originally charged (Eq. 5) and the amount oxidized designated by X .

$$\text{Lb Cr} + \text{Mn in metal after oxidation} = 20 \text{ Cr}_1 - X \quad [10]$$

Combining Eqs. 9 and 10, it is possible to solve for X

$$\begin{aligned} 20 \text{ Cr}_1 - X &= \left(2000 - X \frac{1+S}{S} \right) \frac{\text{Cr}_2}{100} \\ &= 20 \text{ Cr}_2 - X \frac{1+S}{S} \frac{\text{Cr}_2}{100} \end{aligned} \quad [11]$$

Hence

$$X \left(1 - \frac{1+S}{S} \frac{\text{Cr}_2}{100} \right) = 20 (\text{Cr}_1 - \text{Cr}_2)$$

$$\text{Lb Cr} + \text{Mn oxidized: } X = \frac{(\text{Cr}_1 - \text{Cr}_2)}{1 - \frac{1+S}{S} \frac{\text{Cr}_2}{100}}$$

or

$$X = 2000 \frac{\text{Cr}_1 - \text{Cr}_2}{100 - \frac{1+S}{S} \text{Cr}_2} \quad [12]$$

Since total weight oxidized is $X + Y$ and since $S = X/Y$, the total weight oxidized becomes

$$X \left(1 + \frac{1}{S} \right) = X \frac{1+S}{S} \quad [13]$$

Multiplying Eq. 12 by this factor $\frac{1+S}{S}$ then results in

$$\text{Lb metal oxidized} = 2000 \frac{\text{Cr}_1 - \text{Cr}_2}{\frac{100S}{1+S} - \text{Cr}_2} \quad [14]$$

In this equation Cr_1 is known from charge composition, Cr_2 from the analysis after oxidation, and S can be estimated from $[\% \text{ Cr} + \% \text{ Mn}]/[\% \text{ Fe}]$ in the metal after oxidation, using Fig. 2.

Example: A heat containing 11.5 pct Cr and 0.5 pct Mn in the charge is blown with oxygen to 0.05 pct C, reaching a temperature of 3200°F. From Fig. 1 $\text{Cr}_2 = 4.7$ pct is obtained. If there is no nickel in the heat,

$$\frac{\% \text{ Cr} + \% \text{ Mn}}{\% \text{ Fe}} = \frac{4.7}{100 - 4.7} = 0.049$$

Entering Fig. 2 at 0.049, S is estimated as 1.47. Then weight oxidized is

$$W = 2000 \frac{(11.5 + 0.5) - 4.7}{\frac{100 \times 1.47}{1 + 1.47} - 4.7} = 266 \text{ lb per ton charged.}$$

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Technical Note

Note on Contamination of Silicon Ingots

by G. Sandoz and H. E. Stauss

THE purpose of this note is to draw attention to the possibility that a melt may be contaminated by a material not in direct contact with it by means of gaseous intermediate agents. In recent years silicon has assumed a position of importance because of its use in rectifiers and transistors and close attention has been required to control of both purification and contamination during all stages of preparation.¹ This note reports the observation that a graphite heater may have contaminated silicon ingots without direct physical contact through reactions that developed gaseous products.

Several ingots made with the equipment of Hino and Stauss,² using a graphite heater in a dried helium atmosphere, were found to have a small amount of a very hard substance on the free surface. X-ray analysis by F. W. von Batchelder showed the sub-

stance to be SiC. Similar contamination was not found when the heater was tantalum, indicating that the carbon had not come from an original impurity in the silicon powder.

One source of the carbon could have been volatile matter released from the graphite heater. This heater had been used about ten times at the time of the observations. A second source of carbon could have been a direct reaction between the quartz crucible and the graphite heater to form CO, or an indirect reaction involving a crucible-melt interaction and volatile SiO as an intermediate product. Such reactions should have developed SiC on the heater; and in fact a yellow powder did form on the inside of the graphite heater although its composition could not be determined.

References

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