

1.5. MAGNETIC PROPERTIES

Table 1.5.7.1. The forms of the matrix characterizing the piezomagnetic effect

Magnetic crystal class		Matrix representation $\Lambda_{i\alpha}$ of the piezomagnetic tensor
Schoenflies	Hermann–Mauguin	
C_1 C_i	1 $\bar{1}$	$\begin{bmatrix} \Lambda_{11} & \Lambda_{12} & \Lambda_{13} & \Lambda_{14} & \Lambda_{15} & \Lambda_{16} \\ \Lambda_{21} & \Lambda_{22} & \Lambda_{23} & \Lambda_{24} & \Lambda_{25} & \Lambda_{26} \\ \Lambda_{31} & \Lambda_{32} & \Lambda_{33} & \Lambda_{34} & \Lambda_{35} & \Lambda_{36} \end{bmatrix}$
C_2 C_s C_{2h}	2 (= 121) m (= 1m1) $2/m$ (= 12/m1) (unique axis y)	$\begin{bmatrix} 0 & 0 & 0 & \Lambda_{14} & 0 & \Lambda_{16} \\ \Lambda_{21} & \Lambda_{22} & \Lambda_{23} & 0 & \Lambda_{25} & 0 \\ 0 & 0 & 0 & \Lambda_{34} & 0 & \Lambda_{36} \end{bmatrix}$
$C_2(C_1)$ $C_3(C_1)$ $C_{2h}(C_i)$	$2'$ (= 12'1) m' (= 1m'1) $2'/m'$ (= 12'/m'1) (unique axis y)	$\begin{bmatrix} \Lambda_{11} & \Lambda_{12} & \Lambda_{13} & 0 & \Lambda_{15} & 0 \\ 0 & 0 & 0 & \Lambda_{24} & 0 & \Lambda_{26} \\ \Lambda_{31} & \Lambda_{32} & \Lambda_{33} & 0 & \Lambda_{35} & 0 \end{bmatrix}$
D_2 C_{2v} D_{2h}	222 $mm2$ [2mm, m2m] mmm	$\begin{bmatrix} 0 & 0 & 0 & \Lambda_{14} & 0 & 0 \\ 0 & 0 & 0 & 0 & \Lambda_{25} & 0 \\ 0 & 0 & 0 & 0 & 0 & \Lambda_{36} \end{bmatrix}$
$D_2(C_2)$ $C_{2v}(C_2)$ $C_{2v}(C_i)$ $D_{2h}(C_{2h})$	$2'2'$ $m'm'2$ $m'2'm$ [2'm'm] $m'm'm$	$\begin{bmatrix} 0 & 0 & 0 & 0 & \Lambda_{15} & 0 \\ 0 & 0 & 0 & \Lambda_{24} & 0 & 0 \\ \Lambda_{31} & \Lambda_{32} & \Lambda_{33} & 0 & 0 & 0 \end{bmatrix}$
C_4, C_6 S_4, C_{3h} C_{4h}, C_{6h}	4, 6 4, 6 $4/m, 6/m$	$\begin{bmatrix} 0 & 0 & 0 & \Lambda_{14} & \Lambda_{15} & 0 \\ 0 & 0 & 0 & \Lambda_{15} & -\Lambda_{14} & 0 \\ \Lambda_{31} & \Lambda_{31} & \Lambda_{33} & 0 & 0 & 0 \end{bmatrix}$
$C_4(C_2)$ $S_4(C_2)$ $C_{4h}(C_{2h})$	$4'$ $4'$ $4'/m$	$\begin{bmatrix} 0 & 0 & 0 & \Lambda_{14} & \Lambda_{15} & 0 \\ 0 & 0 & 0 & -\Lambda_{15} & \Lambda_{14} & 0 \\ \Lambda_{31} & -\Lambda_{31} & 0 & 0 & 0 & \Lambda_{36} \end{bmatrix}$
D_4, D_6 C_{4v}, C_{6v} D_{2d}, D_{3h} D_{4h}, D_{6h}	422, 622 $4mm, 6mm$ $42m$ [4m2], $\bar{6}m2$ [$\bar{6}2m$] $4/mmm, 6/mmm$	$\begin{bmatrix} 0 & 0 & 0 & \Lambda_{14} & 0 & 0 \\ 0 & 0 & 0 & 0 & -\Lambda_{14} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$
