

## Appendix A

### List of Abbreviations

ECF	Electromechanical coupling factor
EFM	Effective field method
FC	Ferroelectric ceramic
FEM	Finite element method
KNN-T	$(\text{K}_{0.562}\text{Na}_{0.438})(\text{Nb}_{0.768}\text{Ta}_{0.232})\text{O}_3$
KNN-TL	$[\text{Li}_x(\text{K}_{0.501}\text{Na}_{0.499})_{1-x}](\text{Nb}_{0.660}\text{Ta}_{0.340})\text{O}_3$
KNNTL:Mn,	$[\text{Li}_x(\text{K}_{1-y}\text{Na}_y)_{1-x}](\text{Nb}_{1-z}\text{Ta}_z)\text{O}_3:\text{Mn}$ (see Table 1.2)
LBO	$\text{Li}_2\text{B}_4\text{O}_7$
NBT-xBT	$(1-x)(\text{Na}_{0.5}\text{Bi}_{0.5})\text{TiO}_3 - x\text{BaTiO}_3$
PCR	Piezoelectric ceramic from Rostov-on-Don (Russia)
xPIN-yPMN-(1-x-y)PT	$x\text{Pb}(\text{In}_{1/2}\text{Nb}_{1/2})\text{O}_3 - y\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3 - (1-x-y)\text{PbTiO}_3$
PMN-xPT	$(1-x)\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3 - x\text{PbTiO}_3$
PS	Piezoelectric sensitivity
PZN-yPT	$(1-x)\text{Pb}(\text{Zn}_{1/3}\text{Nb}_{2/3})\text{O}_3 - x\text{PbTiO}_3$
PZT	Piezoelectric ceramic of the $\text{Pb}(\text{Zr}, \text{Ti})\text{O}_3$ type
SC	Single crystal
ZTS	Piezoelectric ceramic of the $\text{Pb}(\text{Zr}, \text{Ti})\text{O}_3$ type (Russia)

## Appendix B

# Electromechanical Constants of Components

To analyse the piezoelectric performance, effective properties and related parameters of composites, we use full sets of electromechanical constants of components. A systematisation of data on the components is given in Table B.1.

**Table B.1** Room-temperature electromechanical constants of components

Component	Composition	Set of constants	Table number
SC	BaTiO <sub>3</sub> <sup>a</sup>	$s_{ab}^E, d_{ij}$ and $\varepsilon_{pp}^\sigma$	1.1
	KNN-T <sup>b</sup>	$s_{ab}^E, d_{ij}$ and $\varepsilon_{pp}^\sigma$	1.2
	KNN-TL <sup>b</sup>	$s_{ab}^E, d_{ij}$ and $\varepsilon_{pp}^\sigma$	1.2
	KNNTL:Mn <sup>b</sup>	$s_{ab}^E, d_{ij}$ and $\varepsilon_{pp}^\sigma$	1.2
	PMN-0.33PT <sup>b</sup>	$s_{ab}^E, d_{ij}$ and $\varepsilon_{pp}^\sigma$	1.3
	PMN-0.33PT <sup>c</sup>	$s_{ab}^E, d_{ij}$ and $\varepsilon_{pp}^\sigma$	2.3
	PMN-0.30PT <sup>b</sup>	$s_{ab}^E, d_{ij}$ and $\varepsilon_{pp}^\sigma$	1.3
	PMN-0.29PT <sup>d</sup>	$s_{ab}^E, d_{ij}$ and $\varepsilon_{pp}^\sigma$	1.4
	PMN-0.28PT <sup>b</sup>	$s_{ab}^E, d_{ij}$ and $\varepsilon_{pp}^\sigma$	1.3
	PMN-0.28PT <sup>d</sup>	$s_{ab}^E, d_{ij}$ and $\varepsilon_{pp}^\sigma$	1.4

(continued)

