

THE DIFFUSION OF CARBON DURING PRECIPITATION IN α -IRON*

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The activation energy for precipitation of carbon from α -iron was measured to be 17.1 ± 0.5 kcal/mole by starting the precipitation at one temperature and finishing it at another. The activation energy was the same within experimental error for aging temperatures from 0° to 170°C, for samples strained up to 4 per cent, and for samples of different concentration. This energy is appreciably smaller than that of 20.1 kcal/mole for carbon diffusion in α -iron measured from elastic relaxation methods. Possible reasons for this difference are discussed, but no satisfactory explanation for it is found.

LA DIFFUSION DU CARBONE AU COURS DE LA PRECIPITATION DANS LE FER ALPHA

L'énergie d'activation pour la précipitation du carbone dans le fer alpha a été mesurée en débutant la précipitation à une température et en la terminant à une autre. La valeur ainsi obtenue est de $17,1 \pm 0,5$ kcal/mole. L'énergie d'activation demeure inchangée pour des températures de vieillissement entre 0° et 170°C pour des échantillons déformés de 4% max. et pour des échantillons de concentration différente en carbone. Cette énergie est relativement plus petite que celle (20,1 kcal/mole) obtenu pour la diffusion du carbone dans le fer alpha par des méthodes de relaxation élastique.

Les raisons possibles de cette différence sont discutées par l'auteur mais une explication satisfaisante n'a pas été trouvée.

DIFFUSION VON KOHLENSTOFF WAHREND DER AUSSCHIEDUNG IN α -EISEN

Die Aktivierungsenergie für die Ausscheidung von Kohlenstoff aus α -Eisen wurde zu $17,1 \pm 0,5$ kcal/Mol bestimmt, indem man Beginn und Ende der Ausscheidung bei verschiedenen Temperaturen verlaufen liess. Innerhalb des experimentellen Fehlers ergab sich derselbe Wert für Anlasstemperaturen von 0° bis 170°C, für Verformungsgrade bis 4% und für verschiedene Konzentrationen. Diese Energie ist erheblich geringer als der Wert von 20,1 kcal/Mol, den man mit Hilfe der elastischen Relaxation für die Diffusion von Kohlenstoff in α -Eisen misst. Mögliche Ursachen für diesen Unterschied werden diskutiert, doch fand sich keine befriedigende Erklärung.

INTRODUCTION

Carbon atoms diffuse through the iron matrix to growing carbide particles when these particles precipitate from a supersaturated solution in α -iron. This diffusion is generally assumed to control the rate of growth of the carbide phase, and the diffusion coefficient of carbon is calculated from the results of Wert.⁽¹⁾ Wert measured this diffusion coefficient with a variety of experimental methods over a wide temperature range, and he found the results were best fitted by the equation

$$D = 0.02 \exp(-20,100/RT). \quad (1)$$

Below 125°C Wert measured the diffusion coefficient by means of the elastic after effect and internal friction of carburized iron. Both these methods measure the relaxation time for the return of the interstitial carbon atoms to their equilibrium configuration after this configuration is disturbed by a small stress. Thus the rate of jumping of the carbon atoms from one interstitial site to a neighboring one is directly measured. Wert also measured the

diffusion coefficient of carbon in iron at 150°C and 200°C from the rate of carbide precipitation. In this method the precipitation is started at one temperature T_1 and completed at a higher temperature T_2 . The ratio of the rates of precipitation at the two temperatures is taken to be proportional to the ratio of the carbon diffusion coefficients, since the number of carbide particles should remain constant throughout a run under these experimental conditions. Here the long-range diffusion of the carbon through the iron to the particles is measured, rather than the jumping rate from one interstitial site to another. However, if no "short circuits" for diffusion of carbon to the particles exist, and if the precipitation rate is entirely controlled by solute diffusion through the matrix, this method should give the same activation energy for diffusion as the relaxation methods. Wert found that his measurements at 150°C and 200°C by the precipitation method compared fairly well with those from the relaxation methods.

To determine if the diffusion coefficient calculated from equation (1) is indeed the one involved in the precipitation of carbon from α -iron, the activation energy of the precipitation process was measured by the method of Wert. This activation energy was found

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