



# Physical and Piezoelectric Properties of APC Materials

APC Material:	840	841	850	854	855	860	880
Navy Equivalent	Navy I	Hybrid	Navy II	Navy V	Navy VI	Porous	Navy III
<b>Relative Dielectric Constant</b>							
$K^T$	1275	1375	1900	2750	3300	1200	1050
<b>Dielectric Dissipation Factor (Dielectric Loss(%))*</b>							
$\tan \delta$	0.60	0.40	$\leq 2.00$	$\leq 2.00$	$\leq 2.50$	$\leq 2.00$	0.40
<b>Curie Point (°C)**</b>							
$T_c$	325	320	360	250	200	360	310
<b>Electromechanical Coupling Factor</b>							
$k_p$	0.59	0.60	0.63	0.66	0.68	0.50	0.50
$k_{33}$	0.72	0.68	0.72	0.68	0.76	0.45	0.62
$k_{31}$	0.35	0.33	0.36	-	0.40	-	0.30
$k_{15}$	0.70	0.67	0.68	-	0.66	-	0.55
<b>Piezoelectric Voltage Constant (<math>10^{-3}</math> Vm/N or <math>10^{-3}</math> m<sup>2</sup>/C)</b>							
$g_{33}$	26.5	25.5	24.8	25.5	21.0	38.0	25.0
$-g_{31}$	11.0	10.5	12.4	-	9.0	-	10.0
$g_{15}$	38.0	35.0	36.0	-	27.0	-	28.0
<b>Young's Modulus (<math>10^{10}</math> N/m<sup>2</sup>)</b>							
$Y_{11}^E$	8.0	7.6	6.3	6.0	5.9	-	9.0
$Y_{33}^E$	6.8	6.3	5.4	5.2	5.1	-	7.2
<b>Frequency Constants (Hz*m or m/s)</b>							
$N_L$ (longitudinal)	1524	1700	1500	-	1390	-	1725
$N_T$ (thickness)	2005	2005	2040	2000	2079	1390	2110
$N_p$ (planar)	2130	2055	1980	1972	1920	1900	2120
<b>Density (g/cm<sup>3</sup>)</b>							
$\rho$	7.6	7.6	7.6	7.6	7.6	6.6	7.6
<b>Mechanical Quality Factor</b>							
$Q_m$	500	1400	80	70	65	50	1000
<b>Acoustic Impedance (Mrayl)</b>							
$Z_a$	-	-	31.5	-	-	16.5	-

The values listed above pertain to test specimens. They are for reference purposes only and cannot be applied unconditionally to other shapes and dimensions. In practice, piezoelectric materials show varying values depending on their thickness, actual shape, surface finish, shaping processes and post-processing.

Note: measurements made 24 hours after polarization.  
 Maximum voltage: 5-7 VAC /mil for 850, 851, 855, Type VI VDC ~2X.  
 9-11 VAC /mil for 840, 841, 842, 844, 880, 881 VDC ~2X.

\*At 1 kHz, low field.

\*\*Maximum operating temperature = Curie point/2.

Standard Tolerances  
 (Tighter tolerances available on request)

- Capacitance:  $\pm 20\%$

-  $d_{33}$  Value:  $\pm 20\%$

- Frequency:  $\pm 5\%$  (to  $\pm 0.5\%$  on request)

## Physical and Piezoelectric Properties of APCI Materials

Material:	842	844	851	881	Type I	Type II	Type III
Equivalent Material	Type I		Type II	Type III	Type I	Type II	Type III
<b>Relative Dielectric Constant</b>							
$K^T$	1375	1500	1950	1030	1300	1800	1000
<b>Dielectric Dissipation Factor (Dielectric Loss (%))*</b>							
$\tan \delta$	0.45	0.4	1.5	0.4	1.0	2.0	1.0
<b>Curie Point (<math>^{\circ}\text{C}</math>)**</b>							
$T_c$	325	320	360	310	320	300	300
<b>Electromechanical Coupling Factor (%)</b>							
$k_p$	0.65	0.68	0.71	0.58	0.60	.65	.55
$k_t$	0.48	0.48	0.51	0.46	0.40	.40	.40
<b>Piezoelectric Charge Constant (<math>10^{-12}</math> C/N or <math>10^{-12}</math> m/V)</b>							
$d_{33}$	300	300	400	260	275	375	200
<b>Piezoelectric Voltage Constant (<math>10^{-3}</math> Vm/N or <math>10^{-3}</math> m<sup>2</sup>/C)</b>							
$g_{33}$	26.3	24.5	24.8	26.7	26	25	26
<b>Young's Modulus (<math>10^{10}</math> N/m<sup>2</sup>)</b>							
$Y_{11}^E$	8	7.6	6.3	9	8	6	9
$Y_{33}^E$	6.8	6.3	5.4	7.2	7	5	7
<b>Frequency Constants (Hz*m or m/s)</b>							
$N_T$ (thickness)	2050	2050	2040	2050	2050	2000	2100
$N_P$ (planar)	2230	2250	2080	2300	2200	2000	2200
<b>Density (g/cm<sup>3</sup>)</b>							
$\rho$	7.6	7.7	7.6	7.6	7.6	7.6	7.6
<b>Mechanical Quality Factor</b>							
$Q_m$	600	1500	80	1000	600	80	1000

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