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(56) Measurement of Manganese Diffusivity in a Molten Fe-Mn System

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There have been several significant attempts to measure diffusivity of some elements in liquid iron and results show that the order of magnitude are quite agreable but the over all value are generally incompatible. Manganese is a typical example. Todate, only two measurements for a Fe-Mn system for a limited composition have been reported. Both results however, are in disagreement, firstly, with each other and secondly, with other elements of similar properties. Only one thermodynamic study over the whole range of composition has been reported, none kinetically. It is therefore the primary purpose of this investigation to measure the diffusivity of manganese over the whole range of composition.

A 5 mm. I.D. close end or plugged end Al_2O_3 tube containing the specimen with a total length of 5 cms. was inserted into a vertical 20 KVA Tamman furnace, at a level previously determined. A liquid diffusion couple was formed at the desired temperature. The temperature was manually controlled and measured by a previously calibrated 97 % Tungsten-3% Rhenium VS. 85 % Tungsten-25 % Rhenium thermocouple.

A concentration penetration curve was obtained by analyzing the cooled specimen with the use of an electron probe miroanalyzer. Diffusion coeffecients were calculated by the following equation, which is a solution of Fick's second law and satisfying the boundary conditions of this experiment.

$$C = \frac{1}{2} Co \sum_{n=\infty}^{\infty} \left\{ \mathrm{erf} \frac{h + 2nl - x}{2\sqrt{(Dt)}} + \mathrm{erf} \frac{h - 2nl + x}{2\sqrt{(Dt)}} \right\}$$

Error function series determined from the above equation by aid of electronic computer were utilized to minimize computations. A correction was applied to the time in order to allow for the diffusion which occured during the melting and solidification. A density correction was made to obtain diffusion coeffecients for the liquid state. It was assumed that shrinkage on solidification was taken up entirely by displacement along the longitudinal direction.

Conclusion: (1) Within the experimental error, Mn diffusivity over the whole range of composition vary only slightly. (2) A minimum occurs at about 0.4 N_{Mn} . (3) For practical purposes, the following equation is recommended over the whole range of composition.

$D_{Mn} = 2.8 \times 10^{-3} \exp(-13{,}000/RT)$ cm^2/sec.

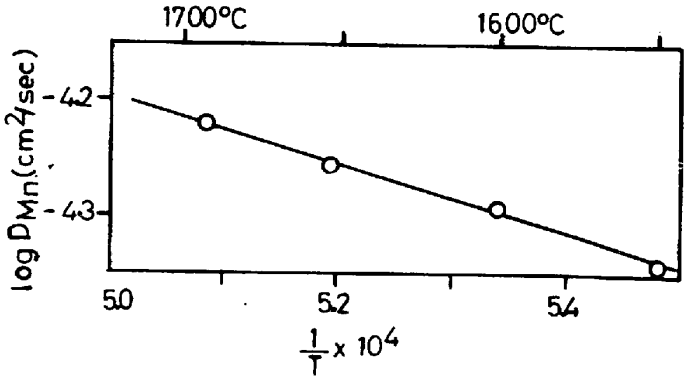

図1 マンガンの拡散恒数の温度依存性