

MPG No. 13.5.130 4'm'm' (4'mm' setting) [ Type III, tetragonal ] [Q tensor]

\* Rank 0 tensor.

$$[Q]$$

$$Q = Q_s^{(1)}$$

\* Rank 1 tensor.

$$[0 \quad 0 \quad Q_z]$$

$$Q_z = Q_{pz}^{(1)}$$

\* Rank 2 tensor (s).

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

$$Q_{xx} = -Q_{du}^{(1)} + Q_s^{(1)}$$

$$Q_{zz} = 2Q_{du}^{(1)} + Q_s^{(1)}$$

\* Rank 2 tensor (a). \* Rank 3 tensor (s).

$$\begin{bmatrix} 0 & 0 & Q_{xxz} \\ 0 & 0 & Q_{xxz} \\ 0 & 0 & Q_{zzz} \\ 0 & Q_{yzy} & 0 \\ Q_{yzy} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$Q_{xxz} = -Q_{faz}^{(1)} + Q_{pz}^{(1)}$$

$$Q_{zzz} = 2Q_{faz}^{(1)} + Q_{pz}^{(1)} + 2Q_{pz}^{(2)}$$

$$Q_{yzy} = -Q_{faz}^{(1)} + Q_{pz}^{(2)}$$

\* Rank 3 tensor (a).

$$\begin{bmatrix} 0 & Q_{yzy} & 0 \\ -Q_{yzy} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$Q_{yzy} = Q_{pz}^{(3)}$$

\* Rank 4 tensor (sss).

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

$$Q_{xxxx} = -2Q_{du}^{(1)} - 4Q_{du}^{(2)} - Q_{gu}^{(1)} + 2Q_g^{(1)} + Q_s^{(1)} + 2Q_s^{(2)}$$

$$Q_{xxyy} = -2Q_{du}^{(1)} + 2Q_{gu}^{(1)} - Q_g^{(1)} + Q_s^{(1)}$$

$$Q_{xxzz} = Q_{du}^{(1)} - Q_{gu}^{(1)} - Q_g^{(1)} + Q_s^{(1)}$$

$$Q_{zzzz} = 4Q_{du}^{(1)} + 8Q_{du}^{(2)} + 2Q_{gu}^{(1)} + 2Q_g^{(1)} + Q_s^{(1)} + 2Q_s^{(2)}$$

$$Q_{yzyz} = Q_{du}^{(2)} - Q_{gu}^{(1)} - Q_g^{(1)} + Q_s^{(2)}$$

$$Q_{xyxy} = -2Q_{du}^{(2)} + 2Q_{gu}^{(1)} - Q_g^{(1)} + Q_s^{(2)}$$

\* Rank 4 tensor (ssa).

$$\begin{bmatrix} 0 & 0 & Q_{xxzz} & 0 & 0 & 0 \\ 0 & 0 & Q_{xxzz} & 0 & 0 & 0 \\ -Q_{xxzz} & -Q_{xxzz} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

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

\* Rank 4 tensor (aas).

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

$$Q_{yzyz} = -2Q_{du}^{(4)} + Q_s^{(3)}$$

$$Q_{xyxy} = 4Q_{du}^{(4)} + Q_s^{(3)}$$

\* Rank 4 tensor (aaa). \* Rank 4 tensor (sa).

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ Q_{yzyz} & 0 & 0 \\ 0 & -Q_{yzyz} & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

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

\* Rank 4 tensor (as).

$$\begin{bmatrix} 0 & 0 & 0 & Q_{yzyz} & 0 & 0 \\ 0 & 0 & 0 & 0 & -Q_{yzyz} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$Q_{yzyz} = -3Q_{du}^{(6)}$$

\* Rank 4 tensor (s).

$$\begin{bmatrix} Q_{xxxx} & Q_{xxyy} & Q_{xxzz} & 0 & 0 & 0 & 0 & 0 & 0 \\ Q_{xxyy} & Q_{xxxx} & Q_{xxzz} & 0 & 0 & 0 & 0 & 0 & 0 \\ Q_{zzxx} & Q_{zzxx} & Q_{zzzz} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & Q_{yzyz} & 0 & 0 & Q_{yzyz} & 0 & 0 \\ 0 & 0 & 0 & 0 & Q_{yzyz} & 0 & 0 & Q_{yzyz} & 0 \\ 0 & 0 & 0 & 0 & 0 & Q_{xyxy} & 0 & 0 & Q_{xyxy} \end{bmatrix}$$

