FIG. 2. Fermi plot for  $C^{14}$ .

shape may appear to be nearly allowed while the classification is still forbidden. However, Gerjuoy<sup>7</sup> has argued that this explanation is implausible. If the transition is really first-forbidden (unfavored) with a parity change,<sup>7</sup> a much wider latitude in fitting the theory to the observed spectrum shape would be permitted. This would require a modification of the shell model prediction.

I would like to thank Mr. P. S. Magee for performing the chemical conversion.

\* Now at the Institute of Radiobiology and Biophysics, University of Chicago, Chicago, Illinois.

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<sup>1</sup> E. Feenberg and K. C. Hammack, *Phys. Rev.* **75**, 1877 (1949).

<sup>2</sup> L. Feldman and C. S. Wu, *Phys. Rev.* **75**, 1286 (1949); L. E. Glendenin and A. K. Solomon, *Phys. Rev.* **74**, 700 (1948); J. L. Berggren and R. K. Osborne, *Phys. Rev.* **74**, 1240 (1948).

<sup>3</sup> Cook, Langer, and Price, *Phys. Rev.* **74**, 548 (1949); Angus, Cockroft, and Curran, *Phil. Mag.* **40**, 522 (1949).

<sup>4</sup> Van Atta, Warshaw, Chen, and Taimuty, *Rev. Sci. Inst.* (to be published).

<sup>5</sup> M. Calvin *et al.*, *Isotopic Carbon* (John Wiley and Sons, Inc., New York, 1949), p. 123.

<sup>6</sup> Quoted in reference 1.

<sup>7</sup> E. Gerjuoy (to be published).

## A Thermal Mechanism for Residual Latent Image Fading in Nuclear Emulsions

ARTHUR BEISER

Department of Physics, New York University, New York, New York

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EXPERIMENTS by Mather<sup>1</sup> on fading rates in nuclear emulsions indicate a reduction of approximately 90 percent in the fading of proton tracks when stored prior to development in a vacuum, indicating that at least that proportion of the fading phenomena is chemical in nature, with some constituent of the atmosphere the agent involved. However, it is proposed that some or all of the residual 10 percent of the fading can be explained on the basis of the thermal ejection of electrons from the silver specks of the latent image.

This mechanism would consist in the acquisition by these electrons of sufficient energy to re-enter the conductance band of the crystal, causing an electrolytic current of silver ions to flow from the latent image into the grain. The electrons will recombine with

the ions in the interior of the grain where the resulting Ag atoms cannot function as nuclei for development, a redistribution of the latent image similar to that occurring in the Herschel effect. The dissociation energy required to remove an electron from the silver specks comprising the latent image will equal the difference between the work function  $\phi$  of the specks and the energy of the lowest state of the conductance band. The most recent value for this energy has been given<sup>2</sup> as 0.77 eV, and is great enough to assure the comparative stability of such images with respect to thermal decomposition at ordinary room temperatures, corresponding to an energy of approximately 0.7 eV. However, a relatively slight change in one of the factors governing the magnitude of the dissociation energy would be sufficient to alter the rate of thermal regression of a latent image at room temperature. This latter condition is fulfilled in nuclear emulsions to a certain degree, since the size of the silver specks after particle irradiation is much smaller than of those in optical emulsions, leading to a lower value for  $\phi$  and hence to a lower value for the energy needed to release a trapped electron. The smaller size will be due to the rapidity with which a radiation particle traverses the halide grains (about  $2 \cdot 10^{-14}$  sec. for 5 MeV alpha-particles). Since the migration of the silver ions through the crystal is considerably slower than that of the electrons, the sensitivity specks will acquire negative charges faster than they can be neutralized and further electrons will be repelled until sufficient silver ions have reached the specks. By that time, however, no further electrons will be available and the repelled electrons will have combined with silver ions in the interior of the crystal. Thus, in a very rapid transfer of energy to the emulsion, the latent image will tend to contain unusually small silver specks, which is generally the case. The small size also may be expected to contribute to the atmospheric instability of the latent image.

<sup>1</sup> K. B. Mather, *Phys. Rev.* **76**, 486 (1949).

<sup>2</sup> J. H. Webb, *J. Opt. Soc. Am.* **40**, 3 (1950).

