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Россия +7(495)268-04-70
Казахстан +(727)345-47-04
Беларусь +(375)257-127-884
Узбекистан +998(71)205-18-59
Киргизия +996(312)96-26-47

эл.почта: cgc@nt-rt.ru || сайт: https://ceramtec.nt-rt.ru

Standard Specification for Rubalit® ZTA

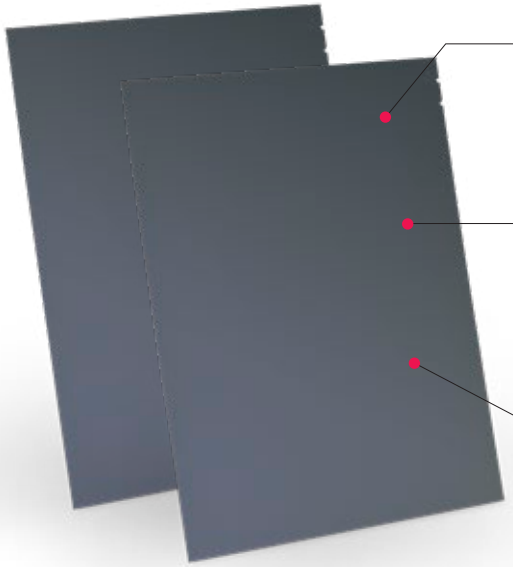
Physical Parameters		Unit	Values	Measurement Method
Composition	Al_2O_3	Wt%	90 +/- 1,2	Measured by XRF at the sintered product
	ZrO_2	Wt%	9 +/- 1,0	
Surface roughness	-	µm	≤ 0,4	Based on DIN EN ISO 4288
Bulk density	-	g/cm³	≥ 3,95	Based on DIN EN 993-1
Bending Strength	Sigma0	MPa	≥ 625	Based on ASTM C1499-08
Young´s Modulus	-	GPa	≥ 310	Based on ASTM C1250-15
Thermal conductivity	RT	W/(m x K)	≥ 26	According to DIN EN 821-2, Standard cp for calculation 0,72 J/gK; Measured thermal conductivity value may vary +/- 10% due to measurement inaccuracy.
Coefficient of thermal expansion	20 - 300 °C	ppm/K	7,1	According to DIN 51045-1, typical value
	20 - 600 °C	ppm/K	8	
	20 - 900 °C	ppm/K	8,6	
Specific heat	20 °C	J/(kg x K)	720	Based on DIN EN 821-3, method B, typical value
Dielectric constant (permittivity)	RT, 1 MHz	-	10,5	Based on ASTM D150, typical value
Dielectric loss factor	RT, 1 MHz	[10^{-3}]	≤ 5	Based on ASTM D150
Volume resistivity	RT	Ωcm	≥ 10^{14}	Based on IEC 62631-3
Breakdown Strength 20 °C	-	kV/mm	≥ 25	Based on DIN EN 60243-1

The measured values mentioned before were determined for test samples and are applicable as standard values. The values were determined on the basis of DIN-/DIN-VDE standards and if these were not available, on the basis of CeramTec standards. The values indicated must not be transferred to arbitrary formats, components or parts featuring different surface qualities. They do not constitute a guarantee for certain properties. We expressly reserve the right to make technical changes.

Silicon Nitrite – Sinalit®

CeramTec's newly developed Silicon Nitrite is the high performance ceramic material with highest bending strength (≥ 700 MPa) and highest fracture toughness (≥ 5-7 MPa*√m) compared to Al_2O_3, ZTA and AlN which leads to extreme robustness for highest power density power electronics with thin Sinalit® substrate (≥ 0.25 mm). Thermal conductivity is also high (80 W/mK). Combined with AMB (Active Metal Brazing) or SMB (Sputter Metal Bonding) metalization Sinalit® is the ideal choice for WBG (Wide Band Gap) Dice, e.g., semiconductors based power modules.

Key advantages



- Highest bending strength ≥ 700 MPa with highest fracture toughness > 6
- Breakdown strength AC: ≥ 25 kV/mm
- Highest robustness for highest power density power electronics

Standard Specification for Sinalit®

Physical Parameters		Unit	Values	Measurement Method
Surface roughness	Ra	µm	< 0.5	Based on DIN EN ISO 4288
Bulk density	-	g/cm³	≥ 3.2	Based on DIN EN 993-1
Bending Strength	Sigma0	MPa	≥ 700	Based on ASTM C1499-08
Young´s Modulus	-	GPa	280	Based on ASTM C1259-15
Thermal conductivity	RT	W/(m x K)	80	According to DIN EN 821-2; measured thermal conductivity value may vary +/- 10% due to measurement inaccuracy.
Coefficient of thermal expansion	100 - 200 °C	ppm/K	2.3	According to DIN 51045-1, typical value
	100 - 300 °C	ppm/K	2.5	
	100 - 600 °C	ppm/K	3.1	
	100 - 800 °C	ppm/K	3.3	
Specific heat	20 °C	J/(kg x K)	≥ 0.6	Based on DIN EN 821-3, method B, typical value
	100 °C	J/(kg x K)	≥ 0.7	
Dielectric constant (permittivity)	RT, 1 MHz	-	8.3	Based on ASTM D150, typical value
Dielectric loss factor	RT, 1 MHz	[10^{-3}]	3	Based on ASTM D150
Volume resistivity	RT	Ωcm	≥ 10^{14}	Based on IEC 62631-3, typical value
Breakdown Strength 20 °C	-	kV/mm	≥ 25	Based on DIN EN 60243-1

