Ceramics Characteristics

Item			Unit	Material / Testing Method	Oxide Ceramics						Non-Oxide Ceramics					Zero or less Thermal Expansion Ceramics			Machinable Ceramics	Other Normal Materials				
					Al_2O_3					ZrO_2	Si_3N_4		SiC		AlN	ZPF	Adceram®							
					A9951	A9951LD	A9951S	A9991	AHPF /AJPF	AYZ-3	ASN-4	SLPF	SiC	CLPF	AlN	N-Type	D1	D3	Macor®	Quartz	Sapphire	Si	Al (5012)	SUS (304)
Color			-	—	White	White	White	Milky White	White	White	Gray	Gray	Black	Black	Gray Beige	Gray	Light Yellow	White	White	Transparent	Transparent	-	-	-
Bulk Density			$(X10^3)kg/m^3$	Water displacement method	3.9	3.9	3.9	3.9	4.0	6.0	3.2	3.3	3.1	3.2	3.3	2.5	2.6	2.3	2.5	2.2	4	2.3	2.7	8.0
Water Absorption Rate			%	Water displacement method	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-
Mechanical Feature	Hardness	Vickers	GPa	JIS R 1610	18	18	16	18	20	13	14	16	24	24	13	7	4.5	4.5	-	-	23	-	-	2
	Bending Strength	20℃	MPa	JIS R 1601	450	350	220	480	550	1000	720	1000	500	500	350	250	200	150	130	50	700	-	-	300
		1000℃	MPa	JIS R 1601	-	350	-	-	550	-	-	800	-	-	330	-	50	50	-	-	-	-	-	-
		1200℃	MPa	JIS R 1601	300	200	170	300	400	350	400	-	600	600	250	-	-	-	-	-	-	-	-	-
	Fracture Toughness		$MPa\sqrt{m}$	JIS R 1607	4	4	7	4	3	6	5	6	3	3	3	3	-	2	-	-	-	-	-	-
	Young's Module		GPa	JIS R 1602	390	390	370	400	400	200	290	310	410	420	320	150	110	90	67	73	470	170	71	200
	Poisson's Ratio		K	JIS R 1602	0.24	0.24	0.24	0.24	0.24	0.32	0.28	0.24	0.16	0.16	0.29	0.28	0.25	0.25	0.29	0.17	-	-	-	-
Thermal Feature	CTE	23±3℃	$1/K(X10^{-6})$	Laser coefficient of thermal expansion	5.3	-	-	-	-	-	-	1.4	-	2.3	-	0.0	-	-	-	-	-	-	-	-
		25～200℃	$1/K(X10^{-6})$	JIS R 1618	5.4	5.6	5.7	5.3	5.6	7.7	1.7	1.7	2.9	2.8	2.4	-	-	-	-	-	7.2 (//C axle)	-	-	-
		25～500℃	$1/K(X10^{-6})$	JIS R 1618	7.3	7.5	6.9	7.5	7.7	10.0	2.3	2.4	4.6	5.0	4.0	-	4.7 (～400℃)	0.9 (～400℃)	9.3 (～300℃)	0.5	-	-	-	-
		25～1000℃	$1/K(X10^{-6})$	JIS R 1618	8.5	8.5	7.8	8.6	8.6	11.0	2.8	2.8	5.0	5.6	5.2	-	5.4 (～800℃)	1.4 (～800℃)	12.6 (～800℃)	-	-	-	-	17.3
	Thermal Conductivity (20℃)		W/m·K	JIS R 1611	30	30	40	33	35	3	26	20	170	150	160	5	2.6	1.3	1.7	1	42	140	140	17
	Specific Heat		J/kg·K	JIS R 1611	800	800	840	800	800	470	630	650	660	660	740	1000	460	590	790	1050	-	690	-	880
	Thermal Fatigue (△T)		K	Water quenching method	200	200	500	200	200	280	700	800	450	450	400	-	350	700	150	-	-	-	-	-
Corrosion Resistance	Chemical Resistance	Hydrochloric Acid (20%)	μm	Boiling 72hr	-0.3	-1.3	-0.6	-0.3	0.0	0.0	Erosion	Erosion	0.0	0.0	Erosion	-	-	-	0.0	-	-	-	-	-
				Room Temp. 24hr	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.3	0.0	0.0	-0.6	-	-	-	-	-	-	-	-	-
		Sulfuric Acid (20%)	μm	Boiling 72hr	-0.3	-1.3	-0.4	0.0	0.0	0.0	Erosion	Erosion	0.0	0.0	Erosion	-	-	-	-	-	-	-	-	-
				Room Temp. 24hr	0.0	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.9	-	-	-	-	-	-	-	-	-
