KINETIC ASPECTS OF MARTENSITIC TRANSFORMATION IN IRON BASE ALLOYS

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Submitted

in fulfilment of the requirements of the degree of

Doctor of Philosophy

to the

Indian Institute of Technology, Delhi

January, 1977

Acknowledgements

The author wishes to place on record his deep sense of gratitude to Professor V. Raghavan, for his stimulating guidance and constant encouragement throughout this research.

The author is thankful to Dr. L. Kaufman of Man. Labs., USA and Dr. A. Brownrigg of BHP, Australia, for their assistance in providing data from their work. He gratefully acknowledges the comments on various aspects of this work from Professor M. Cohen of MIT, USA.

Finally, the author wishes to express his appreciation for the assistance received from Shri Prem Singh, Lab. Asst. in the Materials Science Lab. at IIT, Delhi, during the experimental work.

Abstract

Previous studies on the kinetic aspects of martensitic transformation in iron alloys are reviewed.

An analytical approach to determine the number of nucleation sites during martensitic transformation is presented. This number is determined by the number of sites present initially, the autocatalytic sites, the sites consumed by activation into martensite and the sites swept out by the volume of the transformed material. Firstly, two limiting cases of negligible sweeping and predominant sweeping are analysed. A general expression is then developed which is applicable under all conditions of sweeping that may occur during the transformation.

Assuming the average volume of martensitic plates to remain constant during the last few percent of transformation, the limiting fraction of martensite that can form at a given isothermal test temperature is determined from the experimentally observed transformation curves. This fraction is found to obey the empirical relationships observed for the fraction of martensite that forms athermally at a given test temperature. This suggests strong correlations between the two modes of martensitic transformation.

Isothermal tests are conducted on an Fe-22.4Ni-3.6Mn alloy at liquid air temperature, after introducing different amounts of carbon in the specimens of pre-established grain size by a doping process. It is found that the carbon reduces the transformation rate and the mean aspect ratio of martensitic plates.

The thermal stabilization of austenite has been attributed to the presence of interstitial elements like carbon. The interstitial element may determine the stabilization process in two ways: (i) by pinning the interface of the existing nucleation sites and (ii) by strengthening the austenite. The progress of the isothermal transformation after stabilization has been analysed in light of the above two possibilities. It is found that the observed decrease in the transformation rate is possible, if austenite is strengthened and the activation energy for nucleation is thereby increased.

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