The measured values referenced above were determined for test samples and are applicable as standard values. The values were determined on the basis of DIN-/DIN-VDE standards and if these were not available, on the basis of CeramTec standards. The values indicated must not be transferred to arbitrary and/or other formats, components or parts featuring different surface qualities. They do not constitute a guarantee for certain properties. We expressly reserve the right to make technical changes.

Aluminium Nitride – Alunit® AlN HP

CeramTec's newly developed Aluminium Nitride is a much better material that has improved the quality of our Aluminium Nitride with much higher bending strength (≥ 450 MPa) at the same thermal conductivity (170 W/mK) for best heat transmission / heat spread of your power electronics DCB (Direct Copper Bonded) or AMB (Active Metal Brazing) ceramic board.

Key advantages

Higher Bending Strength
≥ 450 MPa

Breakdown strength
AC: ≥ 15 kV/mm

High robustness means equal bending strength as CT Al_2O_3

Standard Specification for Alunit® AlN HP

Physical Parameters		Unit	Values	Measurement Method
Surface roughness	-	µm	≤ 0.4	Based on DIN EN ISO 4288
Bulk density	-	g/cm³	≥ 3.34	Based on DIN EN 993-1
Bending Strength	Sigma0	MPa	≥ 450	Based on ASTM C1499-08
Young´s Modulus	-	GPa	300	Based on ASTM C1250-15, typical value
Thermal conductivity	RT	W/(m x K)	170	According to DIN EN 821-2; Measured thermal conductivity value may vary +/- 10% due to measurement inaccuracy.
Coefficient of thermal expansion	100 - 200 °C	ppm/K	3.7-5.7	According to DIN 51045-1, typical value
	100 - 300 °C	ppm/K	3.7-5.7	
	100 - 600 °C	ppm/K	4.5-5.9	
	100 - 800 °C	ppm/K	4.8-6.2	
Specific heat	20 °C	J/(kg x K)	≥ 0.6	Based on DIN EN 821-3, method B, typical value
	100 °C	J/(kg x K)	≥ 0.7	
Dielectric constant (permittivity)	RT, 1 MHz	-	8.5	Based on ASTM D150, typical value
Dielectric loss factor	RT, 1 MHz	[10^{-3}]	≤ 10	Based on ASTM D150
Volume resistivity	RT	Ωcm	10^{14}	Based on IEC 62631-3, typical value
Breakdown Strength 20 °C	-	kV/mm	≥ 15	Based on DIN EN 60243-1

The measured values mentioned before were determined for test samples and are applicable as standard values. The values were determined on the basis of DIN-/DIN-VDE standards and if these were not available, on the basis of CeramTec standards. The values indicated must not be transferred to arbitrary formats, components or parts featuring different surface qualities. They do not constitute a guarantee for certain properties. We expressly reserve the right to make technical changes.

