

MPG No. 10.3.34 $\bar{4}'$ [Type III, tetragonal] [M tensor]

* Rank 0 tensor.

$$[M]$$

$$M = M_s^{(1)}$$

* Rank 1 tensor. * Rank 2 tensor (s).

$$\begin{bmatrix} M_{xx} & 0 & 0 \\ 0 & M_{xx} & 0 \\ 0 & 0 & M_{zz} \end{bmatrix}$$

$$M_{xx} = -M_{du}^{(1)} + M_s^{(1)}$$

$$M_{zz} = 2M_{du}^{(1)} + M_s^{(1)}$$

* Rank 2 tensor (a).

$$\begin{bmatrix} 0 & M_{xy} & 0 \\ -M_{xy} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$M_{xy} = T_{pz}^{(1)}$$

* Rank 3 tensor (s).

$$\begin{bmatrix} 0 & 0 & M_{xxz} \\ 0 & 0 & -M_{xxz} \\ 0 & 0 & 0 \\ M_{yza} & M_{zya} & 0 \\ -M_{zya} & M_{yza} & 0 \\ 0 & 0 & M_{xyz} \end{bmatrix}$$

$$M_{xxz} = M_{fbz}^{(1)} - 2T_{dxy}^{(1)}$$

$$M_{yza} = M_{f3}^{(1)} - T_{dv}^{(1)}$$

$$M_{zya} = -M_{fbz}^{(1)} - T_{dxy}^{(1)}$$

$$M_{xyz} = M_{f3}^{(1)} + 2T_{dv}^{(1)}$$

* Rank 3 tensor (a).

$$\begin{bmatrix} M_{yza} & M_{zya} & 0 \\ M_{zya} & -M_{yza} & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$M_{yza} = T_{dv}^{(2)}$$

$$M_{zya} = T_{dxy}^{(2)}$$

* Rank 4 tensor (sss).

$$\begin{bmatrix} M_{xxxx} & M_{xxyy} & M_{xxzz} & 0 & 0 & M_{xxyy} \\ M_{xxyy} & M_{xxxx} & M_{xxzz} & 0 & 0 & -M_{xxxx} \\ M_{xxzz} & M_{xxzz} & M_{zzzz} & 0 & 0 & 0 \\ 0 & 0 & 0 & M_{yzyz} & 0 & 0 \\ 0 & 0 & 0 & 0 & M_{yzyz} & 0 \\ M_{xxyy} & -M_{xxxx} & 0 & 0 & 0 & M_{xyxy} \end{bmatrix}$$

$$M_{xxxx} = -2M_{du}^{(1)} - 4M_{du}^{(2)} - M_{gu}^{(1)} + 2M_g^{(1)} + M_s^{(1)} + 2M_s^{(2)}$$

$$M_{xxyy} = -2M_{du}^{(1)} + 2M_{gu}^{(1)} - M_g^{(1)} + M_s^{(1)}$$

$$M_{xxzz} = M_{du}^{(1)} - M_{gu}^{(1)} - M_g^{(1)} + M_s^{(1)}$$

$$M_{xxxz} = M_{gu}^{(1)}$$

$$M_{zzzz} = 4M_{du}^{(1)} + 8M_{du}^{(2)} + 2M_{gu}^{(1)} + 2M_g^{(1)} + M_s^{(1)} + 2M_s^{(2)}$$

$$M_{yzyz} = M_{du}^{(2)} - M_{gu}^{(1)} - M_g^{(1)} + M_s^{(2)}$$

$$M_{xyxy} = -2M_{du}^{(2)} + 2M_{gu}^{(1)} - M_g^{(1)} + M_s^{(2)}$$

* Rank 4 tensor (ssa).

$$\begin{bmatrix} 0 & 0 & M_{xxzz} & 0 & 0 & M_{xxxz} \\ 0 & 0 & M_{xxzz} & 0 & 0 & -M_{xxxz} \\ -M_{xxzz} & -M_{xxzz} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & M_{yzzx} & 0 \\ 0 & 0 & 0 & -M_{yzzx} & 0 & 0 \\ -M_{xxxz} & M_{xxxz} & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$M_{xxzz} = 3M_{du}^{(3)}$$

$$M_{xxxz} = -2T_{faz}^{(1)} + 2T_{pz}^{(1)}$$

$$M_{yzzx} = -4T_{faz}^{(1)} - T_{pz}^{(1)}$$

* Rank 4 tensor (aas).

