assumed that the μ_{Hp}/μ_{cp} temperature dependence is given by the dotted line for holes in Fig. 14. With this extrapolation and the carrier concentration and mobility results of the preceding sections, the Hall coefficient relation was used to compute μ_{Hn}/μ_{cn}. This result is shown by the dotted line for electrons in Fig. 14. According to Herring these results are what one would expect if the conduction band were composed of multiple surfaces of minimum energy, and the valence band of some structure other than a spherical energy surface. However, on this basis, μ_{Hp}/μ_{cp} is lower than the expected $\mu_H/\mu_c > 1$. A similar result was found at one time for electrons in germanium.[9] This discrepancy disappeared as improved germanium crystals were made. Presumably this same effect may be lowering the μ_H/μ_c values found for both electrons and holes in silicon.[10] It is assumed that, with improvement of the material, μ_{Hp}/μ_{cp} will approach ~ 1, then the peak value for μ_{Hn}/μ_{cn} increasing proportionally may approach ~ 2.2. This is reasonable in the light of the germanium results[6] where the highest value measured was $\mu_{Hp}/\mu_{cp} \sim 1.8$.

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[9] W. Shockley, *Electrons and Holes in Semiconductors* (D. Van Nostrand Company, Inc., New York, 1950), first edition, p. 338.

[10] *Note added in proof.*—See the more recent Hall mobility results of P. P. Debye and T. Kohane, Phys. Rev. **94**, 724 (1954).

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Secondary Electron Yield from Al by High-Energy Primary Electrons*

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The yield of secondary electrons from thin (1.71 mg/cm²) aluminum foils by high-energy primary electrons is reported. The value is 0.0397±0.0003 secondary electron per primary electron from both sides of the foil. The result is independent of the primary-electron energy in the range 111–235 Mev.

IN connection with the development of a nonsaturable monitor[1] for electron beams, we have measured the yield of secondary electrons from thin (1.71 mg/cm²) aluminum foils under bombardment by 150-Mev electrons. A general diagram of the experimental arrangement is shown in Fig. 1.

A monoenergetic beam of electrons from the Stanford Mark III linear accelerator is stripped to $\frac{1}{16}$-inch diameter by a uranium collimator, and, after passing through the double-deflection system[2] of the linear accelerator at the 130-ft station, is brought to a focus on a set of twenty aluminum foils, each $2\frac{1}{2}$ inches by 4 inches in size and 0.00025 inch thick. Alternate foils are connected together and mounted in a vacuum (10^{-6} mm Hg) on polystyrene insulators. One set of foils is biased to a negative potential of 1 kv with respect to the second set which is connected via a vacuum feed-through to a grounded condenser. After passing through the foils, the beam is collected in a lead Faraday-cup integrator. The ratio of the charge integrated on the condenser to the charge collected in the Faraday cup when averaged over the ten foils gives directly the number of secondary electrons liberated from both sides of the foil by a primary electron. The ratio we obtain is 0.0397±0.0003 secondary electron per primary electron, which is in qualitative agreement with low-energy experimental data.[3] No theory of secondary-electron yields at these energies exists.

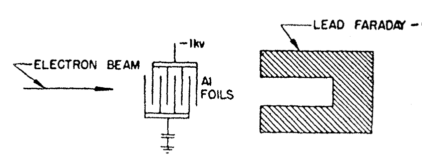

FIG. 1.

Since the theoretical energy distribution of secondary electrons with kinetic energy $W > 2$ kev varies as $1/W^2$, the high-energy secondaries which are not collected in our arrangement give negligible correction to the above ratio. The ratio was found to be independent of the bias voltage from 300 volts to 2 kv and to be independent of the primary-electron energy in the range 111–235 Mev.

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[2] W. K. H. Panofsky and J. A. McIntyre, Rev. Sci. Instr. **25**, 287 (1954).

[3] Shatas, Marshall, and Pomerantz, Phys. Rev. **94**, 757 (1954).