graphic transitions in certain perovskite-type structures, and, while no exact analogies exist, the concept may be extended to the situation in the Group IV *A* hydrides.

An alternate explanation, based on the band theory of metals rather than a chemical bond theory, may be advanced. The transition from a cubic to a tetragonal lattice would then be considered as arising from an overlapping of Brillouin zone boundaries caused by small variations in electron density with temperature. Experiments at lower hydrogen concentration in both titanium and zirconium may provide some evidence bearing on the correctness of this hypothesis.

A discussion of the mechanism of the transformations must also be deferred pending a more complete microscopic and metallographic study. It is certain that they are diffusionless transitions but those aspects of their kinetics which can be deduced from the X-ray data alone do not suggest any other 'martensitic' characteristics.

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Short Communications

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On the occurrence of ε-carbide in iron.*

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It is well known that ε-iron carbide forms during the first stage of tempering hardened steel (Jack, 1951*a*; Roberts, Averbach & Cohen, 1953; Lement, Averbach & Cohen, 1954). Single-crystal X-ray work (Roberts *et al.*, 1953; Kurdjumov & Lyssak, 1947, 1949) on this material has shown that the ε-carbide phase exists in metastable equilibrium with martensite containing about 0·25 wt.% carbon and it was concluded (Roberts *et al.*, 1953) that ε-carbide would not form from martensite containing less than this amount of carbon. It thus appeared unlikely that ε-carbide would form directly from supersaturated ferrite. This view was supported by kinetic measurements (Dijkstra, 1949; Wert, 1949) on the precipitation of carbon from quenched iron containing about 0·02 wt.%

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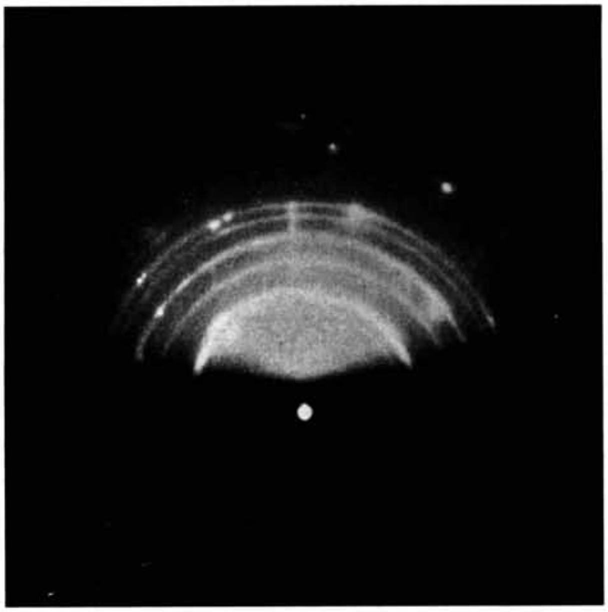

Fig. 1. Electron-diffraction pattern of iron quenched and aged at 200° C. for 2 hr.

carbon which gave no indication of the existence of a metastable phase prior to the formation of cementite. It was thus somewhat surprising when Tsou, Nutting & Menter (1952), using electron-diffraction methods, reported the existence of ε-carbide in iron containing 0·026 wt.% carbon. This is a brief report of further electron-diffraction experiments on iron which support the conclusions of Tsou *et al.*

Both commercial grade (Armco) iron with a nominal carbon content of 0·01 wt.% and high-purity vacuum-melted iron also containing 0·01 wt.% carbon were examined. The results obtained from the two materials were identical. Electron-diffraction patterns were obtained from specimens immediately after quenching from 720° C. after ageing at 200° C. for 2 hr. and after ageing at 400° C. for 1 hr. The quenched specimens gave only spotty patterns due to the iron itself. The additional face-centred cubic γ-iron phase reported by Tsou *et al.* (1952) was not detected. Those specimens aged at 400° C. gave patterns typical of cementite. However, the specimens aged at 200° C. for 2 hr. gave rise to a markedly different pattern shown in Fig. 1. The spots are due to the ferrite matrix and measurements of the continuous rings lead to lattice spacings in agreement with those of ε-iron carbide as shown in Table 1 (Jack, 1951*a*). It is known from internal friction measurements (Dijkstra, 1949; Wert, 1949) that the carbon precipitation process in iron is essentially complete after ageing at 200° C. for 2 hr., hence the most obvious interpretation of the above observations is that a carbide, namely ε-carbide, is present after this treatment.

Since the occurrence of ε-carbide in iron has not been detected except by electron diffraction experiments, other possible interpretations of the pattern obtained from the specimens aged at 200° C. have been considered.

Table 1. *Comparison of the interplanar spacings obtained from iron quenched from* 720° C. *and aged at* 200° C. *for* 2 *hr., with those of ε-iron carbide*

	Interplanar spacings (kX.)	
hkl	Iron aged at 200° C. for 2 hr.	ε-Iron carbide*
100	2·39	2·36
002	Not resolved	2·16
101	2·08	2·07
102	1·59	1·60
110	1·35	1·36
103	1·22	1·23
200	1·17	1·18
112		1·16
201		1·14

* Calculated for $a = 2{\cdot}729$, $c = 4{\cdot}326$ kX. (Jack, 1951*a*).

The alternative explanations would be to postulate (*a*) that it was due to an iron nitride phase, or (*b*) that it was due to two-dimensional diffraction from cementite platelets only a few unit cells in thickness. The first postulate may be ruled out since the nitrogen content of the high-purity iron was only one-tenth that of the carbon content, and thus the intensity of any nitride pattern would be very small compared to that of the carbide. In any case the ε-nitride phase does not occur under these conditions (Jack, 1951*b*, 1952) and the presence of α″-iron nitride or γ′-iron nitride would not account for the observed pattern. As regards the possibility of two-dimensional diffraction, this is also unlikely in view of the microscopically observed dimensions of the precipitate particles. Electron-microscopic examination of the high-purity iron specimen aged at 200° C. for 2 hr. indicated the presence of precipitate particles which were in the form of thin platelets several thousand Ångström units in the large dimension and a few hundred Ångström units thick. It is not possible that cementite platelets of these dimensions could give rise to the patterns observed. It is therefore concluded that the existence of ε-carbide in iron containing as little as 0·01 wt.% carbon is the most reasonable interpretation of the diffraction patterns from the specimens aged at 200° C.

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