combinations of symmetry elements. Each term in (2) gives sinusoidal variations of density in directions parallel to the three axes only, whereas each term in (1) gives sinusoidal variations in all directions.

Expression (2) was originally given by Epstein & Ehrenfest (1924); Compton (1926) correlated A_{hkl} with F_{hkl}/V.

Duane (1925) showed that for sodium chloride $\delta_h = \delta_k = \delta_l = 0$, since sodium chloride crystals possess three mutually perpendicular mirror planes. For such a crystal expression (2) reduces to

$$\varrho(x, y, z) = \frac{1}{V} \sum_h \sum_{k=-\infty}^{+\infty} \sum_l F_{hkl} \cos 2\pi hx/a \cos 2\pi ky/b \cos 2\pi lz/c\,. \quad (3)$$

This was the expression used by Havighurst (1925*a*, *b*, 1926, 1927) in investigating the structure of sodium chloride and other crystals. For sodium chloride δ_{hkl} also is zero and $F_{hkl} = F_{\bar{h}kl} = F_{h\bar{k}l} = F_{hk\bar{l}}$. Hence, by combination of the Fourier terms corresponding to these coefficients, expression (1) also reduces to (3) (Compton & Allison, 1935). The expression used by Duane and Havighurst was therefore correct, although derived from the incorrect form (2).

Other conditions for which (1) and (2) will reduce to a common form are possible, but arise only from certain combinations of symmetry elements which are not present in the general case.

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The orientation relationships between cementite and α-iron.

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(*Received* 27 *September* 1952)

An examination of the precipitation of cementite in the tempering of martensite, which the present author hopes to publish in detail later, is relevant to the recent paper under this title by Trillat & Oketani (1952).

In martensite, the c.p. hexagonal ε-carbide occurs transitionally in the precipitation (Jack, 1951). The best structural fit between cementite and ε-carbide, and a very good one at that, is given by (001) Fe_3C || (112) ε, [100] Fe_3C || $[\bar{1}10]$ ε. Also, in spite of the apparent complexity of cementite, the difference between the two structures lies simply in the stacking and spacing apart of (112) ε and the planes parallel to (001) Fe_3C. Cementite has mirror planes at $z = \pm\frac{1}{4}$ and this stacking can be obtained by a heterogeneous twinning of (112) ε in the $[\bar{1}\bar{1}1]$ direction. Prismatic interstices are generated on the mirror planes and the carbon atoms migrate into these interstices (there is probably also some rejection of carbon). This accommodation of the carbon atoms does not require any displacement of the iron atoms in the same plane, but the spacing apart of the planes becomes unequal, depending upon whether or not there is carbon–iron contact between them. Thus, it appears probable that (001) Fe_3C || (112) ε will give the cementite–ε-carbide orientation because of both the good structural fit and the simplicity of the structural relationship in this orientation.

ε-Carbide forms stringlets, whereas cementite forms platelets (Jack, 1951), so the cementite must eventually grow out of the ε-carbide into the iron solid solution. By that time, the precipitate may have broken away from the matrix and its growth will then be independent of the structural fit; if, however, break away has not taken place, a slight distortion will make (001) Fe_3C parallel to, and in register with, the α-iron planes corresponding to (112) ε. These α-iron planes belong to the two cubic forms {112} and {125} and the following are representative orientations:

$$(001)\ Fe_3C \parallel (211)\ \alpha;\ [100]\ Fe_3C \parallel [0\bar{1}1]\ \alpha;$$
$$(001)\ Fe_3C \parallel (2\bar{1}5)\ \alpha;\ [100]\ Fe_3C \parallel [\bar{3}\bar{1}1]\ \alpha\,.$$

Precipitation from ferrite, instead of martensite, possibly involves ε-carbide, but there may be direct nucleation of cementite. In the latter case, it appears reasonable to suppose that the orientation may again be given by (001) Fe_3C on {112} α or {125} α since these provide the best interfacial fits; that with {112} α is possibly rather the better and may be preferred.

Trillat & Oketani, in their single crystals of iron carburised at 500° C., found (111) Fe_3C || (001) α, $(1\bar{2}1)$ Fe_3C || (110) α. These planes do not themselves represent any close structural fit, but this orientation corresponds almost exactly with the fit of (001) Fe_3C on {112} α. The occasional occurrence of the orientation (100) Fe_3C || (001) α, (010) Fe_3C || (100) α was also detected and this may be due to the rather special nature of their specimens. These were thin films with (001) faces, so the second orientation possibly represents surface nucleation with (100) Fe_3C fitted to (001) α.

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