

Material Data

SPECIFIC PARAMETERS OF THE STANDARD MATERIALS

			Soft PZT materials					Hard PZT materials					Lead-free materials	
		Unit	PIC151	PIC255/ PIC252 ¹⁾	PIC155	PIC153	PIC152	PIC181	PIC184 ²⁾	PIC144 ²⁾	PIC241	PIC300	PIC110	PIC700 ²⁾
Physical and dielectric properties														
Density	ρ	g/cm ³	7.80	7.80	7.80	7.60	7.70	7.80	7.75	7.95	7.80	7.80	5.50	5.6
Curie temperature	T_c	°C	250	350	345	185	340	330	295	320	270	370	150	200 ³⁾
Relative permittivity	in the polarization direction ⊥ to polarity	$\epsilon_{33}^T/\epsilon_0$	2400	1750	1450	4200	1350	1200	1015	1250	1650	1050	950	700
		$\epsilon_{11}^T/\epsilon_0$	1980	1650	1400			1500	1250	1500	1550	950		
Dielectric loss factor	$\tan \delta$	10 ⁻³	20	20	20	30	15	3	5	4	5	3	15	30
Electromechanical properties														
Coupling factor	k_p		0.62	0.62	0.62	0.62	0.48	0.56	0.55	0.60	0.50	0.48	0.30	0.15
	k_t		0.53	0.47	0.48			0.46	0.44	0.48	0.46	0.43	0.42	0.40
	k_{31}		0.38	0.35	0.35			0.32	0.30	0.30	0.32	0.25	0.18	
	k_{33}		0.69	0.69	0.69		0.58	0.66	0.62	0.66	0.64	0.46		
	k_{15}			0.66				0.63	0.65		0.63	0.32		
Piezoelectric charge coefficient	d_{31}	10 ⁻¹² C/N	-210	-180	-165			-120	-100	-110	-130	-80	-50	
	d_{33}		500	400	360	600	300	265	219	265	290	155	120	120
	d_{15}			550				475	418		265	155		
Piezoelectric voltage coefficient	g_{31}	10 ⁻³ Vm/N	-11.5	-11.3	-12.9			-11.2	-11.1	-10.1	-9.8	-9.5		
	g_{33}		22	25	27	16	25	25	24.4	25	21	16	-11.9	
Acousto-mechanical properties														
Frequency coefficients	N_p	Hz · m	1950	2000	1960	1960	2250	2270	2195	2180	2190	2350	3150	
	N_t		1500	1420	1500			1640	1590	1590	1590	1700	2300	
	N_s		1750		1780			2010	1930		1550	1700	2500	
	N_e		1950	2000	1990	1960	1920	2110	2035	2020	2140	2100		
Elastic compliance coefficient	S_{11}^E	10 ⁻¹² m ² /N	15.0	16.1	15.6			11.8	12.7	12.4	12.6	11.1		
	S_{33}^E		19.0	20.7	19.7			14.2	14.0	15.5	14.3	11.8		
Elastic stiffness coefficient	C_{33}^D	10 ¹⁰ N/m ²	10.0		11.1			16.6	14.8	15.2	13.8	16.4		
Mechanical quality factor	Q_m		100	80	80	50	100	2000	400	1000	400	1400	250	
Temperature stability														
Temperature coefficient of ϵ_{33}^T (in the range -20 °C to +125 °C)	$TK \epsilon_{33}$	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) Material for the Multilayer tape technology. Matrix of coefficients on request
- 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.com).