$$\begin{bmatrix} M_{yzyz} & 0 & 0 \\ 0 & M_{yzyz} & 0 \\ 0 & 0 & M_{xyxy} \end{bmatrix}$$

$$M_{yzyz} = -2M_{du}^{(4)} + M_s^{(3)}$$

$$M_{xyxy} = 4M_{du}^{(4)} + M_s^{(3)}$$

* Rank 4 tensor (aaa).

$$\begin{bmatrix} 0 & M_{yzzx} & 0 \\ -M_{yzzx} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$M_{yzzx} = -T_{pz}^{(2)}$$

* Rank 4 tensor (sa).

$$\begin{bmatrix} 0 & 0 & M_{xxxz} \\ 0 & 0 & M_{xxxz} \\ 0 & 0 & M_{zzxy} \\ M_{yzyz} & M_{yzzx} & 0 \\ M_{yzzx} & -M_{yzyz} & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$M_{xxxz} = -T_{faz}^{(2)} + T_{pz}^{(3)}$$

$$M_{zzxy} = 2T_{faz}^{(2)} + T_{pz}^{(3)} + 2T_{pz}^{(4)}$$

$$M_{yzyz} = -3M_{du}^{(5)}$$

$$M_{yzzx} = -T_{faz}^{(2)} + T_{pz}^{(4)}$$

* Rank 4 tensor (as).

$$\begin{bmatrix} 0 & 0 & 0 & M_{yzyz} & M_{yzzx} & 0 \\ 0 & 0 & 0 & M_{yzzx} & -M_{yzyz} & 0 \\ M_{xyxx} & M_{xyxx} & M_{xyzz} & 0 & 0 & 0 \end{bmatrix}$$

$$\begin{aligned}
M_{yzyz} &= -3M_{du}^{(6)} \\
M_{yzzx} &= -T_{faz}^{(3)} + T_{pz}^{(6)} \\
M_{xyxx} &= -T_{faz}^{(3)} + T_{pz}^{(5)} \\
M_{xyzz} &= 2T_{faz}^{(3)} + T_{pz}^{(5)} + 2T_{pz}^{(6)}
\end{aligned}$$

* Rank 4 tensor (s).

$$\begin{bmatrix}
M_{xxxx} & M_{xxyy} & M_{xxzz} & 0 & 0 & M_{xxxz} & 0 & 0 & M_{xxxy} \\
M_{xxyy} & M_{xxxx} & M_{xxzz} & 0 & 0 & -M_{xxyx} & 0 & 0 & -M_{xxxz} \\
M_{zzxx} & M_{zzxx} & M_{zzzz} & 0 & 0 & M_{zzxy} & 0 & 0 & -M_{zzxz} \\
0 & 0 & 0 & M_{yzyz} & M_{yzzz} & 0 & M_{yzyy} & M_{yzxz} & 0 \\
0 & 0 & 0 & -M_{yzxz} & M_{yzzy} & 0 & -M_{yzxx} & M_{yzyz} & 0 \\
M_{xyxx} & -M_{xyxx} & 0 & 0 & 0 & M_{xyxy} & 0 & 0 & M_{xyxy}
\end{bmatrix}$$

$$\begin{aligned}
M_{xxxx} &= -2M_{du}^{(1)} - 4M_{du}^{(2)} - M_{gu}^{(1)} + 2M_g^{(1)} + M_s^{(1)} + 2M_s^{(2)} \\
M_{xxyy} &= -2M_{du}^{(1)} + 2M_{gu}^{(1)} - M_g^{(1)} + M_s^{(1)} \\
M_{xxzz} &= M_{du}^{(1)} + 3M_{du}^{(3)} - M_{gu}^{(1)} - M_g^{(1)} + M_s^{(1)} \\
M_{xxxz} &= M_{gaz}^{(1)} - 2T_{faz}^{(1)} - T_{faz}^{(2)} + 2T_{pz}^{(1)} + T_{pz}^{(3)} \\
M_{xxxy} &= M_{gaz}^{(1)} - 2T_{faz}^{(1)} + T_{faz}^{(2)} + 2T_{pz}^{(1)} - T_{pz}^{(3)} \\
M_{zzxx} &= M_{du}^{(1)} - 3M_{du}^{(3)} - M_{gu}^{(1)} - M_g^{(1)} + M_s^{(1)} \\
M_{zzzz} &= 4M_{du}^{(1)} + 8M_{du}^{(2)} + 2M_{gu}^{(1)} + 2M_g^{(1)} + M_s^{(1)} + 2M_s^{(2)} \\
M_{zzxy} &= 2T_{faz}^{(2)} + T_{pz}^{(3)} + 2T_{pz}^{(4)} \\
M_{yzyz} &= M_{du}^{(2)} - 3M_{du}^{(5)} - M_{gu}^{(1)} - M_g^{(1)} + M_s^{(2)} \\
M_{yzzx} &= -4T_{faz}^{(1)} - T_{faz}^{(2)} - T_{pz}^{(1)} + T_{pz}^{(4)} \\
M_{yzyy} &= M_{du}^{(2)} + 3M_{du}^{(5)} - M_{gu}^{(1)} - M_g^{(1)} + M_s^{(2)} \\
M_{yzxz} &= -4T_{faz}^{(1)} + T_{faz}^{(2)} - T_{pz}^{(1)} - T_{pz}^{(4)} \\
M_{xyxx} &= M_{gaz}^{(1)} + 2T_{faz}^{(1)} - 2T_{pz}^{(1)} \\
M_{xyxy} &= -2M_{du}^{(2)} + 2M_{gu}^{(1)} - M_g^{(1)} + M_s^{(2)}
\end{aligned}$$