$D_4(C_4), D_6(C_6)$ $C_{4v}(C_4), C_{6v}(C_6)$ $D_{2d}(S_4), D_{3h}(C_{3h})$ $D_{4h}(C_{4h}), D_{6h}(C_{6h})$	$42'2'$, $62'2'$ $4m'm', 6m'm'$ $\bar{4}2'm'$ [$\bar{4}m'2'$], $\bar{6}m'2'$ [$\bar{6}2'm'$] $4/mm'm', 6/mm'm'$	$\begin{bmatrix} 0 & 0 & 0 & 0 & \Lambda_{15} & 0 \\ 0 & 0 & 0 & \Lambda_{15} & 0 & 0 \\ \Lambda_{31} & \Lambda_{31} & \Lambda_{33} & 0 & 0 & 0 \end{bmatrix}$
$D_4(D_2)$ $C_{4v}(C_{2v})$ $D_{2d}(D_2), D_{2d}(C_{2v})$ $D_{4h}(D_{2h})$	$4'22'$ $4'mm'$ $4'2m', \bar{4}'m2'$ $4'/mmm'$	$\begin{bmatrix} 0 & 0 & 0 & \Lambda_{14} & 0 & 0 \\ 0 & 0 & 0 & 0 & \Lambda_{14} & 0 \\ 0 & 0 & 0 & 0 & 0 & \Lambda_{36} \end{bmatrix}$
C_3 S_6	3 $\bar{3}$	$\begin{bmatrix} \Lambda_{11} & -\Lambda_{11} & 0 & \Lambda_{14} & \Lambda_{15} & -2\Lambda_{22} \\ -\Lambda_{22} & \Lambda_{22} & 0 & \Lambda_{15} & -\Lambda_{14} & -2\Lambda_{11} \\ \Lambda_{31} & \Lambda_{31} & \Lambda_{33} & 0 & 0 & 0 \end{bmatrix}$
D_3 C_{3v} D_{3d}	32 (= 321) $3m$ (= 3m1) $\bar{3}m$ (= $\bar{3}m1$)	$\begin{bmatrix} \Lambda_{11} & -\Lambda_{11} & 0 & \Lambda_{14} & 0 & 0 \\ 0 & 0 & 0 & 0 & -\Lambda_{14} & -2\Lambda_{11} \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$
$D_3(C_3)$ $C_{3v}(C_3)$ $D_{3d}(S_6)$	$32'$ (= 32'1) $3m'$ (= 3m'1) $\bar{3}m'$ (= $\bar{3}m'1$)	$\begin{bmatrix} 0 & 0 & 0 & 0 & \Lambda_{15} & -2\Lambda_{22} \\ -\Lambda_{22} & \Lambda_{22} & 0 & \Lambda_{15} & 0 & 0 \\ \Lambda_{31} & \Lambda_{31} & \Lambda_{33} & 0 & 0 & 0 \end{bmatrix}$
$C_6(C_3)$ $C_{3h}(C_3)$ $C_{6h}(S_6)$	$6'$ $\bar{6}'$ $6'/m'$	$\begin{bmatrix} \Lambda_{11} & -\Lambda_{11} & 0 & 0 & 0 & -2\Lambda_{22} \\ -\Lambda_{22} & \Lambda_{22} & 0 & 0 & 0 & -2\Lambda_{11} \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$
$D_6(D_3)$ $C_{6v}(C_{3v})$ $D_{3h}(D_3), D_{3h}(C_{3v})$ $D_{6h}(D_{3d})$	$6'22'$ $6'mm'$ $\bar{6}'2m', \bar{6}'m2'$ $6'/m'mm'$	$\begin{bmatrix} \Lambda_{11} & -\Lambda_{11} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -2\Lambda_{11} \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$
T, T_h $O(T)$ $T_d(T)$ $O_h(T_h)$	23, $m\bar{3}$ $4'32'$ $\bar{4}'3m'$ $m\bar{3}m'$	$\begin{bmatrix} 0 & 0 & 0 & \Lambda_{14} & 0 & 0 \\ 0 & 0 & 0 & 0 & \Lambda_{14} & 0 \\ 0 & 0 & 0 & 0 & 0 & \Lambda_{14} \end{bmatrix}$