

## Letters to the Editor.

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## Magnetic Properties of Single Crystals of Zinc and Cadmium.

RECENT investigators have studied the thermal expansion, the electrical resistance, the elastic constant, the thermoelectric and the photoelectric effects of single crystals of metals, but up to the present few accurate results have been obtained for the fundamental para- or diamagnetic properties of such metals.

Last year the susceptibilities of the alkali metals were studied, and it was thought of interest to extend this investigation to a study of the elements of the second column of the periodic system. When these elements were studied previously (Honda and Owen), metals in the form of an isotropic aggregate of crystals were used. As zinc and cadmium form crystals of the hexagonal system, the value of the magnetic susceptibility parallel to the crystallographic axis would be expected to differ from its value in a perpendicular direction.

In making crystals for these experiments, the method described by Bridgman was used. He found that for cadmium and zinc the preferred manner of growth was with the basal plane parallel or perpendicular to the axis of the cylinder. Under a rough optical examination, the crystals used in the experiment referred to appeared to be orientated with the basal plane parallel to the axis of the cylinder.

To study the susceptibility, the crystals were suspended vertically from one arm of a balance so that the lower end hung between the poles of an electromagnet, and weighings were taken in the presence and absence of a known magnetic field. The crystal was rotated through  $360^\circ$  about a vertical axis, readings being taken every  $15^\circ$ . The results obtained are shown in the accompanying diagram (Fig. 1). At the position of maximum and minimum effect, readings were taken for a range of field from 5000 to 12,000 gauss, and corrections for iron impurities were made according to the method given by Owen. By this method, the amount of free iron contained in the metal was found to be of the order of  $0.5 \times 10^{-6}$  gm. of iron per gram of metal. The specific susceptibilities obtained in this manner were, for zinc,  $-0.183 \times 10^{-6}$  in a direction parallel to the principal axis of the crystal, and  $-0.147 \times 10^{-6}$  in a direction perpendicular to this. For cadmium, these values were  $-0.276 \times 10^{-6}$  and  $-0.169 \times 10^{-6}$ . The values given by Owen, obtained from coarse-grained crystals, were, zinc  $-0.155 \times 10^{-6}$  and cadmium  $-0.18 \times 10^{-6}$ .

It is intended to study a still larger number of crystals and to investigate the influence of low temperatures upon their magnetic susceptibility.

One of us, Elizabeth Cohen, has been enabled to

co-operate in this investigation through the award to her of a studentship by the National Research Council of Canada.

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## Passivity and Protective Oxide Films.

IN NATURE of Feb. 11 (p. 222) it is stated that "An X-ray examination of finely divided iron, nickel, and chromium, conducted by F. Krüger and E. Nährung at Greifswald, has shown conclusively that films of oxide thicker than  $10^{-7}$  cm. are not present on the surface of a passive metal." Lest a wrong impression be gained from this statement, I would venture to add a few remarks on the factors which determine the thickness of protective films.

The film produced by oxidising agencies on metals necessarily ceases to thicken as soon as it becomes sufficiently protective to exclude the oxidising agent.

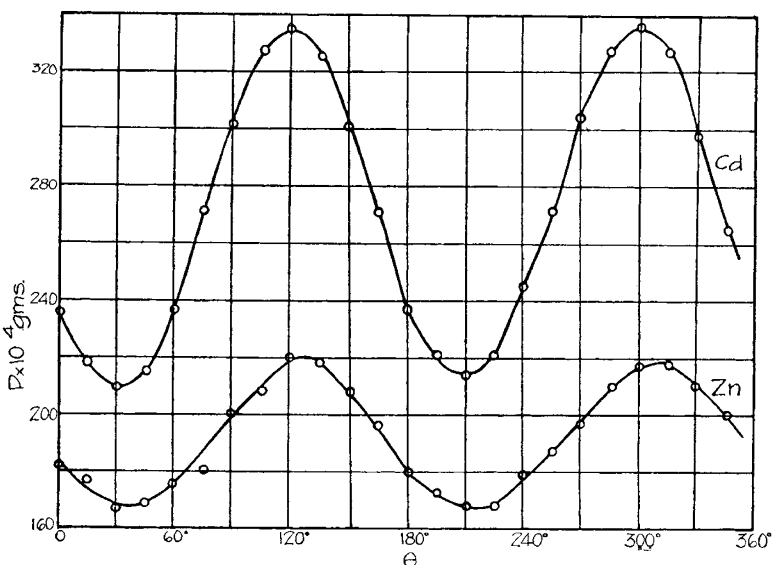


FIG. 1.

Recent work (*Jour. Chem. Soc.*, 1920; 1927) has pointed to the fact that, on freshly abraded iron, the considerable thickening of the film experienced proceeds through the production of cracks due to the internal stresses left by the abrasion; only when this cracking of the film has ceased will the thickening come to an end. Since a cracked film produces no passivity, coarsely ground metal requires a longer time to become passive than finely ground metal, and develops a thicker film, especially if substances be present in the solution which are capable of penetrating the smallest cracks (*e.g.* chlorine ions). The films obtained from abraded specimens attain thicknesses of the order  $10^{-6}$  cm., and can be isolated from their basis and studied. In the presence of a regulated amount of penetrating anions, the thickness may come to exceed  $4 \times 10^{-6}$  cm., and the films will then give rise to interference tints. Great thickening is only to be obtained under conditions which render the material less perfectly protective, and there is naturally some danger that the film will break down altogether. Under suitable conditions, however, considerable thicknesses may be reached; the writer has quite recently prepared