PHYSICAL METALLURGY OF STEEL — BASIC PRINCIPLES

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INTRODUCTION

Steel is primarily an alloy of carbon in iron although most commercial grades contain other alloying elements as well. It is well known that if pure iron is slowly cooled from its liquid state to room temperature it undergoes isothermal transformations at 1534°C from liquid to δ phase, and, at 1390°C from δ to γ phase, and at 910°C from γ to α phase (Fig. 1). These phases have different crystal structures; δ and α phases are BCC whereas γ is FCC. Addition of carbon to iron significantly alters the above transformation characteristics. While in liquid state iron can dissolve considerable amount of carbon, its solubility in solid state is significantly less. This is determined by the spacing of iron atoms in the crystal lattice. FCC structure although more closely packed has larger interstitial spacing than BCC lattice and therefore can accommodate relatively larger amount of carbon. For example maximum solubility of carbon in α or δ (also called ferrite) is 0.08 whereas that in γ (also called austenite) it is 2.06. Carbon in excess of this limit is usually present in steel as a carbide called cementite which is a stable non equilibrium compound represented as Fe_3C. Thus steel at a given temperature and pressure may therefore contain more than one phases. Equilibrium diagram provides a graphic representation of the distribution of various phases as function temperature and overall composition. If properly interpreted this also provides compositions of respective phases and their relative amount. Fig. 2 represents such a diagram for Fe-Fe_3C system. This contains three horizontal lines representing three invariant transformations viz.

Physical Metallurgy Of Steel Basic Principles

Gregory N. Haidemenopoulos

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