## Mechanism of Magnetization in Alnico V

E. A. NESBITT AND H. J. WILLIAMS

Bell Telephone Laboratories, Murray Hill, New Jersey

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USING magnetic powder pattern technique,<sup>1</sup> new information has been obtained on the mechanism of magnetization in the alloy containing 14 percent Ni, 8 percent Al, 24 percent Co, 51 percent Fe, and 3 percent Cu (Alnico V). This permanent magnet alloy is unique in that it responds to heat treatment in a magnetic field, and the work here reported has been done to try to explain this action.

Figure 1 shows photographs of magnetic powder patterns of polycrystalline Alnico V cooled from 1300°C at 2° to 5°C per second to 810°C and then oil-quenched, a field being present from 900°C to room temperature. Figures 1(a-c) show photographs in which the specimen was magnetized vertically during heat treatment and horizontally during observation. In (a), domains are seen to lie in a vertical direction and as the field is increased from zero to successively higher values (b, c) the domain boundaries either disappear or the domains contract in width and the horizontal lines (splotches), which indicate the direction of magnetization,<sup>1</sup> gradually rotate toward a vertical position. When the specimen is near saturation, the boundaries of the domains disappear and the originally horizontal lines have become vertical. It is evident, therefore, that in this case the mechanism of magnetization is mainly one of rotation and not of boundary displacement.

Figure 2 shows the magnetization curve for the specimen shown in Figs. 1(a-c). The coercive force of this specimen was only 17 oersteds and yet the knee of the magnetization curve occurs in the neighborhood of 450 oersteds. This indicates that the material has a high anisotropy caused by heat treatment in a field. If this material could be divided into fine particles<sup>2</sup> (e.g., by precipitation

