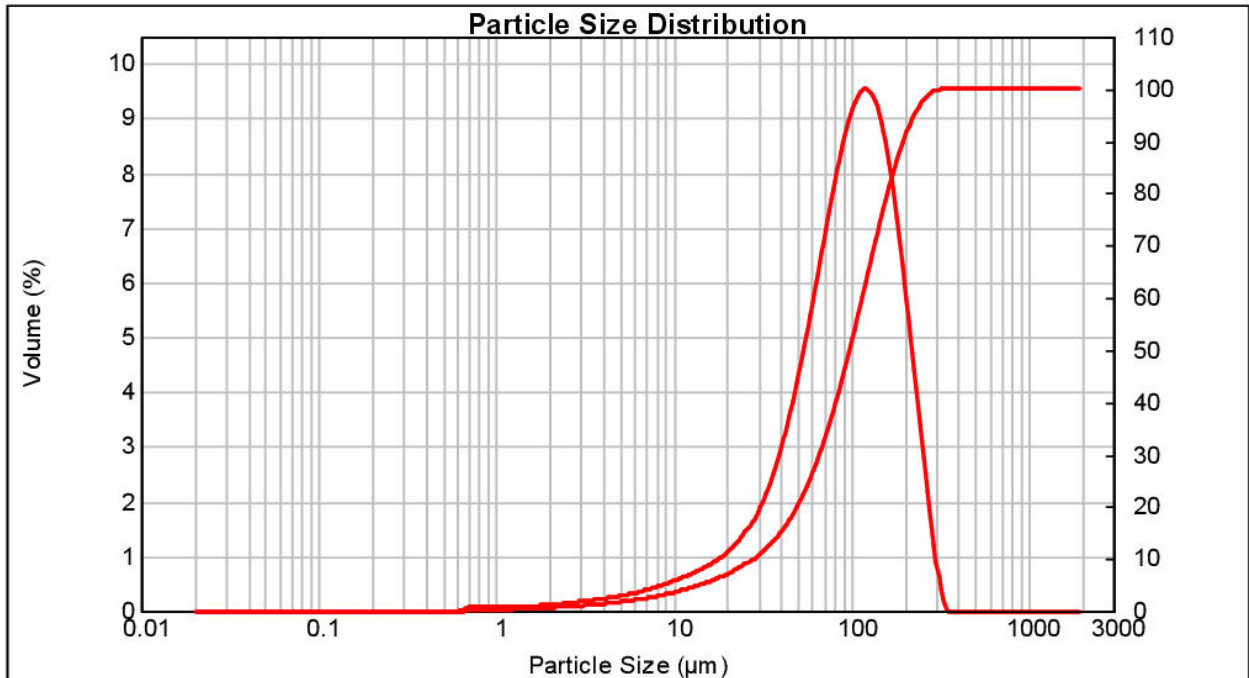
**Determination of particle size distribution**

Date of testing: August 09, 2017

Determination of grain size with Malvern Mastersizer 2000

	<b>Granulite-300</b>
<b>D10 – value [µm]</b>	<b>28,07</b>
<b>D25 – value [µm]</b>	<b>57,86</b>
<b>D50 – value [µm]</b>	<b>97,90</b>
<b>D75 – value [µm]</b>	<b>147,28</b>
<b>D90 – value [µm]</b>	<b>197,83</b>

D(0.10) : 28.07 µm      D(0.25) : 57.86 µm      D(0.50) : 97.90 µm      D(0.75) : 147.28 µm      D(0.90) : 197.83 µm



**Determination of loose bulk density**  
determined according to DIN EN 1097-3

*Date of testing:* August 14, 2017

<b>Sample</b>	<b>Loose bulk density [Mg/m<sup>3</sup>]</b>	<b>Average loose bulk density [Mg/m<sup>3</sup>]</b>
<b>Granulite-160</b>	<b>0,402 0,399 0,403</b>	<b>0,402</b>
<b>Granulite-300</b>	<b>0,404 0,403 0,405</b>	<b>0,404</b>



