

### Anomalous X-Ray Diffraction Intensities.

The accompanying photographs (Fig. 1) show an interesting example of a case where the relative intensities of the lines in any X-ray spectrum may vary without a corresponding change in atomic arrangement. They are Debye photographs of chromium plated wires obtained under different conditions of electrodeposition. It is seen at once that the intensity of the middle line, the (200) reflection, in comparison with that of the other two lines, the (110) and (211), is as strong as normally it should be in the top photograph. In the second photograph it has become relatively weak. In the bottom photograph it has disappeared entirely.

These intensity changes could be explained in various ways if foreign atoms capable of scattering

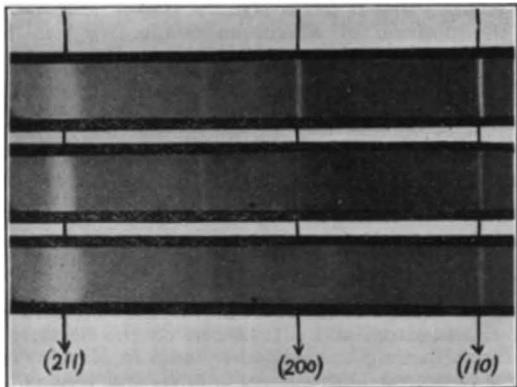


FIG. 1.

X-rays were present to any extent in the deposits. The point of this case, however, is that the metal is apparently free from such impurities. Photographs taken on larger films failed to reveal any appreciable orientation of the grains. The presence of lattice distortion, which also might cause the effect, was considered unlikely because the values of the spacings were found to be constant and equal to those usually accepted for chromium.

The probable explanation follows from the work of Laue on X-ray reflection from crystals of a sub-microscopic order of magnitude. The excessive breadth of the lines in the photographs shows that the deposits are composed of such very small crystallites. If those crystals are shaped haphazardly and do not exhibit a preferential habit, all the lines should be broadened in the regular way required by Laue's equations, the broadening being normally larger as the glancing angles increase. But if a majority of the crystals develop a particular form, a flat plate-like shape, for example, or a needle-like shape, then certain sets of planes contain fewer reflecting components, and the resolving power of those planes, in comparison with the others, will decrease until in time they will not produce a spectral line of any degree of visibility. This apparently is what has happened in the case of the (200) line in the photographs. The relative intensities are influenced by the shape of the crystallites.

It is interesting also to note that the type of chromium plating which showed the above effect appeared to be the one characterised by a brilliant lustre. The grey matt type of deposit gave a normal intensity distribution. The full results of the X-ray study of chromium deposits it is hoped to publish elsewhere.

Finally, in view of the fact that the effect occurs

with a pure substance, it would seem that the deduction of atomic structure from the relative intensities of the lines on a powder photograph, when the material is in a fine state of subdivision, must be attended with one more complication.

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### Properties of Dielectrics in Electric Fields.

THE issue of NATURE of Jan. 3 contained a letter from Mr. A. Morris Thomas, of the British Electrical and Allied Industries Research Association, in which, while agreeing generally with the principles in my letter in NATURE of Nov. 22 last, he pointed out that the term 'permittivity' is frequently used now instead of 'dielectric constant'.

I was not unaware of this when writing originally; but the term 'permittivity' was proposed by Heaviside before the electrical nature of matter was discovered, and while answering his immediate purpose, it suggests that the action of the field is through the dielectric, while modern knowledge shows that it is directly on the opposite charges constituting the molecules of the dielectric.

Again, modern work shows also that what is called 'capacity' may arise from at least three different causes, which cannot properly be all comprehended under one term, except for special purposes. In two communications to the *Phil. Mag.* (May 1924 and Jan. 1926) I showed that Maxwell's law was true in the case of 11 out of the 19 non-metallic elements of which the value of  $\epsilon$  was known, including those most important, and that the same almost certainly would apply to, at any rate, 6 of the remainder. The greatest deviation from equality was about 10 per cent.

On the other hand, for many substances, compounds formed of the above elements, the relative values of  $\epsilon$  and  $N^2$  widely differ.

As to this, it is now generally accepted that atoms and molecules can be divided into two classes:

(1) *Non-Polar*.—In this class, in an outside field there is repulsion of the nucleus and attraction of the electrons, but no tendency to orientation. Debye calls this the 'distortion'; it is small and any dissipation of energy accompanying it is small also. It agrees approximately with the square of the refractive index.

(2) *Polar*.—In numerous cases the positive and negative charges of the molecules are not symmetrically situated in an outside field: thus, in addition to distortion, they have a moment and tend to be rotated and oriented in line with the field. The capacity of the system is thus increased. This type of capacity, unlike the distortional form, is affected by change of temperature, falling as the temperature is raised and also by increase of frequency.

Both these forms of capacity are due to direct action between the field and the mass of the molecules of the substance acted on. There is, however, a third form of capacity. Ions usually exist in small quantities in dielectrics and constitute polar molecules of the strongest type, with the addition that one pole is stronger than the other; thus, besides orientation, there is a direct pull on the stronger pole of the ion in the direction of the opposite electrode of the field. Thus the capacity of the system is again increased, and at low frequencies this increase may be very large.

In this latter form of capacity the action of the field is on inclusions of electrolytic type, the molecules of which are scattered through the dielectric, and not on the mass of the molecules of the dielectric itself,