Material Properties of Rubalit®, Alunit®, Zirkolit® and Sinalit®

Property	Definition Property	Unit	Range	Rubalit® 708 D**	Rubalit® 708S C ***	Rubalit® 708 HP C***	Rubalit® 710F C***	Rubalit® ZTA***	Thomit® 600 D**	Alunit® AlN 170 C***	Alunit® AlN 170 D**	Alunit® AlN HP***	Sinalit® Si_3N_4*** Launch in 2024	Zirkolit® ZrO_2 5Y C***
Al_2O_3 content		[wt-%]	≥	95.8	96.0	96.0	+/– 99.6	90 +/- 1.2	45.0					
Surface roughness R_a	@ as fired surface	[µm]	≤	0.8	0.6	0.6	0.12	0.4	0.9	0.6	1.0	0.4	0.4	0.2
Density		[g/m³]	≥	3.73	3.73	3.73	3.80	3.95		3.26	3.28	3.34	3.2	5.7
Bending strength DR sigma 0	@ double ring method	[MPa]	≥	300	450	450	420	625	130	320	200	450	700	800
Coefficient of thermal expansion (CTE)	@ 100°C – 200°C @ 100°C – 300°C @ 100°C – 600°C @ 100°C – 800°C	[10^{-6}/K] [10^{-6}/K] [10^{-6}/K] [10^{-6}/K]	+/– +/– +/– +/–		6.0 – 8.0 6.0 – 8.0 6.7 – 8.7 7.0 – 9.0	6.0 – 8.0 6.0 – 8.0 6.7 – 8.7 7.0 – 9.0	6.0 – 8.0 6.0 – 8.0 6.7 – 8.7 7.0 – 9.0	6.3 – 8.5 6.4 – 8.6 6.9 – 10.3	5.0 – 7.0 5.0 – 7.0 5.5 – 7.5 5.5 – 7.5	3.7 – 5.7 3.7 – 5.7 4.5 – 5.9 4.8 – 6.2	3.5 – 5.5 4.0 – 6.0 4.5 – 6.5 4.6 – 6.7	3.7 – 5.7 3.7 – 5.7 4.5 – 5.9 4.8 – 6.2	2.3 2.5 3.1 3.3	9 – 12 9 – 12 9 – 12 9 – 12
Dielectric constant (@ Ra ≤ 0.4 µm)	@ 1 GHz @ 2mm thickness @ 10 MHz @ 2mm thickness @ 100 MHz @ 2mm thickness	–/– –/– –/–	+/– +/– +/–	8.3 – 11.3 8.3 – 11.3 8.3 – 11.3	8.3 – 11.3 8.3 – 11.3 8.3 – 11.3	8.3 – 11.3 8.3 – 11.3 8.3 – 11.3	8.5 – 11.5 8.5 – 11.5 8.5 – 11.5	10.5 (@1 Mhz)		7.2 –9.8 7.2 –9.8 7.2 –9.8		8.5 (@1 MHz)	8.3 (@1 MHz)	
Dielectric loss factor (@ Ra ≤ 0.4 µm)	@ 1 GHz @ 2mm thickness @ 10 MHz @ 2mm thickness @ 100 MHz @ 2mm thickness	[10^{-3}] [10^{-3}] [10^{-3}]	≤ ≤ ≤	10 10 10	10 10 10			5 (@1 MHz)		10 10 10		10 (@1 MHz)	3 (@1 MHz)	
Dielectric strength	@ thickness ≤ 1 mm	[kV/mm]	≥		15	15	15	25	15	15		15	25	10
Specific heat capacity	@ 100°C @ 20°C	[J/g*K] [J/g*K]	≥ ≥	0.9 0.7	0.7 0.7	0.8 0.7	0.8 0.7	0.7		0.7 0.6	0.7 0.6	0.7 0.6	0.7 0.6	0.4 0.3
Thermal conductivity*	@ 20°C @ Xe-flash @ sample 16*16 mm² @ material specific thickness ≤ 3.5 mm	[W/m*K]		22.0	22.0	22.0	25.0	26.0	2.0	170	170	170	80	1.5
Volume resistivity	@ 20°C @ 200°C @ 400°C @ 600°C @ 800°C	[Ohm*cm] [Ohm*cm] [Ohm*cm] [Ohm*cm] [Ohm*cm]	≥ ≥ ≥ ≥ ≥	10^{13} 10^{11} 10^{9} 10^{7}	10^{13} 10^{11} 10^{9} 10^{7} 10^{7}	10^{13} 10^{11} 10^{9} 10^{7} 10^{7}	10^{13} 10^{11} 10^{9} 10^{7} 10^{7}	10^{14}		10^{14} 10^{13} 10^{12} 10^{9} 10^{9}	10^{14} 10^{13} 10^{12} 10^{9}	10^{14} 10^{11} 10^{9} 10^{9} 10^{8}	10^{14}	
Chemical composition		–/–		The material main component is Al_2O_3. Remainer mainly consists of MgO, SiO_2 and CaO and traces of other elements.	The material main component is Al_2O_3. Remainer mainly consists of MgO, SiO_2 and CaO and traces of other elements.	The material main component is Al_2O_3. Remainer mainly consists of MgO, SiO_2 and CaO and traces of other elements.	The material main component is Al_2O_3. Remainer mainly consists of MgO and traces of other elements.	The material main components are Al_2O_3 and ZrO_2. Additional component is Y_2O_3. Remainer mainly consists of MgO, SiO_2 and CaO and traces of other elements.	The material main components are Al_2O_3 and SiO_2. Additional components are BaO and traces of other elements.	The material main component is AlN. Additional components are Y_2O_3 and traces of other elements.	The material main component is AlN. Additional components are Y_2O_3 and traces of other elements.	The material main component is AlN. Additional components are Y_2O_3 and traces of other elements.	The material main component is Si_3N_4. Additional components are Y_2O_3, MgO, ZrO_2, and traces of other elements.	The material main component is ZrO_2. Additional components are Y_2O_3 and traces of other elements.

* *typical value based on a measurement precision of +/– 10%*
** *Dry pressed*
*** *Tape casted*

Indexes and parameters for ceramic substances
In order to profile ceramic substances certain parameters are indicated. The crystalline nature of these substances, statistical fluctuations in the composition of the substances and in the factors that impact on the production processes indicate that the figures quoted are typically mean values and hence the substance parameters quoted in this brochure are only standard, recommended or guide values that might differ given dissimilar dimensions and production processes.

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