

peratures, below the transition where fractures are 100 pct brittle.

2—Within the transition range, the increased deformation results in strain markings which branch out from the notch, and a larger strained area at the bottom of the specimen due to compressive stresses is obtained. The correspondingly smaller elastically stressed portion is characteristic of partially "brittle" fractures within the transition energy range.

3—Above the transition temperature, the entire region from the bottom of the specimen to the notch, and a broad area following the contour of the notch, shows plastic flow. The 100 pct "ductile" fractures are characteristic of this energy level.

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#### Technical Note

### Diffusion of Silicon in Iron

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AT temperatures between 1095° and 1347°C, 13 runs have been made on the diffusion of silicon in iron. In two of the runs the couple compositions were entirely within the  $\gamma$  loop of the Fe-Si system; the base alloys contained 0.0 and 1.0 wt pct Si. The other runs in which the couples consisted of a 2.3 wt pct Si alloy welded to a 3.7 pct Si alloy were  $\alpha$  phase throughout. The alloys were made by melting electrolytic iron and commercially pure silicon. Trace impurities were not determined.

The butt welded couples were diffused in an inert atmosphere of argon or hydrogen. After cooling, cuts of two mils or greater thickness were machined parallel to the weld interface. The chips were analyzed for silicon. When the concentration and distance data were examined on the conventional probability plot,<sup>1</sup> no marked variation of the diffusion coefficient with concentration was indicated over the narrow composition ranges employed. Therefore, a single diffusion coefficient is recorded for each run in Table I. The temperatures and atmospheres of the diffusion anneal are listed along with the compositions of the base alloys.

For  $\alpha$  iron the silicon diffusion coefficient is given by the equation:

$$D = 0.44 e^{-48,000/RT}$$

where  $R$  is the gas constant and  $T$ , the absolute temperature. However, since the scatter in the data is fairly large, the activation energy may be in error by as much as 6000 cal per g-atom.

The two  $\gamma$  iron points do not permit estimation of the activation energy with any reasonable certainty. They do indicate that the coefficients reported by Smithells<sup>2</sup> and Jost,<sup>3</sup> based on the work of Fry,<sup>4</sup> are much too high.

Although very dilute solutions in iron of manganese,<sup>5</sup> nickel,<sup>6</sup> cobalt,<sup>7</sup> and molybdenum<sup>8</sup> give dif-

Table I. Diffusion Coefficients of Silicon in  $\alpha$  and  $\gamma$  Iron

Composition Range, Wt Pct	Annealing Atmosphere	Temperature, °C	Diffusion Coefficient, Sq Cm per Sec
0.0-1.0	Hydrogen	1206	$4.0 \times 10^{-10}$
0.0-1.0	Hydrogen	1293	$1.7 \times 10^{-9}$
2.3-3.7	Argon	1095	$1.5 \times 10^{-8}$
2.3-3.7	Argon	1194	$2.4 \times 10^{-8}$
2.3-3.7	Argon	1201	$4.2 \times 10^{-8}$
2.3-3.7	Argon	1202	$3.2 \times 10^{-8}$
2.3-3.7	Hydrogen	1249	$5.0 \times 10^{-8}$
2.3-3.7	Hydrogen	1255	$5.7 \times 10^{-8}$
2.3-3.7	Hydrogen	1284	$1.3 \times 10^{-7}$
2.3-3.7	Hydrogen	1300	$9.0 \times 10^{-8}$
2.3-3.7	Hydrogen	1306	$1.1 \times 10^{-7}$
2.3-3.7	Hydrogen	1344	$1.2 \times 10^{-7}$
2.3-3.7	Hydrogen	1347	$1.3 \times 10^{-7}$

fusion coefficients quite close to those obtained for self-diffusion in iron, the silicon values are considerably higher, though of the same order of magnitude. This seems to be consistent with the fact that the silicon atom is the only one of those listed here which is appreciably smaller than iron.

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