Thus the g shift is in the opposite direction from that found in sodium.[2]

The temperature independence of T_2 suggests that impurity scattering via spin-orbit coupling[4] is responsible for the electron spin relaxation time. The situation seems similar to that in lithium in which the broadening effect of impurities was experimentally demonstrated.[2] Another evidence of the importance of the impurities is the fact that in some samples obtained from different sources no resonance was observed. This presumably is due to the higher impurity concentration which would broaden the line and decrease the signal. This could also explain the failure of Gutowsky and Frank[5] to observe the resonance in beryllium. The sample in which we observed the resonance was supplied by the French company Pechiney[6] and quoted to be 99.5 percent pure.

Because of the unknown particle size distribution of the sample we were unable to determine the absolute value of the susceptibility. Attempts to observe a resonance in beryllium sheets have been successful so far, probably again because of impurities.

We are indebted to Professor E. Segrè for supplying us with the beryllium sheets.

* Assisted in part by the U. S. Office of Naval Research and the U. S. Signal Corps.

[1] F. J. Dyson (to be published).
[2] G. Feher and M. Browne (to be published).
[3] C. A. Hutchison and R. C. Pastor, Phys. Rev. 81, 282 (1951).
[4] R. J. Elliott (to be published).
[5] H. S. Gutowsky and P. S. Frank, Phys. Rev. 94, 1067 (1954).
[6] U. S. representative of Pechiney Company, International Selling Corporation, 122 East 42nd St., New York 17, New York.

Structure of the Intermediate State in Superconductors

A. L. Schawlow, B. T. Matthias, H. W. Lewis, and G. E. Devlin
Bell Telephone Laboratories, Murray Hill, New Jersey
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It has long been known[1] that there exists a state of a superconducting sample in a magnetic field which is intermediate in properties between the normal state and the pure superconducting state. In particular, the mean magnetic induction B takes values between zero, characteristic of the latter, and μH, characteristic of the former, where μ is the normal permeability of the material and H is the applied field. This situation applies for applied fields between some lower limit determined by the shape of the specimen and the critical field H_c at the upper end.

Currently it appears that this state is characterized by a subdivision of the specimen into regions, some of which are superconducting, with induction zero, and some normal, with induction μH_c, and that the relative total volumes of these two types of region is determined by the mean induction. Contrary to what was for a time thought to be the case, it is now believed that this subdivision extends to the surface of the specimen and can be observed there. This has been done with bismuth microprobes.[1]

We have succeeded in making these domains visible by distributing a superconducting niobium powder on the surface of a tin sample in the intermediate state.

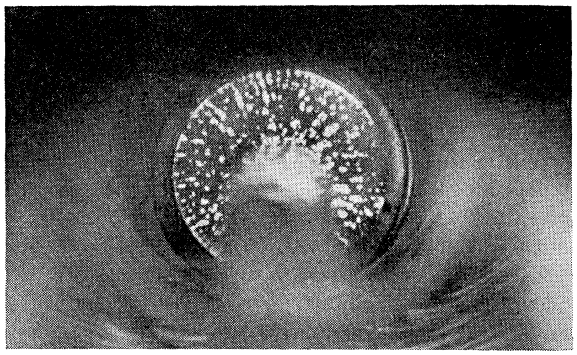

Fig. 1. Island pattern. The light spots are regions from which flux emerges.

The powder, in view of its perfect diamagnetism, migrates to the regions of the surface in which there is no field, and leaves the others relatively bare. The "island" type pattern previously mapped by the bismuth probe technique was directly observed, and a photograph of a typical example is shown in Fig. 1. The sample here was in the shape of a horizontal circular disk, 2 cm in diameter and 1 cm thick, with a hole drilled through

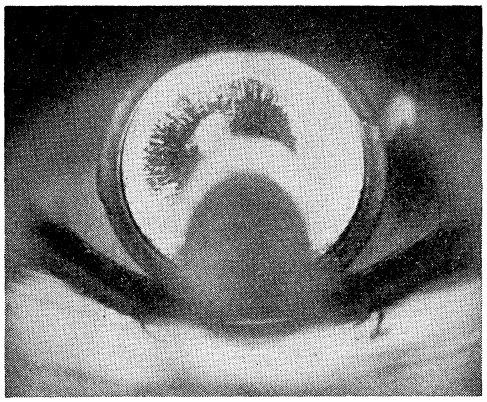

Fig. 2. Radial spoke pattern.

the center for mounting purposes, and was in a vertical magnetic field. One sees the region between the mounting rod and the periphery of the disk.

During the exploration, various transient patterns, such as that of Fig. 2, were seen and are still only imperfectly explained. The one shown was produced after the field was turned off.

We feel that this technique furnishes a useful tool for the study of the intermediate state, and we are pressing the work with a view to contributing to the understanding of both the statics and dynamics of the transition.

[1] See D. Shoenberg, *Superconductivity* (Cambridge University Press, Cambridge, 1952), for a full discussion.

Distribution of the Mass Transported from a Collector into a Germanium Crystal by the Forming Process*

M. W. Aarons, M. Pobereskin, J. E. Gates, and E. B. Dale
Battelle Memorial Institute, Columbus, Ohio
(Received July 8, 1954)

A MAJOR problem in transistor physics is the elucidation of the effects of the forming process in point contact crystal triodes. An hypothesis for the high α's observed in formed collectors is the "hook" theory of Shockley.[1] The combination of mass transfer and thermal effects during the forming pulse have been proposed as a possible mechanism for "hook" formation. The purpose of this note is to report preliminary results of experiments measuring the distribution of the transported mass in the crystal.