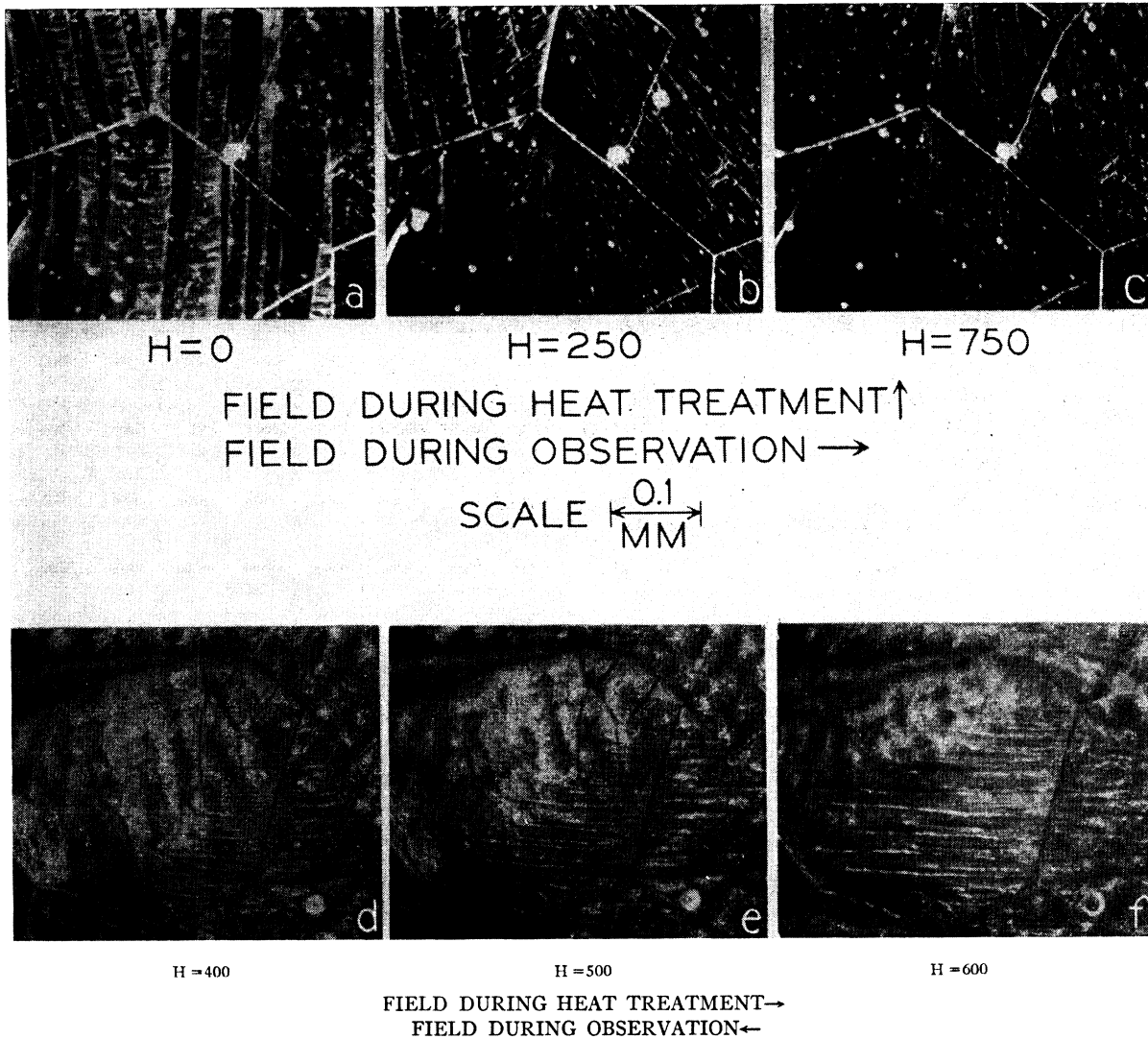


FIG. 1. Magnetic powder patterns on polycrystalline Alnico V; (a), (b), and (c) cooled from 1300°C at 2° to 5° per second to 810°C then oil-quenched a transverse field being present from 900°C to room temperature; (d), (e), and (f) standard Alnico V treatment.

of plates),<sup>3</sup> so that for all orientations the magnetization change would have to occur by rotation, then the anisotropy observed from the magnetization curve could account for coercive forces of the order of 400 to 600 oersteds, as observed for Alnico V.

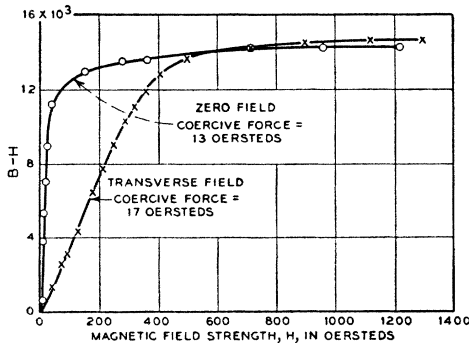


FIG. 2. Magnetization curve on Alnico V cooled from 1300°C at 2° to 5°C per second to 810°C then oil-quenched, a field (indicated) being present from 900°C to room temperature.

If the specimen is heat treated and aged, so as to obtain 600 oersteds coercive force, the domains are visible but much smaller. At residual induction, the domains are not normally visible but as the demagnetizing field is applied in the vicinity of 400 oersteds, spike-like domains appear as in Fig. 1(d). Further increase in the field strength causes these regions of reverse magnetization to grow as in Figs. 1(e) and (f). Finally, however, as saturation is approached they merge and the boundaries again disappear.

At first thought it may seem that the existence of these large spike-like domains in a material of 600 oersteds coercive force is inconsistent with the fine-particle theory of coercive force. This is not necessarily the case since it is entirely possible that these spike-like domains are aggregates of many fine-particle domains which are oriented in the same direction.

The authors are greatly indebted to R. M. Bozorth for valuable discussion and to J. G. Walker for assistance with the photography.

<sup>1</sup> H. J. Williams, *Phys. Rev.* **70**, 106 (1946); Williams, Bozorth, and Shockley, *Phys. Rev.* **75**, 155 (1949).

<sup>2</sup> L. Néel, *Comptes Rendus* **225**, 109 (1947); E. C. Stoner and E. P. Wohlfahrt, *Nature* **160**, 650 (1947).

<sup>3</sup> Kittel, Nesbitt, and Shockley, *Phys. Rev.* **77**, 839 (1950). Drozhjina, Luzhenskaya, and Shur, *J. Tech. Phys. U.S.S.R.* **19**, 95 (1949).

