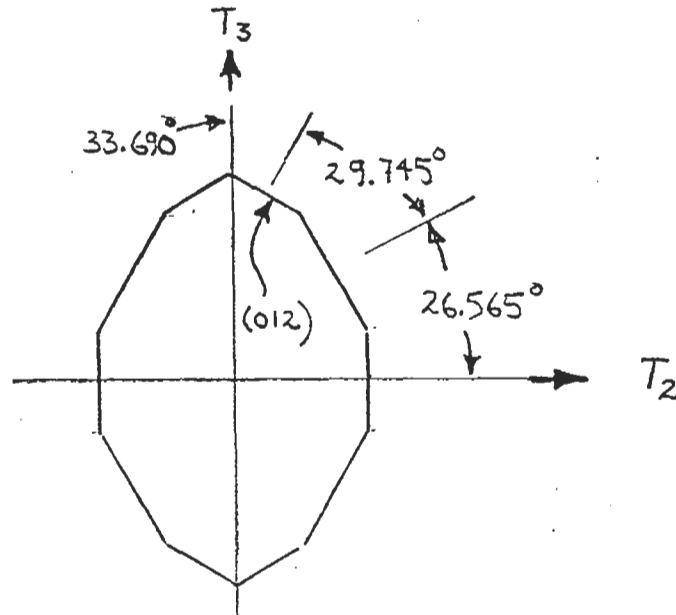


3.60 Symmetry, Structure and Tensor Properties of Materials

Problem Set 5

(1) A particular crystal is known to have a lattice with three translations that are mutually orthogonal. The crystal has the following cross-sectional shape in a plane perpendicular to T_1 .



The angles indicated in the diagram are values measured between normals to the faces. One of the faces is identified as (012).

- (a) What is the ratio of the length of T_3 to T_2 ?
 - (b) Assign indices to the remaining faces.
- (2) Let's consider point group $4mm$.
- (a) Sketch the arrangement of symmetry elements in the group and a representative pattern of objects that conforms to this symmetry.
 - (b) Identify the set of operations present in the group and, by constructing the group multiplication table, show that this set of operations constitutes a group.
 - (c) Show that the number of objects in the pattern is the same as the order of the group and that the individual elements of the group specify how any given object in the pattern is related to all of the others that are present.

(3) We considered, early on in our discussion, the combination of a rotation operation, A_α , with a translation having an orientation perpendicular to the rotation axis. Upon letting these symmetry operations repeat one another we arrived at a nifty little construction that could not be self-consistent unless the condition

$$\cos \alpha = (1 - p)/2$$

was met, where p is an integer.

This construction is obviously a special case. We will soon begin working with three-dimensional lattices which will contain translations that are not normal to rotation axes.

Consider, therefore, a generalization of the two-dimensional special case—that is, combination of a rotation operation, A_α , with a translation that is *not* perpendicular to the rotation axis.

Can you show that this leads to the same restrictions on α ?