5.2.2. Uniaxial Strain

It seems likely that uniaxial compression along certain crystallographic directions will activate the bcc to hcp transformation. The present search for possible uniaxial compression transformations is limited to compressions of the triclinic cell of Fig. 5.2(b).

This cell attains hexagonal symmetry by uniaxial compression in the [001] direction; then the 70°30' angle between sides in the basal plane becomes 60°. Due to the symmetry of cubic crystals six different planes exist which contain a triclinic cell like that of Fig. 5.2(b). However, there are only six directions of uniaxial compression which will produce hexagonal symmetry. Planes which contain triclinic cells and directions of uniaxial compression which transform the cell to hcp are:

Plane	Direction
$(1\bar{1}0)$	$[001],[00\bar{1}]$
(110)	$[001],[00\bar{1}]$
(011)	$[100],[\bar{1}00]$
$(0\bar{1}1)$	$[100],[\bar{1}00]$
(101)	$[010],[0\bar{1}0]$
$(\bar{1}01)$	$[010],[0\bar{1}0]$

The relative displacement required to obtain the 60° angle is $a/a_0 = 0.816$ = relative volume for uniaxial strain. To produce this compression in iron requires a shock stress near 400 kbar. The actual transformation occurs at 130 kbar, which suggests that some other process is active at lower stresses or some local expansion occurs laterally.

5.2.3. Fraction Transformed

Theories of martensitic transformations have progressed to the point where the volume fraction transformed can be expressed as a function of time for constant temperature and pressure or as a time-independent function of temperature for constant pressure.[47] Transformations of the first kind are called "isothermal," the latter are called "athermal." Isothermal data show that reaction rate decreases rapidly during the course of transformation. This has been explained by Fisher[46] as a consequence of repeated subdivision of grains by succeeding generations of martensitic plates. Plates growing from any initiation site are stopped at grain boundaries or other plates so that, as a grain subdivides, the transformed volume growing from each nucleation site diminishes as in Fig. 5.4. If nucleation sites are activated at a constant rate, and if this rate is slow compared to individual growth rate, then it necessarily follows that volume transformation rate diminishes with time; the amount of material transforming depends on the amount of material available to transform. The "final" state reached in such experiments has been observed to contain a residue of phase 1.[47]

In constant pressure athermal studies a sample is heated above the martensitic transition temperature, M_T, and rapidly cooled to a reference temperature below M_T. It is then examined