and a tungsten wire attached to the outside, are brought into contact with the melt in the two arms of the U tube. The temperature of the melt in each arm and the thermal emf developed between the tungsten wires and the molten FeS are measured with a potentiometer. Temporary turning off of the high-frequency heating current produces no change in the thermal emf, indicating the latter is not produced by induction and rectification. The temperature of the melt in each arm and the thermal emf developed between the tungsten and the molten FeS melt but permitting a complete thermal and electrical circuit did not change the observed emf. Since there was negligible

![Fig. 1. Experimental arrangement for measuring thermoelectric power of molten FeS against tungsten.](image)

secondary electron emission yield as a function of primary electron energy for a single crystal of MgO. The lower curve (solid points) represents the yield before any heating of the crystal. The upper curve (open points) represents the yield after heating the crystal substrate to 800°C for several hours and cooling to room temperature.

![Fig. 1. Secondary emission yield as a function of primary electron energy for a single crystal of MgO.](image)

with 100 microamp/cm² at 1200 ev primary electron energy for several hours. No evidence of time-delayed or field effect emission (Molter effect) has been observed.

The magnesium oxide crystals were obtained from the Infra-Red Development Company, Welwyn Garden City, Hertfordshire, England. Each crystal is cleaved to a thickness of 1/16 inch in air immediately before mounting it in a continuously pumped secondary emission tube. The crystal is mounted on the target holder through a long sidearm tube. The glass sidearm is then sealed off at least 8 inches from the crystal while an inert gas flows through the tube. Pressure in the vacuum system has ranged from 10⁻⁷ to 10⁻⁵ mm, using mercury pumps and liquid nitrogen traps. No effect on the secondary emission yield has been observed by varying the pressure within this range. Similarly no decay in yield with time has been observed that could be attributed to gas adsorption on the surface.

The crystal is mounted on a substrate (tungsten, or tungsten coated with graphite) such that the substrate can be heated. Several of the crystals exhibited an increase in the secondary emission yield after heating the crystal substrate to 800°C and cooling to room temperature. An example of this is shown in Fig. 1. The lower curve is the initial yield as a function of primary electron energy for one of the crystals before heating. The upper curve was obtained after heating the crystal substrate to 800°C

**Secondary Electron Emission of Single Crystals of MgO**

N. REY WHETTEN AND A. B. LAPONSKY

General Electric Research Laboratory, Schenectady, New York

(Received November 9, 1956)

LYE has reported that single crystals of magnesium oxide cleaved in a high vacuum exhibit unusually high secondary emission yields in the range of 20-25. The results presented here, obtained during a study of the energy distribution of secondary electrons from MgO, confirm the high yields reported by Lye. The yields in the present experiment must be taken as typical of gas-covered surfaces of the single crystals, since the crystals are cleaved in air before sealing them into the vacuum system. No decay in yield with time that could be attributed to gas adsorption on the surface has been observed. High yields have been obtained to date from five different crystals.

The secondary emission measurements are made using a single pulse technique described elsewhere. The system sensitivity is sufficiently high that only 10⁻¹⁴ coulomb of bombarding charge is used per measurement. However, no significant change in yield has been observed after dc bombardment of two of the crystals

**Acknowledgments.**—This work is part of a research program sponsored by the U. S. Atomic Energy Commission. The possibility of a thermal emf in these melts was suggested originally by R. Smoluchowski, but the quantitative measurement could not be made until now.

3. Bourgon, Pound, and Derge, to be presented at the February 1957 Winter Meeting, American Institute of Mining and Metallurgical Engineers.
and cooling to room temperature. Several other crystals showed no significant increase after heating.

Our experience has indicated that the secondary emission yield of MgO crystals may be adversely affected if the glass vacuum system is baked above 300°C. The decrease in yield may possibly result from a reaction at the crystal surface with water vapor emitted from the glass walls during bakeout. 6

The authors wish to express their thanks to Dr. P. E. Pashler and Professor W. G. Shepherd for encouragement and for many stimulating discussions, and to Mr. C. R. Bunting for continued assistance throughout the work.

