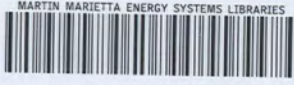


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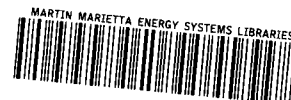
SEMICONDUCTOR NUCLEAR RADIATION DETECTORS

James L. Blankenship

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SEMICONDUCTOR NUCLEAR RADIATION DETECTORS

INTRODUCTION

This bibliography is the outgrowth of a program initiated by the Basic Instrumentation Research Group of the Oak Ridge National Laboratory. The purpose of the program is to investigate the potential uses of semiconductors as nuclear radiation detectors. Most references on the uses of cadmium sulfide have been omitted, except for recent articles, because excellent bibliographies have already been prepared.

BIBLIOGRAPHY ON SEMICONDUCTOR NUCLEAR RADIATION DETECTORS

1. Adirovich, E. I. and V. G. Kololilova
"Diffusion of a Short Impulse of β Particles into an N-Type Semiconductor Single Crystal and the Electron-Hole Transition."
Zh. Eksper. Noi I. Theoret. Fiz. 29, 770 (1955).
2. Airapetyants, A. V., A. V. Kogan, N. M. Reinov, S. M. R̄vkin, and I. A. Sokolov
"On the Use of Germanium N-P α -Ray Counters at Low Temperatures."
Soviet Physics-Technical Physics 2, No. 7, 1482 (1957). English Trans. of Zh. Tekh. Fiz. SSSR 27, 7, 1599 (1957).
3. Airapetyants, A. V. and S. M. R̄vkin
"On the Mechanism of the Influence of Illumination by Visible Light on the Size of the Pulses in CdS α -Counters."
Soviet Physics-Technical Physics 2, No. 1, 89 (1957). English Trans. of Zh. Tekh. Fiz. 27, No. 1, 106 (1957).
4. Airapetyants, A. V. and S. M. R̄vkin
"The Characteristics and Mechanism of Operation of Germanium P-N α -Counters."
Soviet Physics-Technical Physics 2, No. 1, 79 (1957). English Trans. of Zh. Tekh. Fiz. 27, No. 1, 95 (1957).
5. Alferov, Zh. I, B. M. Konvalenko, S. M. R̄vkin, V. M. Tuchkevich, and A. I. Uvarov
"Plane Germanium Photodiodes."
Zh. Tekh. Fiz. 25, No. 1, 11 (1955). English translation available from Morris D. Friedman, Inc., A-106.
6. Bachman, C. H., O. J. Gelormini, H. W. Davis (Syracuse University)
"A CdS Radiation Probe of High Resolution."
Am. J. Roentgenol. Radium Therapy Nuclear Medicine 73, No. 1, 98 (1955).
7. Benny, A. H. B. and F. C. Champion
"Neutron Bombardment of Counting Diamonds."
Proc. Roy. Soc. A 234, 432 (1956).
Note: Effect of neutron bombardment on pulse height distribution of monoenergetic α bombardment.
8. Braunbeck, J. and J. Zakovsky
"The Dependence of the Barrier Photo Effect on X-Irradiation."
Naturwissenschaften 42, 602 (1955).
Note: Experiments on the effect of X-irradiation on the emitter and collector currents of germanium transistors are briefly reported.

9. Bridgers, Scaff and Shive
Transistor Technology
D. Van Nostrand Co., New York 1957. Bell Lab. Series.
10. Brown, D. C. and B. P. Faraday
"A Transistorized Radiation Monitor."
Nuclear Instr. 1, 133 (1957).
Note: A good article. Comments on several solid state detectors.
Uses a PNP transistor as the α detector head.
11. Cassen, B., Burkig, and Selle
"Development of a Germanium Crystal Dosimeter."
AF-SAM-57-90 (Jan. 29, 1957).
Note: Fast neutron dosimeter using 30 ohm-cm germanium.
12. Cassen, B., T. Crough, and H. Gass
"Semiconductor Fast Neutron Dosimeter."
Nucleonics 13, No. 3, 58 (1955).
Note: See UCLA-309.
13. Cassen, B., T. Crough, and H. Gass
"Initial Development of a Semiconductor Fast Neutron Dosimeter."
UCLA-309.
Note: Single crystals of germanium measure 200-4800 REP.
14. Champion, F. C.
"Some Physical Consequences of Elementary Defects in Diamonds."
Proc. Roy. Soc. A 234, 541 (1956).
Note: Interpretation of behavior of diamond counters from theories advanced.
15. Champion, F. C. and B. Dale
"Variations in the Photoconductivity and in the Electrical Counting Properties of Diamonds."
Proc. Roy. Soc. A 234, 419 (1956).
Note: β rays on diamonds as conduction counters and dosimeters.
16. Champion, F. C. and D. L. O. Humphreys
"Variations in the Ultraviolet Absorption of Counting Diamonds."
Proc. Phys. Soc. B 70, Pt. 3, 320 (1957).
Note: Correlation has been established between counting efficiency and freedom from ultraviolet absorption, and an explanation is given.
17. Chynoweth, A. G.
"Conductivity Crystal Counters."
Am. J. Phys. 20, 218 (1952).
Note: A brief survey paper.
18. Collins, C. B., R. O. Carlson, and C. J. Gallagher
"Properties of Gold-Doped Silicon."
Phys. Rev. 105, 1168 (1957).

