Material Data

Specific parameters of the standard materials

				Soft PZT materials						Hard PZT materials				
			Unit	PIC151	PIC255/ PIC252	PIC155	PIC153	PIC152		PIC181	PIC184	PIC144	PIC241	PIC300
Physical and dielectric properties														
Density		ρ	g/cm³	7.80	7.80	7.75	7.60	7.75		7.85	7.75	7.90	7.80	7.75
Curie temperature		T_c	°C	250	350	340	160	340		330	320	320	270	370
Relative permittivity	in the polarization direction	$\varepsilon^T_{33} / \varepsilon_0$		2500	1800	1600	4500	1350		1200	1200	1300	1750	1030
	⊥ to polarity	$\varepsilon^T_{11} / \varepsilon_0$		1980	1750	1850	3500	1100		1250	1250	1500	1500	960
Dielectric loss factor		tan δ	10^{-3}	20	20	25	30	15		3	3	3	5	3
Electro-mechanical properties														
Coupling factor		k_p		0.62	0.62	0.62	0.62	0.48		0.56	0.55	0.60	0.55	0.47
		k_t		0.53	047	0.48	0.49	0.41		0.46	0.44	0.48	0.45	0.41
		k_{31}		0.38	0.35	0.35	0.33	0.25		0.32	0.30	0.30	0.32	0.27
		k_{33}		0.69	0.69	0.69	0.72	0.58		0.66	0.63	0.66	0.65	0.57
		k_{15}		0.65	0.66	0.65	0.66	0.46		0.63	0.65	0.65	0.63	0.48
Piezoelectric charge coefficient		d_{31}		-210	-180	-165	-295	-90		-120	-99	-105	-140	-85
		d_{33}	10^{-12} C/N	500	400	360	600	240		265	220	225	300	190
		d_{15}		610	550	540	780	235		475	421	419	431	248
Piezoelectric voltage coefficient		g_{31}		-10.1	-11.8	-12.8	-7.9	-8.7		-10.6	-10.7	-10.4	-9.2	-9.3
		g_{33}	10^{-3} Vm/N	21.5	25	27.9	16.4	23.4		23	22.4	23.3	19.9	20.8
		g_{15}		33.9	38.4	46	23.3	23.7		37.2	35.8	33.9	33.3	29.3
Acousto-mechanical properties														
Frequency coefficient (Serial resonance)		N_p		1940	2000	1930	1940	2280		2270	2175	2170	2200	2400
		N_1		1500	1420	1500	1380	1570		1640	1590	1620	1590	1700
		N_3	Hz · m	1360	1370	1340	1345	1530		1560	1560	1540	1550	1700
		N_t		1950	2000	1990	2020	2100		2110	2035	2035	2020	2100
		N_5		830	870	820	890	1130		1000	960	960	980	1050
Elastic compliance coefficient		S_{11}^E		16.4	16	16.1	17.2	13.1		11.8	12.2	12.4	12.6	11.2
		S_{33}^E	10^{-12} m²/N	19.4	19	19.3	20	14.8		13.3	13.7	14.3	14.4	12
Elastic stiffness coefficient		C_{33}^D	10^{10} N/m²	15.7	15.4	15.8	15.5	16.6		17	15.8	16.6	15.5	16.3
Mechanical quality factor		Q_m		100	80	80	50	100		2000	400	1000	500	1400
Temperature stability														
Temperature coefficient of ε^T_{33} (in the range of -20 to +125°C)		TK ε_{33}	10^{-3}/K	4	3	4	15	2		3	4		3	2
Time stability (relative change of the parameter per decade of time in %)														
Relative permittivity		C_ε			-1.0	-2.0					-4.0			
Coupling factor		C_k	%		-1.0	-2.0					-2.0			

Lead-free materials on request.
Modified barium titanate materials on request.
Recommended operating temperature: up to 50 % of Curie temperature.

The following values are valid approximations for all PZT materials from PI Ceramic:

Specific heat capacity:
WK = approx. 350 J kg^{-1} K^{-1}

Specific thermal conductivity:
WL = approx. 1.1 W m^{-1} K^{-1}

Poisson's ratio (lateral contraction):
σ = approx. 0.34

Coefficient of thermal expansion:
α3 = approx. -4 to -6 × 10^{-6} K^{-1}
(in the polarization direction, shorted)
α1 = approx. 4 to 8 × 10^{-6} K^{-1}
(perpendicular to the polarization direction, shorted)

Static compressive strength:
>600 MPa

The data is determined using test pieces with the geometric dimensions laid down in EN 50324-2 standard and are typical values.

All data provided is determined 24 h to 48 h after the time of polarization at an ambient temperature of 23 ±2°C.

A complete coefficient matrix of the individual materials is available on request. If you have any questions about the interpretation of the material characteristics, please contact PI Ceramic.

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