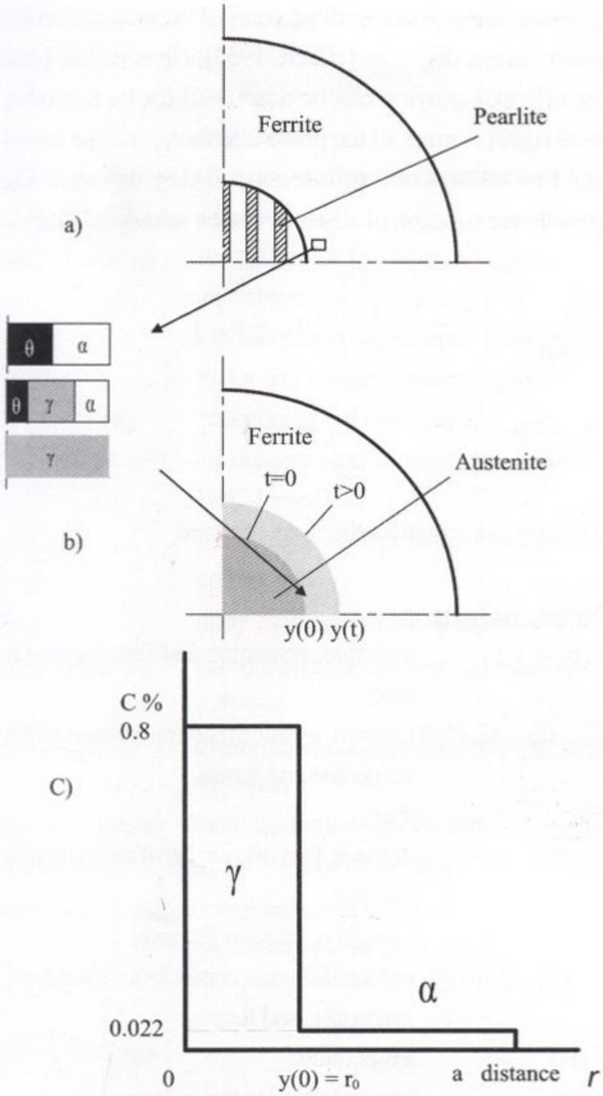

Fig. 7. Illustration of austenitization for a pearlite and ferrite parent material. a) Parent phase; b) Grain growth of austenite; c) Carbon concentration profile when $t=0$.

$$f = 1-\exp\left[-I_0\exp\left(\frac{-\Delta G}{RT}\right)g_0^N\exp\left(\frac{-NQ_V}{RT}\right)\frac{t^{N+1}}{N+1}\right] \quad (6)$$

where ΔG is the energy barrier for stable austenite nucleation, Q_v is the activation energy of austenite grain growth. R is the universal gas constant, I_0 and g_0 are material constants and N is a factor that mainly depends on the morphology of new phase.

Using these models, it is possible to predict the volume fraction of austenite under a specific heating rate accurately and with development, they may be used for austenitization cases for a range of heating rates. Also, a

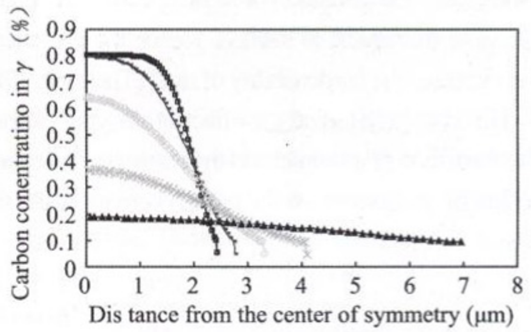

Fig. 8. Calculated carbon distribution in austenite, for different austenitization times.

TTT diagram with better accuracy has been generated by Tszeng and Gshi (2004). using the above models.

4. The effect of alloying elements in austenitization

Addition of various alloying elements is widely used to produce specific properties in steels (Habraken and Brouwer, 1996; Rose and Schrader, 1966; Bain and Paxton, 1961; Lee and Lee, 1999), such as to promote or stabilize the formation of a certain phase during the heat treatment or cooling process, affect grain growth of austenite, change the eutectoid point of steels, etc. Some alloys remain as insoluble particles in steels while others dissolve. During austenitization, when a moving austenite grain boundary encounters an insoluble second phase particle, grain is hindered as the surface energy of the particle and austenite grain boundary system is changed (Maazi and Rouag, 2001). Therefore, controlling the quantity of insoluble particles is an efficient way to control austenite grain size. For the soluble particles, boron for example, most of the predominant boron compound, the so-called effective compound Fe23(BC)6 dissolves in the steel. Thus, free boron atoms are able to diffuse throughout the steel at austenitization temperature like carbon atoms, and a large number of boron atoms diffuse towards the grain boundaries and concentrate there (Morral and Cameron, 1980). Atomic contact is thereby established between Fe23(BC)6 and austenite, resulting in a reduction in the surface tension and grain-boundary energy. If quenching follows austenitization, the solubility of boron is reduced, and its presence at austenite grain boundaries