MEASUREMENTS ON THE MAGNETIC ANISOTROPY IN EVAPORATED IRON FILMS
by R. VRAMBOUT and L. DE GREVE
Instituut voor Lage Temperatures en Technische Fysica, Leuven, Belgium

Summary
We have examined the problem of the magnetic anisotropy in evaporated iron films by use of the magneto-optic Kerr effect method. As a result we found that there exists a weak anisotropy in some iron films coming from mechanical tensions.

§ 1. Introduction. Since a few years we have been especially interested in the magnetic structure of evaporated iron films 1). At present we report on the result of our latest measurements on magnetic anisotropy, obtained with the use of the magneto-optic Kerr effect method. This method does not only allow to study the hysteresis phenomenon of the whole film, but also at any particular point of the film. Indeed, the illuminated surface of the film can easily be reduced to a few tenths of a millimeter.

It may now safely be assumed that thin ferromagnetic films are composed of a single Weiss domain, especially after being subjected to a magnetic field. Before magnetization, Bloch walls may in some cases be found 1), but as a rule they disappear completely when an external field is applied.

We have tried to determine the different factors that influence the magnetic properties of these one-domain iron layers. When measuring as a function of thickness and especially when evaporating in a rather poor vacuum, we experienced earlier that it was practically impossible to obtain reproducible results. So we decided to restrict our investigation to layers of practically the same thickness (between 730 and 1120 Å). According to Kittel's theory 3) and our own previous measurements these films should indeed be composed of only one domain.
§ 2. Experimental method. Our experimental method has been briefly described in an earlier paper 2). In the Kerr effect a polarized lightbeam is reflected from the layer that is to be studied. This causes a small rotation of the plane of polarization. Our actual experimental device differs only little from the previously described apparatus. The CdS photoconductive cell, that was then used in order to measure the changes in light intensity after reflection, was of course not sensitive enough to measure differences in coercive fields with a sufficient accuracy. So it was replaced by a photomultiplier, in this way increasing the sensitivity of the method by several orders. This allowed us to use a weaker source of light. One of the disadvantages of a high pressure mercury arc lies in the difficulty of getting it sufficiently stabilised. So the mercury arc was replaced by a much weaker incandescent lamp of the type commonly used in microscopes.

The iron film can be rotated in its own plane between two Helmholzt coils in such a way that the magnetic field always remains parallel to the plane of the film. Hysteresis loops are then measured in different directions of the film. The angle between the long axis of the rectangular glass support and the external magnetic field varies between 0° and 180°.

The films were evaporated in a vacuum of the order of $10^{-5}$ to $10^{-6}$ mm Hg on polished rectangular glass plates. The dimensions of the layers were of the order of 3 to 4 mm in either direction. The thickness of the layers was measured by means of the optical multiple interference method of Tolansky.

§ 3. Experimental results. The determination of hysteresis loops as a function of the position of the layer is a very reliable method for detecting the existence of any anisotropy axis. Indeed, any change of magnetization in such films can only be attributed to a rotation of the magnetic moment in the whole film and not to the displacement of Bloch walls. Hysteresis loops which are measured parallel to an anisotropy axis should be rectangular, while loops measured perpendicular to this axis can be expected to be almost flattened out. From our measurements it appeared that often a relatively weak anisotropy occurs. Nevertheless in some layers no anisotropy can be detected. Mostly, however, the shape of the hysteresis loop and also the coercive force changes as a function