**Determination of solid state density by Gaspycnometry with Helium gas**  
determined according to DIN 66137-2

Date of testing: until August 15, 2017

True density [g/cm <sup>3</sup> ]				
Sample	Single value 1 [g/cm <sup>3</sup> ]	Single value 2 [g/cm <sup>3</sup> ]	Single value 3 [g/cm <sup>3</sup> ]	<u>Mean value</u> [g/cm <sup>3</sup> ]
<b>Granulite-160</b>	0,827	0,825	0,824	<b><u>0,825</u></b>
<b>Granulite-300</b>	0,837	0,845	0,842	<b><u>0,841</u></b>



**Particle size analysis (dry)**

Determined according to DIN 66165 part 1+2

Date of testing: August 14, 2017

		<b>Granulite-160</b>	<b>Granulite-300</b>
dried sample:	[g]	100,07	100,02
<b>&gt; 0,5 mm</b>	<b>[%]</b>	-	-
<b>0,5 – 0,25 mm</b>	<b>[%]</b>	-	-
<b>0,25 – 0,125 mm</b>	<b>[%]</b>	<b>65,68</b>	<b>82,94</b>
<b>0,125 – 0,063 mm</b>	<b>[%]</b>	<b>29,19</b>	<b>14,68</b>
<b>&lt; 0,063 mm</b>	<b>[%]</b>	<b>5,13</b>	<b>2,38</b>



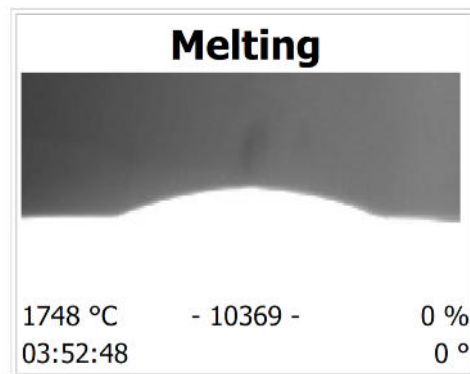
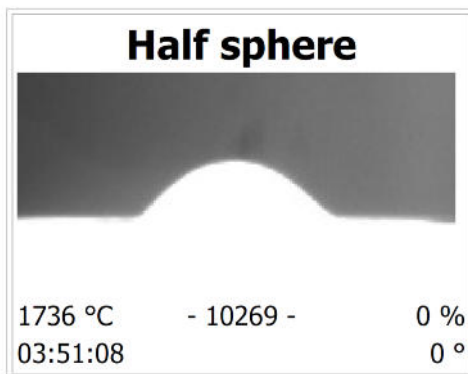
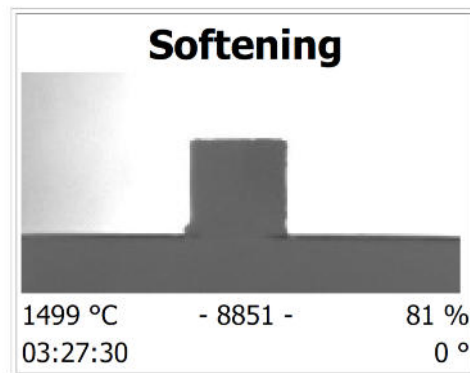
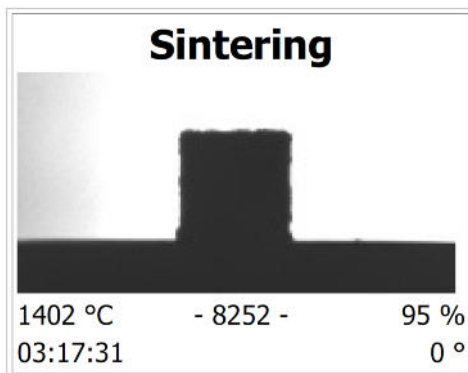


**Hot stage microscopy**  
determined according DIN 51730

Date of testing: August 14, 2017

Code		Granulite-160
A	Softening temperature [°C]	1499
C	Hemisphere temperature [°C]	1736
D	Flow temperature [°C]	1748