**Table B.1** (continued)

Component	Composition	Set of constants	Table number
	PMN-0.28PT <sup>c</sup>	$s_{ab}^E$ , $d_{ij}$ and $\epsilon_{pp}^\sigma$	2.3
	PZN-0.09PT <sup>d</sup>	$s_{ab}^E$ , $d_{ij}$ and $\epsilon_{pp}^\sigma$	1.4
	PZN-0.08PT <sup>b</sup>	$s_{ab}^E$ , $d_{ij}$ and $\epsilon_{pp}^\sigma$	1.3
	PZN-0.07PT <sup>b</sup>	$s_{ab}^E$ , $d_{ij}$ and $\epsilon_{pp}^\sigma$	1.3
	PZN-0.07PT <sup>d</sup>	$s_{ab}^E$ , $d_{ij}$ and $\epsilon_{pp}^\sigma$	1.4
	PZN-0.045PT <sup>b</sup>	$s_{ab}^E$ , $d_{ij}$ and $\epsilon_{pp}^\sigma$	1.3
	0.26PIN- 0.42PMN- 0.32PT:Mn <sup>b</sup>	$s_{ab}^E$ , $d_{ij}$ and $\epsilon_{pp}^\sigma$	1.3
	0.26PIN- 0.42PMN- 0.32PT:Mn <sup>d</sup>	$s_{ab}^E$ , $d_{ij}$ and $\epsilon_{pp}^\sigma$	1.4
	0.27PIN- 0.40PMN- 0.33PT <sup>b</sup>	$s_{ab}^E$ , $d_{ij}$ and $\epsilon_{pp}^\sigma$	1.3
	NBT-0.05BT <sup>b</sup>	$s_{ab}^E$ , $d_{ij}$ and $\epsilon_{pp}^\sigma$	1.3
	LBO <sup>c</sup>	$c_{ab}^E$ , $e_{ij}^z$ and $\epsilon_{pp}^z$	3.1
FC <sup>f</sup>	Compositions with perovskite-type structure (BaTiO <sub>3</sub> , PZT, PCR, ZTS, modified PbTiO <sub>3</sub> , etc.)	$s_{ab}^E$ , $d_{ij}$ and $\epsilon_{pp}^\sigma$	1.5
	Compositions with perovskite-type structure (BaTiO <sub>3</sub> , PZT, PCR, ZTS, modified PbTiO <sub>3</sub> , etc.)	$e_{ij}$ , $g_{ij}$ and $h_{ij}$	1.6
	(Pb <sub>1-x</sub> Ca <sub>x</sub> )TiO <sub>3</sub> <sup>h</sup>	$c_{ab}^E$ , $e_{ij}^z$ and $\epsilon_{pp}^z$	3.5

(continued)

**Table B.1** (continued)

Component	Composition	Set of constants	Table number
Polymer	Araldite <sup>h</sup>	$s_{ab}$ and $\epsilon_{pp}$	2.1
	Polyurethane <sup>h</sup>	$s_{ab}$ and $\epsilon_{pp}$	2.1
	Elastomer <sup>h</sup>	$s_{ab}$ and $\epsilon_{pp}$	2.1
	PE (monolithic) <sup>h</sup>	$s_{ab}$ and $\epsilon_{pp}$	2.1
	Auxetic PE <sup>h</sup>	$s_{ab}$ and $\epsilon_{pp}$	2.1
	PVDF <sup>i</sup>	$s_{ab}^E$ , $d_{ij}^E$ and $\epsilon_{pp}^\sigma$	3.7

<sup>a</sup>Polydomain SC,  $mm2$  symmetry, calculated electromechanical constants

<sup>b</sup>Domain-engineered [001]-poled SC,  $4mm$  symmetry

<sup>c</sup>Single-domain [111]-poled SC,  $3m$  symmetry

<sup>d</sup>Domain-engineered [011]-poled SC,  $mm2$  symmetry

<sup>e</sup>Piezoelectric SC,  $4mm$  symmetry

<sup>f</sup>Poled FC,  $\infty mm$  symmetry

<sup>g</sup>Calculated electromechanical constants

<sup>h</sup>Piezo-passive polymer, isotropic medium

<sup>i</sup>Poled ferroelectric polymer,  $\infty mm$  symmetry

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