FOR EXCELLENT SHAPING OF **CHALLENGING PRODUCTS!**

Sembach Technical Ceramics is an international market leader in the field of technical ceramics in mechanical and plant engineering, the automotive industry, energy technology and household appliances as well as measuring and control technology. Sembach technical ceramics are also used to create decorative objects.

Technical ceramics are characterized by properties such as:

- Excellent temperature resistance
- Very good wear and corrosion properties
- High to very high tensile strength
- Exceptional density
- Electrical and thermal insulation
- Shape stability

Benefit from our knowledge

As a family-owned business in its fourth generation we are one of the top international manufacturers of technical ceramics. We guarantee 100 % customized manufacturing. Involve us at an early stage in your construction process and benefit from our experience. We manufacture your prototypes and support you in the development process. This reduces time and limits the impact on your budget.

Please contact us for further information if you would like to know whether your construction can be carried out using technical ceramics.

Sembach GmbH & Co. KG · info@sembach.de · **sembach.com**

Sembach
TECHNICAL CERAMICS

MATERIAL PROPERTIES

DIN EN 60672 for electrotechnical applications

Type	C221	C230	C250	C410	C511	C520	C620	C780	C786	C795	C799
Designation	**High-frequency steatite**	**High-frequency steatite**	**Forsterite***	**Cordierite**	**Porous cordierite ceramics**	**Porous cordierite ceramics**	**Aluminum silicate 65 - 80 %**	**Alumina ceramics 80 - 86 %**	**Alumina ceramics 86 - 95 %**	**Alumina ceramics 95 - 99 %**	**Alumina ceramics > 99 %**
Open porosity [Vol%]	0	10 - 35	0	0.5	20	20	0	0	0	0	0
Density ρ [g/cm^3]	2.7	1.7 - 2.3	2.8	2.1	1.9	1.9	2.8	3.2	3.4	3.5	3.7
Dielectric strength E_d [kV/mm]	20	–[1]	20	10	–[1]	–[1]	15	10	15	15	17
Permittivity factor 48 to 62 Hz ε_r	6	–[1]	7	5	–[1]	–[1]	8	8	9	9	9
Loss factor at 20°C 48 - 62 Hz tanδ [10^{-3}] 1 MHz tanδ [10^{-3}]	 1.5 1.2	 –[1] –[1]	 1.5 0.5	 25 7	 –[1] –[1]	 –[1] –[1]	 –[1] –[1]	 1 1.5	 0.5 1	 0.5 1	 0.2 1
Specific resistance at 20°C ρv [Ωm] at 600°C ρv [Ωm]	 10^{11} 10^{5}	 –[1] –[1]	 10^{11} 10^{5}	 10^{10} 10^{3}	 –[1] 10^{3}	 –[1] 10^{3}	 10^{11} 10^{4}	 10^{12} 10^{5}	 10^{12} 10^{6}	 10^{12} 10^{6}	 10^{12} 10^{6}
Ave. coefficient of thermal expansion at 30 - 1000°C $\alpha_{30\text{-}1000}$ [$10^{-6}K^{-1}$]	7 - 9	8 - 10	10 - 11	2 - 4	4 - 6	2 - 4	5 - 7	6 - 8	6 - 8	6 - 8	7 - 8
Specific heat capacity at 30 - 1000°C $cp_{30\text{-}1000}$ [J/kgK]	800 - 900	800 - 900	800 - 900	800 - 1,200	750 - 850	750 - 900	850 - 1,050	850 - 1,050	850 - 1,050	850 - 1,050	850 - 1,050
Thermal conductivity at 30 - 100°C $\lambda_{30\text{-}100}$ [W/mK]	2 - 3	1.5 - 2	3 - 4	1.2 - 2.5	1.3 - 1.8	1.3 - 1.8	6 - 15	10 - 16	14 - 24	16 - 28	19 - 30
Maximum temperature of use [°C]	1,200	1,000[2]	1,200	1,200	1,200	1,200	1,200	1,200 - 1,400	1,400	1,400 - 1,500	1,400 - 1,700
Resistance to thermal shock [assessed]	good	good	good	very good	very good	very good	good	good	good	good	good
Abrasion resistance [assessed][2]	good	low	good	good	good	good	good	good	very good	excellent	excellent
Corrosion resistance [assessed][2]	good	good	good	good	good	good	good	good	good	very good	excellent
Bending strength σ [MPa]	140	30	140	60	25	30	150	200	220	280	300
Elastic modulus E [GPa]	110	–[1]	–[1]	–[1]	–[1]	40	150	200	250	280	300

