EXPERIMENTAL INVESTIGATION OF THE KINETICS OF THE SHOCK-INDUCED ALPHA TO EPSILON PHASE TRANSFORMATION IN ARMCO IRON

ABSTRACT

Experimental data were obtained on the evolution of shock waves in polycrystalline Armco iron when the final driving stress is near 200 kbar. There was little or no variation of plastic I wave amplitude for propagation distances between 0.9 and 6.35 mm. The difference between impact stress and amplitude of the plastic I wave at 1 mm yields a lower limit of 2×10^7/sec for initial transformation rate. If variations of pressure with volume on the iron Hugoniot between 130 and 250 kbar are attributed to variations in mass fraction of phase 2, a relation is obtained between mass fraction, f, transformed, and the difference in the Gibbs energies, $G_2 - G_1$:

$$1 - f = \exp\left(\theta(G_2 - G_1 - A)\right)$$

where θ is constant, and A is the value of $G_2 - G_1$ at the onset of transformation. This relation shows that an increase in $G_2 - G_1$ results in more transformation. To provide a basis for understanding this behavior, a relation between the number of "frozen-in" nucleation sites and driving force, $G_2 - G_1$, is established. The "frozen-in" nuclei occur because equilibrium embryos of the second phase, which result from statistical fluctuations, may be forced into the stability field of the second phase by sudden application of sufficient pressure. The relation so established has at best a remote numerical similarity to the experimental relation, but it shows promise of further development.