Rough estimates of the number of atoms expected to be transferred indicated 10^9 atoms into a volume of 10^{-8} cm^3. In order to detect so small a quantity of matter, carrier-free radio isotopes were considered. A survey of available isotopes resulted in the selection of gold 199 as a suitable tracer material.

Very briefly, the experiments proceeded as follows: Gold 199 and 197 were separated from irradiated platinum and plated on a tungsten needle. The plated needle was used to "form" single crystals of 7 ohm-cm n-type germanium. The amount of gold transferred was measured by counting with an end-window Geiger tube, and the area of gold distribution was measured from an autoradiograph. Microphotographs of the autoradiographs were subsequently analyzed by a photodensitometer to obtain the area and distribution of the gold at that level. The surface was then precisely lapped and counted and an autoradiograph taken. By repeating this procedure to a depth in the crystal at which no activity could be detected, the concentration of gold atoms as a function of depth was obtained. The results of two forming experiments are presented in Tables I and II.

Table I. The distribution of Au in crystal 1 after forming. The forming pulse was 0.053 seconds long, with an average current of 65 ma at 240 volts. A total of 1.6×10^9 Au atoms was transferred into a volume of about 10^{-7} cm^3. There was no visible damage to the crystal surface.

Thickness of layer lapped off, microns	Diameter of formed region at top of layer, microns	Average Au concentration in formed region of layer, atoms/cm^3
5	180	1.9×10^{16}
2.5	72	8.9×10^{14}
2.5	72	2.8×10^{15}

Table II. The distribution of Au in crystal 2 after forming. The forming pulse was 0.053 seconds long, at a peak voltage of 400 volts. A total of 7.4×10^{10} Au atoms was transferred into a volume of about 10^{-6} cm^3. A crater 230 microns in diameter and about 15 microns deep was observed in the crystal surface after forming. A conical protuberance was noted in the center of the crater.

Thickness of layer lapped off, microns	Diameter of formed region at top of layer,[a] microns	Average Au concentration in formed region of layer, atoms/cm
5	Broad and diffuse	3.3×10^{17}
10	232	1.3×10^{15}
9	198	1.6×10^{15}
9	153	5.7×10^{14}

[a] The diameter of the active region on the crystal surface after the last lap was 108 microns.

No activity remained in crystal 1 after the third lap. To compute the concentration of gold in the third layer, the formed region in that layer was assumed to be conical, with a base equal to the exposed active area after the second lap, and a height equal to the thickness of the third layer.

Crystal 2 was destroyed after the fourth lap. At that time 4.6×10^7 foreign atoms remained in the crystal.

From these results, it appears that the distribution in depth of the transferred gold atoms was as follows: a high concentration region at the surface, followed by a region of diminished concentration, terminating in a region of somewhat higher concentration than the minimum. The concentration drops abruptly beyond this point.

Experiments on the effects of emitter current flowing in the crystal during the forming of the collector are in progress.

* This work was sponsored by the Air Force Cambridge Research Center, Cambridge, Massachusetts.

[1] W. Shockley, *Electrons and Holes in Semiconductors* (D. Van Nostrand Company, Inc., New York, 1950), p. 108.

Effect of Chemical Combination on the Characteristic Energy Loss of Electrons*

Lewis B. Leder and L. Marton
National Bureau of Standards, Washington, D. C.
(Received July 6, 1954)

IN a recent note we presented measurements of the characteristic energy loss of 30-kev electrons passing through thin films of solids.[1] There have been some attempts to explain these losses by associating them with secondary electron emission,[2] by electron plasma oscillation,[3] and by comparison with x-ray absorption data.[4,5] The data available are not complete enough to verify any of the possible explanations. We have, there-

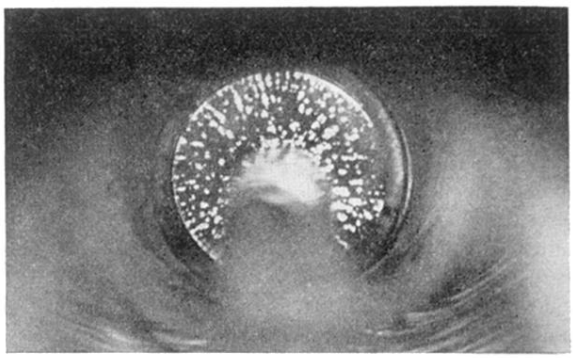

FIG. 1. Island pattern. The light spots are regions from which flux emerges.

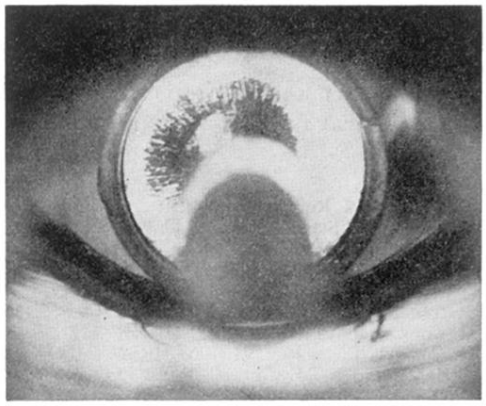

FIG. 2. Radial spoke pattern.