Material Data

SPECIFIC PARAMETERS OF THE STANDARD MATERIALS

			Soft PZT materials					Hard PZT materials					Lead-free materials	
		Unit	PIC151	PIC255	PIC155	PIC153	PIC152	PIC181	PIC141	PIC241	PIC300	PIC110	PIC050[1]	PIC700[2]
Physical and dielectric properties														
Density	ρ	g/cm³	7.80	7.80	7.80	7.60	7.70	7.80	7.80	7.80	7.80	5.50	4.7	5.6
Curie temperature	T_c	°C	250	350	345	160	340	330	295	270	370	150	>500	200[3]
Relative permittivity in the polarization direction	$\varepsilon_{33}^T/\varepsilon_0$		2400	1750	1450	4200	1350	1200	1250	1650	1050	950	60	700
⊥ to polarity	$\varepsilon_{11}^T/\varepsilon_0$		1980	1650	1400			1500	1500	1550	950		85	
Dielectric loss factor	$tan\ \delta$	10^{-3}	20	20	20	30	15	3	5	5	3	15	<1	30
Electromechanical properties														
Coupling factor	k_p		0.62	0.62	0.62	0.62	0.48	0.56	0.55	0.50	0.48	0.30		0.15
	k_t		0.53	0.47	0.48			0.46	0.48	0.46	0.43	0.42		0.40
	k_{31}		0.38	0.35	0.35			0.32	0.31	0.32	0.25	0.18		
	k_{33}		0.69	0.69	0.69		0.58	0.66	0.66	0.64	0.46			
	k_{15}			0.66				0.63	0.67	0.63	0.32			
Piezoelectric charge coefficient	d_{31}		-210	-180	-165			-120	-140	-130	-80	-50		
	d_{33}	10^{-12} C/N	500	400	360	600	300	265	310	290	155	120	40	120
	d_{15}			550				475	475	265	155		80	
Piezoelectric voltage coefficient	g_{31}	10^{-3} Vm/N	-11.5	-11.3	-12.9			-11.2	-13.1	-9.8	-9.5			
	g_{33}		22	25	27	16	25	25	29	21	16	-11.9		
Acousto-mechanical properties														
Frequency coefficients	N_p	Hz · m	1950	2000	1960	1960	2250	2270	2250	2190	2350	3150		
	N_1		1500	1420	1500			1640	1610	1590	1700	2300		
	N_3		1750		1780			2010	1925	1550	1700	2500		
	N_t		1950	2000	1990	1960	1920	2110	2060	2140	2100			
Elastic compliance coefficient	S_{11}^E	10^{-12} m²/N	15.0	16.1	15.6			11.8	12.4	12.6	11.1			
	S_{33}^E		19.0	20.7	19.7			14.2	13.0	14.3	11.8			
Elastic stiffness coefficient	C_{33}^D	10^{10} N/m²	10.0		11.1			16.6	15.8	13.8	16.4			
Mechanical quality factor	Q_m		100	80	80	50	100	2000	1500	1200	1400	250		
Temperature stability														
Temperature coefficient of ε^T_{33} (in the range -20 °C to +125 °C)	$TK\ \varepsilon_{33}$	10^{-3}/K	6	4	6	5	2	3	5		2			
Time stability (relative change of the parameter per decade of time in %)														
Relative permittivity	C_ε	%		-1.0	-2.0				-4.0			-5.0		
Coupling factor	C_K			-1.0	-2.0				-2.0			-8.0		

Recommended operating temperature:
50 % of Curie temperature.
1) Crystalline material
2) Preliminary data,
subject to change
3) Maximum operating 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:
α_3 = approx. -4 to -6 × 10^{-6} K^{-1}
(in the polarization direction, shorted)
α_1 = approx. 4 to 8 × 10^{-6} K^{-1}
(perpendicular to the polarization direction, shorted)

Static compressive strength:
> 600 MPa

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

All data provided was 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 (info@piceramic.de).