

relation, whose derivation is the subject of the next section,

$$d\alpha = f(v, T, \alpha) dt. \quad (3.22)$$

Then substituting Eqs. (3.21) and (3.22) into (3.13) and (3.14) and solving for dp and dT , we get

$$dp = F/G \quad (3.23)$$

$$dT = -M/G \quad (3.24)$$

where

$$F = [m_2 + m_1(p+q)]dv + (m_1n_2 - m_2n_1) f(v, T, \alpha) dt$$

$$M = [l_2 + l_1(p+q)]dv + (l_1n_2 - l_2n_1) f(v, T, \alpha) dt$$

$$G = l_1m_2 - m_1l_2$$

In Eq. (3.8) it is assumed that E_1 and E_2 are known functions of p and T . These can be calculated by integrating Eq. (3.12) along two paths, provided specific heats are known:

1. Integrate over T at $p = 0$
2. Integrate over p at constant temperature, T .

Then

$$E_i = E_i^{oo} + \int_0^T C_{pi}^o dT - \int_0^p Q dp \quad (3.25)$$

where

$$Q = T(\partial v_i / \partial T)_p + p(\partial v_i / \partial p)_T$$

$$i = 1, 2$$

$$E_i^{oo} = \text{specific internal energy at absolute zero Kelvin and } p = 0 \text{ (this is zero-point energy),}$$

and

C_{pi}^0 = specific heat capacity at zero pressure.

In summary, the generalized constitutive relations now consist of:

1. Equations of state

$$v_i = v_i(p, T)$$

2. Specific heat capacities

$$C_{pi} = C_{pi}(p, T)$$

3. Zero-point energy difference

$$E_1^{00} - E_2^{00}$$

4. Relaxation relation

$$d\alpha/dt = f(v, T, \alpha)$$

5. Artificial viscosity, q .

To complete the above description we must find a relaxation relation and an expression for q .

3.3 Irreversible Thermodynamics and Phase Relaxation

This section is concerned with the mechanism of phase transformations in the solid state. It should be possible to describe the mechanism of phase change in solids in terms of interatomic forces by use of kinetic theory. Actually, because of the problem's complexity, no such quantitative description has been achieved. However, very successful phenomenological theories for the kinetics of phase change have been developed (16,17,18,19). Such theories are of two kinds, known as