		Nitric Acid (61%)	μm	Boiling 72hr	0.0	-0.5	-0.4	0.0	0.0	0.0	Erosion	Erosion	0.0	0.0	Erosion	-	-	-	-	-	-	-	-	-
				Room Temp. 24hr	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.6	0.0	0.0	-0.6	-	-	-	-	-	-	-	-	-
		Phosphoric Acid (85%)	μm	Boiling 72hr	Erosion	Erosion	Erosion	-0.3	0.0	-3.2	Erosion	-2.1	0.0	0.0	Erosion	-	-	-	-	-	-	-	-	-
				Room Temp. 24hr	-2.8	0.0	0.0	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	-1.8	-	-	-	-	-	-	-	-	-
		Sodium hydroxide (20%)	μm	Boiling 72hr	0.0	-0.5	0.0	0.0	0.0	0.0	-1.1	0.0	0.0	0.0	Erosion	-	-	-	-	-	-	-	-	-
				Room Temp. 24hr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.5	-	-	-	-	-	-	-	-	-
		HF(47%)	μm	20℃ 72hr	0.0	Erosion	-0.2	0.0	0.0	Erosion	-3.3	-2.4	0.0	0.0	-3.6	-	-	-	-	-	-	-	-	-
Electronic Feature	Insulation Strength		kV/mm	Bias voltage applied LB technique	12	12	-	12	12	＞10	＞10	＞10	-	-	＞15	-	20	20	40	＞10	＞30	-	-	-
	Volume Resistivity (20℃)		Ω·cm	3 probes method	$＞10^{14}$	$＞10^{14}$	$＞10^{14}$	$＞10^{14}$	$＞10^{14}$	10^{12}	$＞10^{14}$	$＞10^{14}$	10^6	10^6	10^{14}	10^{12}	10^{12}	10^{10}	10^{16}	$＞10^{14}$	$＞10^{14}$	-	-	-
	Dielectric constant (25℃)	1MHz	-	Bridge method	10	10	10	10	10	35	8	8	-	-	9	-	7.5	7.5	6	4	11.5 (//C axle)	-	-	-
		3GHz	-	Dielectric resonator method	10	10	10	10	10	40	8	8	-	-	8	-	-	-	-	-	-	-	-	-
	Dielectric Loss (25℃)	1MHz	$X10^{-4}$	Voltammeter method	30	3	4	7	1	20	3	10	-	-	10	-	35	35	5	1	-	-	-	-
		3GHz	$X10^{-4}$	Dielectric resonator method	4	1	4	-	＜1	10	90	10	-	-	130	-	-	-	-	-	＜1	-	-	-
Abrasion performance (Blast abration loss)			μm	30°,5.5kg/cm²,2min.	2.1	2.3	-	1.0	0.8	0.5	-	0.3	1.6	1.3	-	1.2	-	-	-	-	-	-	-	-
Relative Magnetic Permeability			-	-	1.0000	-	-	-	-	-	-	1.0000	1.0002	1.0000	-	1.0000	-	-	-	-	-	-	-	-
Feature					Possible for huge size, Relatively-low cost	Low dielectric constant, Possible for huge size, Relatively-low cost	High fracture toughness, High thermal shock resistance, Low dielectric constant, Possible for huge size,Relatively-low cost	Possible for huge size	Pore free (Dense),Low chemical resistance,Low dielectric constant	High strength, High fracture toughness, Low thermal conductivity, High wear resistance		Pore free High strength		Pore free	High thermal conductivity, High plasma resistance, Suitable for ESC	Zero thermal expansion, High stiffness comparing to glass material, Pore free, Suitable for ESC		Low thermal expansion, High thermal shock resistance	Short lead-time, High machinability, High electric insulation, Low thermal conductivity				
					High strength, High wear resistance, High chemical resistance, High electric insulation						High fracture toughness, Low thermal expansion, High thermal shock resistance, High wear resistance		High hardness, High stiffness, High thermal conductivity, High chemical resistance				High strength comparing to glass material, Low thermal conductivity					