Remark: without platinum

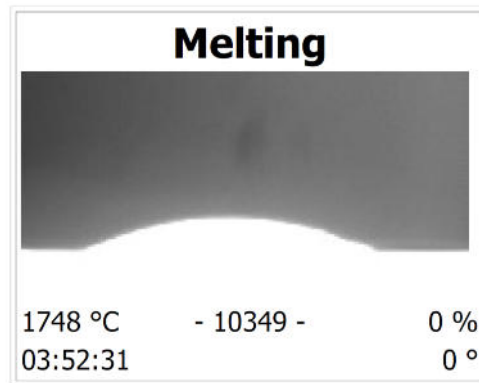
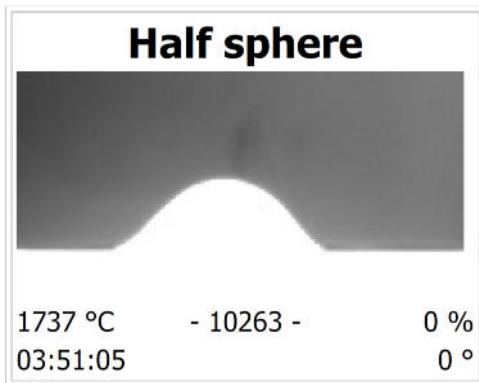
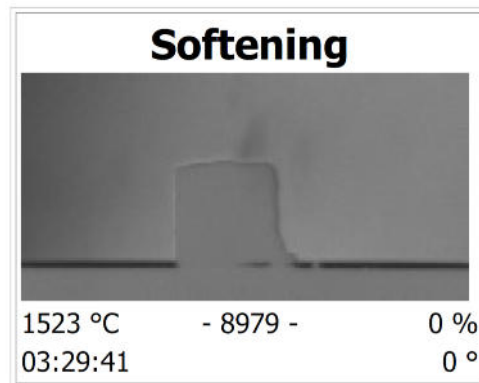
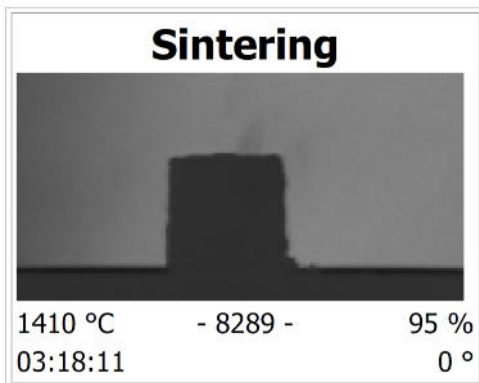


**Hot stage microscopy**  
determined according DIN 51730

Date of testing: August 15, 2017

Code		Granulite-300
A	Softening temperature [°C]	1523
C	Hemisphere temperature [°C]	1737
D	Flow temperature [°C]	1748

Remark: without platinum



### Sinker

internal test method

*Date of testing: August 25, 2017*

#### **Scope**

This test method covers measurement of the relative resistance of granulates to absorption of water

#### **Significance and use**

This test method allows to differ the floating and sinking amount of the granulates

#### **Apparatus**

Graduated separating funnel 1000 ml

800 ml H<sub>2</sub>O

100 g of the sample

#### **Procedure**

Weigh in the 100 g of the sample in the measuring cylinder.

Fill in 800 ml of H<sub>2</sub>O.

Pivot the separating funnel to horizontal, hold it 10 seconds, then decline it 180° in the other direction. Repeat 20 times.

Wait the settling time of 1 hour.

Let the lower phase out by the plug valve, dry the lower phase 24 h by 110°C

Weigh the amount of the dried sediment.

<b>Sample</b>	<b>Total Amount [g]</b>	<b>Sediment [g]</b>	<b>Sediment [%]</b>
<b>Granulite-160</b>	<b>100</b>	<b>4,8</b>	<b>4,8</b>
<b>Granulite-300</b>	<b>100</b>	<b>2,7</b>	<b>2,7</b>