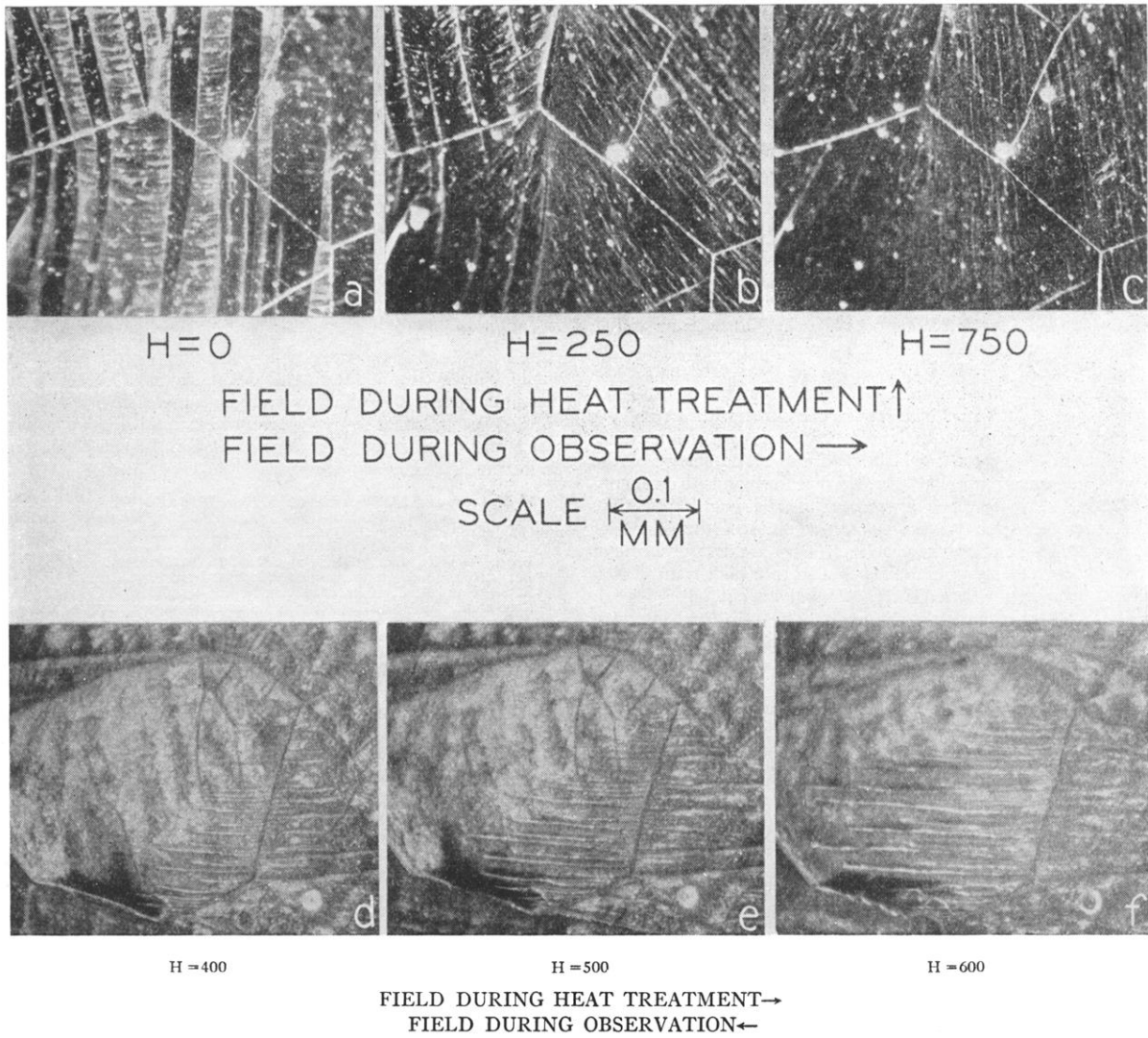


FIG. 1. Magnetic powder patterns on polycrystalline Alnico V; (a), (b), and (c) cooled from 1300°C at 2° to 5° per second to 810°C then oil-quenched a transverse field being present from 900°C to room temperature; (d), (e), and (f) standard Alnico V treatment.