NATURE OF χ-IRON CARBIDE

By M. J. DUGGIN
Department of Physics and Metallurgical Engineering, University of Pittsburgh
AND
DR. L. J. E. HOFER
Mellon Institute, Pittsburgh

SINCE χ-iron carbide (Hägg carbide) was first prepared[1], attempts have been made to determine the lattice parameters of its unit cell. Jack[2] attempted to index a powder pattern of the carbide $Fe_{20}C_9$ on the basis of a complex orthorhombic structure with the lattice parameters $a = 9{\cdot}061$ Å, $b = 15{\cdot}694$ Å, $c = 7{\cdot}937$ Å; this interpretation was later found to be incorrect[3]. Wilson believed the Hägg carbide to be a species of strained cementite[4,5]. Sénateur, Fruchart and Michel[6] prepared an iron carbide which they determined to be Fe_5C_2 (refs. 6, 7) since its powder diffraction pattern could be indexed on the basis of a unit cell the parameters of which were close to those of Mn_5C_2 (refs. 8, 9). Hofer[10] has prepared a magnetically pure sample of Hägg carbide, with no Curie point other than the one at 247° C, the composition of which is known to be very close to that of the stoichiometric composition Fe_2C. The sample was prepared at 240° C, so that it contained little free carbon. The powder diffraction pattern[10] of this carbide may be indexed, as shown in Table 1, on the basis of a monoclinic unit cell the parameters of which are

$$a = 11{\cdot}56 \text{ Å} \quad b = 4{\cdot}56 \text{ Å} \quad c = 5{\cdot}03 \text{ Å} \quad \beta = 98° 3'$$

where the accuracy of the lattice parameters is approximately ± 0·4 per cent. The relative X-ray line intensities reported by Hofer[10] suggest a structure isomorphous with that of Mn_5C_2 (ref. 9); further structural investigations are under way.

Table 1. INDEXED REFLEXIONS OF Fe_2C (FeK_α RADIATION)

h	k	l	dÅ
3	1	$\bar{1}$	2·62
0	0	2	2·48
3	1	1	2·39
2	0	$\bar{2}$	
0	2	0	2·26
1	1	$\bar{2}$	2·18
2	0	2	
5	1	0	2·06
0	2	1	
3	1	$\bar{2}$	2·03
4	0	$\bar{2}$	
5	1	$\bar{1}$	1·98
2	2	$\bar{1}$	
2	2	1	1·91
3	1	2	1·80
5	1	1	
4	0	2	1·76
4	2	$\bar{1}$	1·72
5	1	$\bar{2}$	1·67
6	0	$\bar{2}$	1·62
1	1	$\bar{3}$	1·57
4	2	$\bar{2}$	1·50
3	3	$\bar{1}$	1·37
3	3	1	1·34
8	0	$\bar{2}$	1·32
5	3	$\bar{1}$	1·27
7	1	2	1·25
1	1	$\bar{4}$	1·21
8	2	$\bar{1}$	
6	2	$\bar{3}$	1·17
9	1	$\bar{2}$	
4	2	3	1·16
8	0	2	
8	2	1	1·14
0	4	0	
10	0	0	
1	3	$\bar{3}$	1·13
6	0	$\bar{4}$	
0	4	1	1·11
4	0	4	1·09

It is known that there is a range of solid–solubility from Fe_5C_2 to Mn_5C_2 (ref. 3), and it appears that over at least a portion of this range the unit cell of the intermediate carbide $(Fe,Mn)_5C_2$ is monoclinic[11]. It is likely therefore, that the unit cell of Fe_5C_2 is monoclinic, as proposed by Sénateur, Fruchart and Michel[6]. In this case, it appears that there is a range of composition between Fe_5C_2 and Fe_2C over which the unit cell of the carbide is monoclinic.

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NATURE OF χ-CARBIDE AND ITS POSSIBLE OCCURRENCE IN STEELS

By PROF. K. H. JACK and S. WILD
Department of Metallurgy, University of Newcastle upon Tyne

As stated by Duggin and Hofer[1], the interpretation of the powder pattern of Hägg carbide (otherwise known as χ-carbide and iron percarbide) as having an orthorhombic unit cell with contents $Fe_{20}C_9$ (ref. 2) is incorrect. It was realized more than ten years ago that the structure was probably of lower symmetry, and attempts were made by one of us (K. H. J.) to observe shifts of reflexions with related indices when some of the iron atoms were substituted by

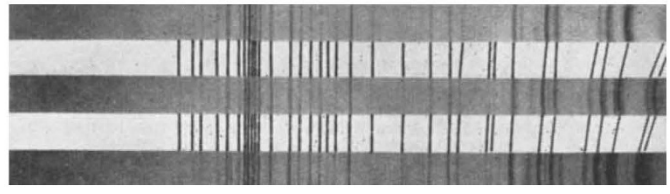

Fig. 1. X-ray diffraction patterns of $Fe_{20}C_8$, $Fe_{10}Mn_{10}C_8$ and $Mn_{20}C_8$ (CrK_α crystal-reflected monochromatic radiation; 19 cm diameter 'Unicam' camera).