

may provide information regarding the nature of the mechanism of high-frequency discharges, as well as their action on the walls of containing tubes.

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¹ Banerji and Ganguli, *Phil. Mag.*, 15, 676; 1933.

Complex Chromium and Iron Carbides

THE carbide phase of a stainless steel containing about 13 per cent chromium and 0.3 per cent carbon has the same crystal structure as the lowest of the chromium carbides¹. The latter, which contains about 20 atomic per cent carbon, has been found to be face-centred cubic. From its lattice parameter, 10.64 Å., and density, 6.97, the number of atoms in its unit cell may be calculated; it is 116. Its formula should accordingly be Cr₂₃C₆. As this, however, is contrary to the rule of simple stoichiometric proportions, it was considered more probable that in the unit cell were present not 116 but 120 atoms, and that the true composition of the carbide² agreed with the formula Cr₄C. The carbide of stainless steel has consequently been denoted by (Cr,Fe)₄C (iron content up to about 25 atomic per cent).

A determination of the atomic grouping of the cubic chromium carbide has now proved that its formula is in fact Cr₂₃C₆. Its space group is O_h², and using Wyckoff's notation the atomic positions are:

4 Cr at 4(a), 32 Cr at 32(f), ($u = 0.385$),

8 Cr at 8(c), 48 Cr at 48(h), ($v = 0.165$),

24 C at 24(d), ($w = 0.275$).

The intensities of the reflections calculated on the assumption of this structure agree perfectly with those observed.

In a chromium-tungsten carbide of this type, containing about 7 atomic per cent tungsten, the tungsten atoms occupy mainly the points of 8(c). The formula of this substituted carbide may thus be written Cr₂₁W₂C₆.

As stated in a recent communication to NATURE³, the iron-tungsten and iron-molybdenum carbides present in low tungsten and molybdenum steels are analogous in structure to the cubic chromium carbide. With but slightly modified parameter values, the positions of the atoms in these substances are the same as in Cr₂₃C₆. Also in these double carbides the heavier metal atoms are not distributed at random among the iron atoms, but occupy preferably the points of the position 8(c). These substances may thus be considered to be Fe₂₁W₂C₆ and Fe₂₁Mo₂C₆, in which tungsten and molybdenum to some extent are substituted by iron.

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¹ *J. Iron and Steel Inst.*, 117, 383; 1928.

² *K. Vetenskapsakademiens Handl.*, III:2, No. 5; 1926.

³ NATURE, 132, 61, July 8, 1933.

Constitution of Water in Different States

In a former publication¹, the changes in the distribution of intensity of the Raman band of water with temperature have been explained on the

hypothesis that water consists of three types of molecules, single (H₂O), double (H₂O)₂ and triple (H₂O)₃, as revealed by the presence of three components in the band. Since these components were mixed up, it was not then possible to analyse the band to estimate quantitatively their relative intensities, for the determination of the proportions of these three types of molecules. Further work with ice and water at 0°, 4°, 38°, and 98° C. has now made such an analysis possible.

Ice is found to give a band consisting of two components only with Raman frequencies 3196 cm.⁻¹ and 3321 cm.⁻¹. Daure² obtained, with water vapour, a sharp line with the above frequency equal to 3655 cm.⁻¹. In water at different temperatures, all the above three components are found with varying relative intensities. On the assumption that ice consists of only the double and triple molecules, its Raman band is analysed, from which the positions of the components corresponding to the double and triple molecules are known. Knowing also the position of the component attributed to the single molecules from the Raman spectrum of water vapour, the intensity curves for the band at different temperatures of water are also analysed on the assumption that the positions of the three components are the same in all the states. From the intensities of the components thus analysed are calculated the relative proportions of the single, double and triple molecules, which are assumed to be directly proportional to the above intensities. The values thus obtained are:

	Ice	Water (0°)	Water (4°)	Water (38°)	Water (98°)
H ₂ O	0	19	20	29	36
(H ₂ O) ₂	41	58	59	50	51
(H ₂ O) ₃	59	23	21	21	13

The maximum number of double molecules in water at 4° perhaps explains the maximum density of water at this temperature, as the graphic formula for these molecules indicates that it is more compact than the triple molecules. Since these latter type predominate in ice, the packing of molecules is less dense in this state, thus leading to its smaller density.

The only quantitative determination of the proportions of these is that by Sutherland³ from values of the specific volume of water at different temperatures. This is, of course, an indirect method, whereas that adopted by me is more direct.

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¹ *Proc. Roy. Soc.*, A, 130, 495; 1931.

² *C.R.*, 192, 1721; 1931.

³ *Phil. Mag.*, 50, 460; 1900.

Electrostatic Deflection of Positive Electrons

It is already known that the so-called 'positive electron' is deflected in a magnetic field. We are able now to deflect it in an electrostatic field.

The experimental arrangement may be shortly described as follows: the source of positive electrons is placed in an evacuated box, between the pole pieces of an electromagnet, but in the marginal region of non-uniform magnetic field. If a film be placed along the same diameter of the pole pieces, opposite to the source, a photographic record may be obtained of the positive electrons.

Thus, the positive particle describes short circles