

3.60 Symmetry, Structure and Tensor Properties of Materials

Problem Set 11

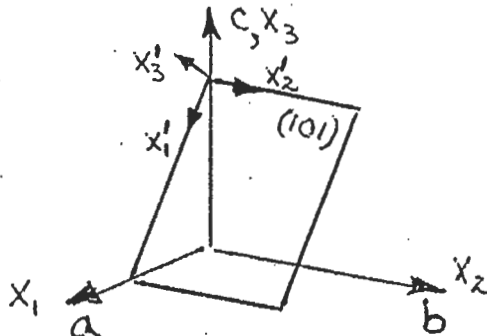
- A set of Cartesian axes x_i is transformed to a new set x_i' by a clockwise rotation of θ about the x_2 axis:

 - Sketch the position of the new coordinate system relative to the original system.
 - Label the angles corresponding to the inverse cosines of c_{11} , c_{13} , c_{31} , c_{23} and c_{32} .
 - Evaluate the direction cosine array c_{ij} by determining cosines of the appropriate angles.
- For each of the following operations, write the equations specifying the new axes x_i' in terms of the original axes x_i . Establish the direction cosine scheme by extracting the appropriate coefficients from these equations

 - reflection in the x_2x_3 plane
 - a 120° rotation about the $[111]$ axis of a cubic crystal
 - a 2-fold rotation about $[1\bar{1}0]$ in a cubic crystal
- Aragonite is an orthorhombic form of CaCO_3 , point group $2/m\ 2/m\ 2/m$, with lattice constants $a = 4.94$, $b = 7.94$, $c = 5.72$ Å. Measured relative to the crystallographic axes, the dielectric susceptibility* is given by

$$k_{ij} = \epsilon_0 \begin{bmatrix} 8.8 & 0 & 0 \\ 0 & 6.7 & 0 \\ 0 & 0 & 5.6 \end{bmatrix}$$

where ϵ_0 , the permittivity of space, is $8.85 \cdot 10^{-12}$ coulombs/volt-meter. Suppose a (101) plate is cut from the crystal. What is the form of the susceptibility tensor referred to axes taken relative to the plate?



*The dielectric susceptibility relates polarization, P (dipole moment per unit volume) to an applied electric field: $P_i = k_{ij} E_j$