LETTERS TO THE EDITORS

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New X-ray Evidence on the Nature of the Structural Changes in Cold-worked Metals

A PROBLEM in X-ray diffraction has been the diffusion of the X-ray reflexions from a metal which has been subjected to plastic deformation. A crucial experiment has long been called for which would indicate clearly what modifications in structure of the deformed metal are mainly responsible for the effect. The method usually suggested is indecisive: it involves a laborious measurement of changes scarcely greater than experimental error, and, as recent publications have shown, gives different results in the hands of different workers[1,2]. It may be of interest, therefore, to record an alternative method which, for a number of metals, including iron and steel, appears to solve the problem in a simple direct manner.

It had already been shown that the systematic deformation of metals in general produces two fundamental effects, either of which could cause the diffusion. These are: (*a*) the breakdown of the metallic grains to crystallites characterized by a lower limiting size; and (*b*) permanent overall changes in dimensions of the atomic lattice to an extent related to the external deformation of the metal[3,4]. The former factor could cause diffusion if the crystallites became less than about 10^{-4} cm. in size, when, with standard diffraction techniques, the number of atomic planes in each becomes too small to produce sharp reflexions; the latter because the lattice strain can produce an overall change in diameter of the diffraction rings, and as the lattice strain is not likely to be the same from point to point, the change in diameter will vary about a mean. Actually it was concluded from other evidence that both effects were usually present, a point especially illustrated by copper; but it was decided to try to develop a reliable criterion to distinguish the predominant factor.

The usual method[1,2] is based on the fact that, with fine crystallite size, the broadening of the reflexions formed at different angles should vary as $\sec\theta$, where θ is the Bragg angle; whereas, for variability of lattice spacing, the broadening should vary as $\tan\theta$. But, in practice, at small values of θ, when $\sec\theta$ and $\tan\theta$ differ most, the broadening is too small for reliable measurement; while at large values of θ, when the broadening does become measurable, the difference between $\sec\theta$ and $\tan\theta$ is too small to be of much use. Moreover, the necessity of having to photograph the whole angular range of the spectrum would restrict the method to a type of specimen unsuitable for serious study of mechanical deformation.

The method now used here utilizes the fact that at a given reflexion angle the broadening due to fine grain is proportional to λ, the X-ray wave-length used to obtain the diffraction pattern; but that due to variability of lattice spacing is independent of wave-length. The success of the method, however, really arises because a technique has been developed for photographing large-scale back reflexions formed by short incident wave-lengths such as molybdenum $K\alpha$ radiation without unduly long exposures, a procedure usually regarded as impracticable. It is then possible to confine attention to the large-angle reflexions, which show the broadening on an easily measurable scale. The wave-lengths normally employed to obtain back-reflexions range from 1·5 to 2 angströms. If a photograph is obtained with one of these as incident radiation and then with molybdenum radiation ($\lambda = 0{\cdot}7$ A.) or a similar short wave-length, then the broadening, if due to fine grain, will change sensitively by a factor of 2 to 3 times, well beyond experimental error.

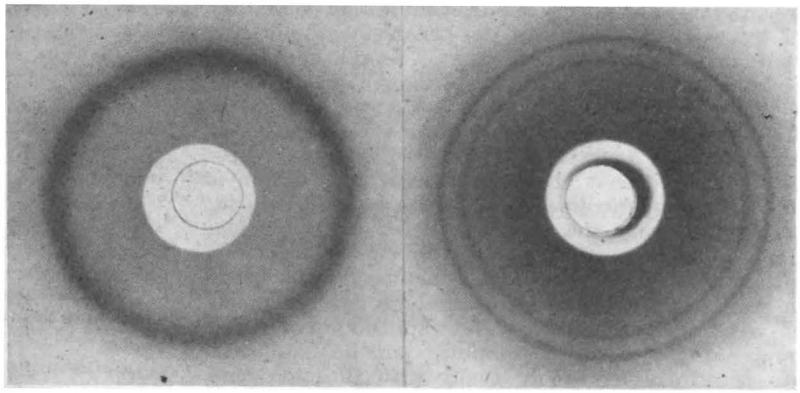

Fig. 1. Fig. 2.

In fact, when the main factor is fine grain, the change is so striking that it may be of interest to illustrate the effect. Fig. 1 shows the very diffuse back-reflexion (310) ring obtained from a heavily deformed steel with cobalt radiation ($\lambda = 1{\cdot}8$ A.); it is too diffuse to show the component $\alpha_1\alpha_2$ doublet. Fig. 2, in contrast, shows a ring at approximately the same diffraction angle with the molybdenum radiation. The $\alpha_1\alpha_2$ doublet now forms rings so obviously sharper that, in any event for steel, the long-standing problem can be solved by inspection.

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[1] Dehlinger and Kochendorfer, *Z. Krist.*, **101**, 134 (1939).
[2] Stokes, Pascoe and Lipson, NATURE, **151**, 137 (1943).
[3] Wood, *Proc. Roy. Soc.*, A, **172**, 231 (1939).
[4] Wood and Smith, *Proc. Roy. Soc.*, A, **178**, 93 (1941); **179**, 450 (1942); **181**, 72 (1942).

Mechanism of Biological Action of Vitamin K and its Synthetic Analogues

THE correlation between structure and biological action of the vitamin K group is an object of many investigations. However, in spite of much experimental material we still lack a satisfactory explanation of both the established correlations and of the mechanism of biological action of the natural vitamins K_1 and K_2 and of their synthetic analogues. It was already in 1939 that L. F. Fieser first suggested the hypothesis[1] further developed in 1941[2] that the