DIN EN 12 212 for mechanical applications

Type	ATI	Al_2O_3				ZTA	Mg-PSZ	Y-TZP	Si_3N_4
Designation	**Aluminum titanate**	**Alumina 80 %**	**Alumina 86 %**	**Alumina 95 %**	**Alumina > 99 %**	**Zirconia thoughend Alumina**	**Partially stabilized Zirconia**	**Partially stabilized Zirconia**	**Silicon nitride**
Open porosity [Vol%]	10 - 16	0	0	0	0	0	0	0	0
Density ρ [g/cm^3]	3.0 - 3.7	> 3.2	3.4 - 3.8	3.5 - 3.9	3.7 - 3.97	4.0 - 4.1	5.5	6.0	3.2 - 3.3
Dielectric strength E_d [kV/mm]	–[1]	10	15	15	17	–[1]	–[1]	–[1]	20
Permittivity factor 48 to 62 Hz ε_r	–[1]	9	9	9	9	–[1]	20	20	8 - 12
Loss factor at 20°C 48 - 62 Hz tanδ [10^{-3}] 1 MHz tanδ [10^{-3}]	 –[1] –[1]	 0.5 - 1 1	 0.3 - 0.5 1	 0.2 - 0.5 1	 0.2 - 0.5 1	 –[1] –[1]	 –[1] –[1]	 –[1] –[1]	 2 2
Specific resistance at 20° C ρv [Ωm] at 600m_{sat} C ρv [Ωm]	 10^{14} 10^{9}	 10^{12} - 10^{13} 10^{6}	 10^{12} - 10^{14} 10^{6}	 10^{12} - 10^{15} 10^{6}	 10^{12} - 10^{15} 10^{6}	 10^{14} 10^{6}	 10^{8} - 10^{13} 10^{3} - 10^{6}	 10^{8} - 10^{13} 10^{3} - 10^{6}	 10^{11} - 10^{12} 10^{9}
Ave. coefficient of thermal expansion at 30 - 1000°C $\alpha_{30\text{-}1000}$ [$10^{-6}K^{-1}$]	5	6 - 8	6 - 8	6 - 8	7 - 8	9 - 11	10 - 11	10 - 11	2.5 - 3.5
Specific heat capacity at 30 - 1000°C cp 30-1000 [J/kgK]	800	850 - 1,050	850 - 1,050	850 - 1,050	850 - 1,050	800	400 - 550	400 - 550	700 - 850
Thermal conductivity at 30 - 100°C λ30-100 [W/mK]	1.5 - 3	10 - 16	14 - 24	16 - 28	19 - 30	15	2 - 3	2 - 3	15 - 40
Maximum temperature of use T [°C]	900 - 1,600	1,200 - 1,400	1,400 - 1,500	1,400 - 1,500	1,400 - 1,700	1,500	900	1,200	1,300
Resistance to thermal shock [assessed]	excellent	good	good	good	good	good	good	good	very good
Abrasion resistance [assessed]^2	–[1]	good	good	very good	excellent	excellent	good	good	very good
Corrosion resistance [assessed]^2	very good	good	good	good	very good	good	good	good	good
Bending strength σ [MPa]	15 - 40	> 200	230 - 400	280 - 400	300 - 580	400 - 480	500	1,000	700 - 1,000
Elastic modulus E [GPa]	10 - 30	> 200	220 - 340	220 - 350	300 - 380	380	200	200	290 - 330
Hardness HV [GPa]	-	12 - 15	12 - 15	12 - 20	17 - 23	16 - 17	12 - 20	12 - 20	14 - 16
Critical stress intensity factor K_{1C} [MPa $\sqrt{m}$]	1	3.5 - 4.5	4 - 4.2	4 - 4.2	4 - 5.5	4.4 - 5	> 6	8	5 - 8.5

* No longer included in DIN EN 60 672 1) Usually not specified 2) Depends on application

sembach.de