$$Q_{xxxx} = -2Q_{du}^{(1)} - 4Q_{du}^{(2)} - Q_{gu}^{(1)} + 2Q_g^{(1)} + Q_s^{(1)} + 2Q_s^{(2)}$$

$$Q_{xxyy} = -2Q_{du}^{(1)} + 2Q_{gu}^{(1)} - Q_g^{(1)} + Q_s^{(1)}$$

$$Q_{xxzz} = Q_{du}^{(1)} + 3Q_{du}^{(3)} - Q_{gu}^{(1)} - Q_g^{(1)} + Q_s^{(1)}$$

$$Q_{zzxx} = Q_{du}^{(1)} - 3Q_{du}^{(3)} - Q_{gu}^{(1)} - Q_g^{(1)} + Q_s^{(1)}$$

$$Q_{zzzz} = 4Q_{du}^{(1)} + 8Q_{du}^{(2)} + 2Q_{gu}^{(1)} + 2Q_g^{(1)} + Q_s^{(1)} + 2Q_s^{(2)}$$

$$Q_{yzyz} = Q_{du}^{(2)} - 3Q_{du}^{(5)} - Q_{gu}^{(1)} - Q_g^{(1)} + Q_s^{(2)}$$

$$Q_{yzyy} = Q_{du}^{(2)} + 3Q_{du}^{(5)} - Q_{gu}^{(1)} - Q_g^{(1)} + Q_s^{(2)}$$

$$Q_{xyxy} = -2Q_{du}^{(2)} + 2Q_{gu}^{(1)} - Q_g^{(1)} + Q_s^{(2)}$$

\* Rank 4 tensor (a).

$$\begin{bmatrix} 0 & 0 & 0 & Q_{yzyz} & 0 & 0 & Q_{yzyy} & 0 & 0 \\ 0 & 0 & 0 & 0 & -Q_{yzyy} & 0 & 0 & -Q_{yzyz} & 0 \\ 0 & 0 & 0 & 0 & 0 & Q_{xyxy} & 0 & 0 & -Q_{xyxy} \end{bmatrix}$$

$$Q_{yzyz} = -2Q_{du}^{(4)} - 3Q_{du}^{(6)} + Q_s^{(3)}$$

$$Q_{yzyy} = 2Q_{du}^{(4)} - 3Q_{du}^{(6)} - Q_s^{(3)}$$

$$Q_{xyxy} = 4Q_{du}^{(4)} + Q_s^{(3)}$$

\* Rank 4 tensor (t).

$$\begin{bmatrix} Q_{xxxx} & 0 & 0 \\ 0 & Q_{xxxx} & 0 \\ 0 & 0 & Q_{zzzz} \\ 0 & 0 & Q_{yyzz} \\ Q_{zzxx} & 0 & 0 \\ 0 & Q_{xxyy} & 0 \\ 0 & Q_{yzzy} & 0 \\ 0 & 0 & Q_{zxzx} \\ Q_{xxyy} + Q_{yyzz} - Q_{yzzy} - Q_{zxzx} + Q_{zzxx} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$Q_{xxxx} = -2Q_{du}^{(1)} - 4Q_{du}^{(2)} - Q_{gu}^{(1)} + 2Q_g^{(1)} + 3Q_s^{(1)}$$

$$Q_{zzzz} = 4Q_{du}^{(1)} + 8Q_{du}^{(2)} + 2Q_{gu}^{(1)} + 2Q_g^{(1)} + 3Q_s^{(1)}$$

$$Q_{yyzz} = Q_{du}^{(1)} + 3Q_{du}^{(3)} - Q_{gu}^{(1)} - Q_g^{(1)} + Q_s^{(1)}$$

$$Q_{zzxx} = Q_{du}^{(1)} - 3Q_{du}^{(3)} - Q_{gu}^{(1)} - Q_g^{(1)} + Q_s^{(1)}$$

$$Q_{xxyy} = -2Q_{du}^{(1)} + 2Q_{gu}^{(1)} - Q_g^{(1)} + Q_s^{(1)}$$

$$Q_{yzzy} = Q_{du}^{(2)} + 3Q_{du}^{(5)} - Q_{gu}^{(1)} - Q_g^{(1)} + Q_s^{(1)}$$

$$Q_{zxzx} = Q_{du}^{(2)} - 3Q_{du}^{(5)} - Q_{gu}^{(1)} - Q_g^{(1)} + Q_s^{(1)}$$