* Rank 4 tensor (a).

$$\begin{bmatrix}
0 & 0 & 0 & M_{yzyz} & M_{yzxx} & 0 & M_{yzyy} & M_{yzxz} & 0 \\
0 & 0 & 0 & M_{yzxz} & -M_{yzyy} & 0 & M_{yzzx} & -M_{yzyz} & 0 \\
M_{xyxx} & M_{xyxx} & M_{xyzz} & 0 & 0 & M_{xyxy} & 0 & 0 & -M_{xyxy}
\end{bmatrix}$$

$$\begin{aligned}
M_{yzyz} &= -2M_{du}^{(4)} - 3M_{du}^{(6)} + M_s^{(3)} \\
M_{yzzx} &= -T_{faz}^{(3)} - T_{pz}^{(2)} + T_{pz}^{(6)} \\
M_{yzyy} &= 2M_{du}^{(4)} - 3M_{du}^{(6)} - M_s^{(3)} \\
M_{yzxz} &= -T_{faz}^{(3)} + T_{pz}^{(2)} + T_{pz}^{(6)} \\
M_{xyxx} &= -T_{faz}^{(3)} + T_{pz}^{(5)} \\
M_{xyzz} &= 2T_{faz}^{(3)} + T_{pz}^{(5)} + 2T_{pz}^{(6)} \\
M_{xyxy} &= 4M_{du}^{(4)} + M_s^{(3)}
\end{aligned}$$

* Rank 4 tensor (t).

$$\begin{bmatrix} M_{xxxx} & M_{xxxxy} & 0 \\ -M_{xxxxy} & M_{xxxxx} & 0 \\ 0 & 0 & M_{zzzz} \\ 0 & 0 & M_{yyzz} \\ M_{zzxx} & 0 & 0 \\ M_{xxxy} & M_{xxyy} & 0 \\ 0 & M_{yzyy} & 0 \\ 0 & 0 & M_{zxxz} \\ M_{xxyy} + M_{yyzz} - M_{yzyy} - M_{zxxz} + M_{zzxx} & -M_{xxxy} & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$M_{xxxx} = -2M_{du}^{(1)} - 4M_{du}^{(2)} - M_{gu}^{(1)} + 2M_g^{(1)} + 3M_s^{(1)}$$

$$M_{xxxxy} = M_{gaz}^{(1)}$$

$$M_{zzzz} = 4M_{du}^{(1)} + 8M_{du}^{(2)} + 2M_{gu}^{(1)} + 2M_g^{(1)} + 3M_s^{(1)}$$

$$M_{yyzz} = M_{du}^{(1)} + 3M_{du}^{(3)} - M_{gu}^{(1)} - M_g^{(1)} + M_s^{(1)}$$

$$M_{zzxx} = M_{du}^{(1)} - 3M_{du}^{(3)} - M_{gu}^{(1)} - M_g^{(1)} + M_s^{(1)}$$

$$M_{xxyy} = -2M_{du}^{(1)} + 2M_{gu}^{(1)} - M_g^{(1)} + M_s^{(1)}$$

$$M_{yzyy} = M_{du}^{(2)} + 3M_{du}^{(5)} - M_{gu}^{(1)} - M_g^{(1)} + M_s^{(1)}$$

$$M_{zxxz} = M_{du}^{(2)} - 3M_{du}^{(5)} - M_{gu}^{(1)} - M_g^{(1)} + M_s^{(1)}$$