nucleation and growth processes and martensitic transformations. This nomenclature is rather unfortunate, as pointed out by Christian, because growth from nuclei also occurs during martensitic reactions.

In nucleation and growth processes a new phase grows from critical nuclei at the expense of the old phase. The reaction proceeds to completion by a slow migration of the interphase boundary, the velocity of which varies markedly with temperature. Most atoms have different neighbors in a new phase. On the other hand in martensitic transformation the reaction takes place by coordinated atom movements (e.g., shear-like), and atoms have the same neighbors after transformation. The latter is often observed in rapid cooling of alloys.

The basic model for describing nucleation and growth phenomena is based on the following conditions:

1. Steady state reaction
2. Isothermal and isobaric process
3. Thermal fluctuations as driving force
4. Boltzman's law for the relative probability of different energy states.

The expression of this theory is:

1. Nucleation

   I (nucleation frequency) α $\exp(-\Delta G^*/kT)$

   where ΔG^* is defined to be the critical net free energy change on forming the nucleus of the new phase.

2. Growth

There are many expressions for the growth law. An often used form is:

$$x = 1 - \exp(-kt^n)$$

where x = the volume fraction transformed

k = a complicated function of the nucleation frequency I

t = time

n = constant of magnitude 3 to 4.

The principal difficulties in applying this model to the shock-induced transition are the conditions imposed in deriving the rate equation. In a shock front the situation is neither isothermal nor isobaric, nor is it steady state.

A description of the nucleation of martensitic transformation is given (20) for an athermal case (e.g., quenching), but the result is less conclusive than that for a nucleation and growth process. This transformation has a negligible free energy barrier (21) and proceeds very rapidly to completion. Therefore at present the quantitative information obtained is mainly concerned with the amount of transformation with respect to the cooling rate but not with time.

It is tempting to use the martensitic transformation in describing shock-induced transformations because of its high speed. There are some who suggest the martensitic transition for iron ($\alpha \rightarrow \epsilon$) in shocks (22,23). However, a quantitative description of the rate equation is not yet available for inclusion in the constitutive relations.