Source of Abnormality in Hypereutectoid Steels

by Arthur Dube

IN hypereutectoid steels the normal mode of formation of ferritecarbide aggregates from austenite leads to a microstructure consisting of proeutectoid cementite and pearlite. However microstructures have been observed which exhibit a partial or complete disappearance of pearlite. These structures thus show a cementite network enveloping the core of the former austenite grains which now consists of a mixture of ferrite and pearlite.

This type of abnormal structure has already been the subject of many investigations. However no general agreement has yet been reached as to what factors will lead to its occurrence. According to the present viewpoint, the abnormal structure results from a synchronous deposition of the ferrite and carbide phase at temperatures just slightly below Ae_1. The continued growth of the primary cementite network after the ferrite phase is formed is possible by the diffusion of carbon through the α phase.

The cessation of this synchronous deposition can occur only through the precipitation of new cementite nuclei at the ferrite-austenite interface. Such precipitation always leads to the formation of pearlite. This formation of pearlite is a comparatively faster process than the growth of the ferrite envelope and, when initiated, effectively stops the further growth of the latter.

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It is clear from the above mechanism that in order to develop an abnormal structure a steel must be reacted completely at temperatures near Ae_1. Such a condition is obtained by very slow cooling or by isothermal transformation in this temperature range. Lowering of the temperature will cause the cessation of the development of abnormal structure through precipitation of new cementite nuclei.

A second essential condition to the development of abnormal structures is a sufficiently fine austenite grain. In view of the fact that the thickness x of the ferrite envelope varies with time t according to $x = k\sqrt{D^c_\alpha t}$ when k is a constant and D^c_α is the coefficient of carbon in α iron, it is clear that with steels of larger austenite grains the precipitation of new cementite grains after ferrite has been found is much more readily formed.

Finally the carbon content of the steel is also important in the sense that it is easier to completely envelop the austenite grains with cementite when the carbon content of the steel is higher.

Preliminary experiments performed at the Metals Research Laboratory at the Carnegie Institute of Technology have substantiated the validity of the ideas presented herein.

Yielding in Plain Carbon Steels

by C. S. Roberts
and
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THE elastic limits and yield points of a series of plain carbon steels and pure irons in different states of microstructure and residual stress have been determined by a sensitive method. The elastic limit is defined as that stress above which the first plastic deformation is observed. The yield point, a parameter present only with special microstructures, is defined as that relatively constant stress at which the plastic strain shows large discontinuous increases.

The specimens used were threaded 4 in. test bars with a strained region 2½ in. long and 0.252 in. diam. The ends were spherically ground to a 4 in. diameter. The length of each bar was determined to ± 2 microinches per inch by the precision comparator method of Averbach, Cohen and Fletcher. It was then loaded in a hydraulic testing machine to a given stress, unloaded and then measured again. If no increase in length was observed after the conclusion of any relaxation effects, the strain was still purely elastic, and the specimen was reloaded to a slightly higher stress. By this procedure, the first plastic strain, within a sensitivity of $\pm 2 \times 10^{-6}$ could be detected. The initial stages of plastic deformation have been studied in detail and stress-plastic strain curves have been plotted. Relaxation effects with time, whenever existent, have been readily observed.

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