2 N. Rey Whetten and A. B. Laponsky (to be published).
3 The Minnesota group has observed a decay in yield with time on some crystals cleaved in a high vacuum and not on others. (Private communication from Professor W. G. Shepherd.)
4 A. B. Laponsky and N. Rey Whetten (to be published).

Slow Remagnetization Times in 4–79 Molybdenum Permalloy
J. D. BLADES and R. A. TRACY
Burroughs Research Center, Paoli, Pennsylvania
(Received June 18, 1956; revised version received February 4, 1957)

Measurements of the slow remagnetization time \( \tau \) as a function of an externally applied pulsed magnetic field \( H \) have been made for a 4–79 molybdenum Permalloy \( \frac{1}{2} \)-inch diameter toroidal core, consisting of ten insulated wraps of \( \frac{1}{2} \)-mil thickness and \( \frac{1}{2} \)-inch width. The experimental values of \( 1/\tau \) and \( H-H_0 \) are presented logarithmically in Fig. 1, where \( H_0 \) is the value of an applied dc field that causes the material to begin its final approach to saturation as \( H \) is increased slowly (the second knee of the hysteresis loop reached by the material as a reversal of magnetization occurs). Under static conditions the magnetic saturation of the core occurs at \( H_0 \leq 0.276 \) oersted, the coercive force is \( H_c = 0.125 \) oersted (\( B = 0 \)), and \( H_0 = 0.138 \) oersted. In this experiment eddy current effects are considered to be negligible. This is verified by the agreement obtained in the fast switching region with the measurements of Menyuk and Goodenough. 1

An interesting result of this experiment is the transition (change of slope of the curve), occurring in the fast switching region. This transition is significant in that it suggests a change in the type of remagnetization mechanism, e.g., a wall motion process giving way to a "coherent" rotation process, when the pulsing applied field is approximately twice the dc value of \( H_0 \).

Fast switching times are predictable, including the effects of a coercive force, by the rotation model of Coleman. 2 If in the switching time expression, we use \( \lambda = 4.1 \times 10^4 \) sec \(^{-1} \) and a magnetic moment per unit volume of 700 emu. These predictions are represented in Fig. 1 by the dashed line. The value of ferromagnetic spin relaxation time (converted Bloch damping constant) for 4–79 molybdenum Permalloy has been determined by a ferromagnetic resonance line width experiment, employing apparatus and procedures like Bloembergen. 3 The possible field dependence of \( \lambda \) in adapting to a rotation mechanism has not been investigated.

The qualitative agreement with experiment that has been obtained with the rotation model and with the domain wall model \( d \) in the fast switching range in \( \frac{1}{2} \)-mil 4–79 tape further points up the complexity of ferromagnetic experiments, and the need for improved observations to clarify this phase of the physical situation.

The slow switching time measurements have been made by C. Thompson and his efforts are greatly appreciated.

Erratum: Solubility and Diffusivity of Gold, Iron, and Copper in Silicon
[J. Appl. Phys. 27, 1506 (1956)]
J. D. STRUTHERS
Bell Telephone Laboratories, Inc., Murray Hill, New Jersey

THE values for the diffusion constant of gold in silicon (Fig. 2) are plotted erroneously, and are low by a factor of ten.

Errata: Secondary Waves of Electroluminescence
[J. Appl. Phys. 28, 117–123 (1957)]
C. H. HAAKE
Lamp Division, Westinghouse Electric Corporation, Bloomfield, New Jersey

Lines 21 and 22 of Sec. D, p. 118, should be deleted. The temperature cited at the top of Fig. 3 should be \(-60^\circ C\). In the denominator of Eq. (5c), \( \gamma/4^2 \) should be replaced by \( \gamma/4 \) and \( \gamma/18^2 \) by \( \gamma/18 \). In the final equation for \( \psi \) on page 120, \( (\rho/4)^{1/2} \) should be replaced by \( (\rho/4)^{1/2} \). The last equations in Sec. F2 should be

\[
\frac{\partial^2}{\partial \rho^2}(gm/m_0)_{t_0} = 0
\]

and

\[
\frac{\partial^2}{\partial \phi^2}(gm/m_0)_{t_0} = 0.
\]