19. Cotty, W. F.
"Diamond, A Practical Radiation Counter."
J. Brit. Inst. Radio Engrs. 16, 329 (1956).
20. Czyzak, S. J., W. M. Baker, R. C. Crane, et. al.
"The Study of Properties of Single Crystals for Use as Detectors
and Crystal Counters."
NP-5791(Oct. 1955).
Note: CdS, ZnS, with and without added impurities (44 pages).
21. Davis, W. D.
"Gold-Doped Silicon Counters."
Journal Appl. Phys. 29, 231 (1958).
22. Davis, W. D.
"Silicon and Gold-Doped Silicon as Positive Ion Detectors."
KAPL-1565, Report of the Physics Section for March-April-May 1956.
Note: Pulses up to 2 volts with S/N of 10^4 for 10^4 V/CM across
1 mm gap.
23. Diethorn, W. S., et. al.
"Neutron Dosimetry Research."
NP-6433, Battelle Memorial Inst. (Q.P.R.)
Note: Semiconductor tissue-equivalent ionization chamber for
Signal Corps' selection of field dosimeter.
24. Dunlap, W. C., Jr.
"Amphoteric Impurity Action in Germanium."
Phys. Rev. 100, 1629 (1955).
Note: A good reference.
25. Dunlap, W. C. Jr.
"Electrical Properties of Gold-Germanium Alloys."
Phys. Rev. 91, 1282 (1953).
Note: At 77°K , $\rho \simeq 5 \times 10^7$ ohm-cm.
26. Dunlap, W. C., Jr.
"Gold as an Acceptor in Germanium."
Phys. Rev. 97, 614 (1955).
Note: A good reference.
27. Dunlap, W. C. Jr. (Gen. Elect. Res. Lab.)
Paper Abstract: "Acceptor States of Gold in Germanium."
Phys. Rev. 91, 208 (1953).
28. Freeman, G. P. and H. A. Van Der Velden
"Differences Between Counting and Non-Counting Diamonds, Parts I
and II."
Physica 18, 1 and 9 (1952).

29. Freeman, G. P. and H. A. Van Der Velden
"Some Aspects of the Counting Properties of Diamond."
Physica 17, 565 (1951).
30. Goassick, B. and J. Mayer
"Use of Gold-Germanium Broad Area Barrier as an Alpha-Particle Spectrometer."
Rev. Sci. Instrum. 27, 407 (1956).
31. Heinz, O., E. M. Gyorg, and R. S. Ohl
"Solid State Detector for Low Energy Ions."
Rev. Sci. Instrum. 27, 43 (1956).
Note: The electrical properties of a polished surface of high purity silicon can be used as an indicator of heavy ion bombardment.
32. Hofstadter, R.
"Crystal Counters. Part I."
Nucleonics 4, No. 4, 2 (1949).
"Crystal Counters. Part II."
Nucleonics 4, No. 5, 29 (1949).
33. Hofstadter, R.
"Crystal Counters."
Proc. Inst. Radio Engrs. 38, 726 (1950).
Note: A survey article, essentially a reprint of the Nucleonics articles.
34. Hofstadter, R.
Letter: Remarks on Diamond Crystal Counters with respect to Tests for Selection of Counters: Luminescence, Birefringence, Mosaic, and Infrared Transmission.
Phys. Rev. 73, 631 (1948).
35. Hofstadter, R., J. C. D. Milton, and S. L. Ridgeway
"Behavior of Silver Chloride Crystal Counters."
Phys. Rev. 72, 977 (1947).
Note: Gives risetimes, mobilities, "yield", pulse heights for five crystals tested.
36. Hollander, L., Jr. (Victoreen)
"Preparation of High Sensitivity Cadmium Sulfide Cells for Gamma Ray Detection."
Rev. Sci. Instrum. 28, 322 (1957).
Note: Dark $\rho = 10^9 - 10^{10}$ ohm-cm.
In 50 R/hr $\rho = 10^6$ ohm-cm.
37. Hollander, Lewis E.
"Bibliography on Photoconductivity for X and Gamma Ray Detection."
Victoreen Instrument Co., Cleveland, Ohio, Nov. 1956.
Note: Mostly on CdS as a conduction type dose rate meter.

38. Kallman, H. and R. Warminsky
"On the Amplification Effect of the Electrical Conduction of a Cadmium Sulfide Crystal for Irradiation with α -Particles, Electrons and γ -Rays. (A Method for Counting Individual Particles.)"
Ann. Physik. 4, 69 (1948).
39. Konovalenko, B. M., S. M. Ryvkin, and V. M. Tuchkevich
"On the Sensitivity of Germanium Photodiodes to X-Ray Irradiation."
Zh. Tekh. Fiz. 25, 18 (1955).
40. McKay, K. G.
"Electron Bombardment Conductivity in Diamond."
Phys. Rev. 74, 1606 (1948).
Note: Influence of time, voltage on "yield" or multiplication is given.
41. McKay, K. G.
"A Germanium α -Counter."
Phys. Rev. 76, 1537 (1949).
Note: Used Po- α source, got 12 mv at 8-10 volts back bias. Used phosphor bronze point contact barrier on N-type germanium, at room temperature.
42. McKay, K. G.
"Electron Bombardment Conductivity in Diamond, Part II."
Phys. Rev. 77, 816 (1950).
43. McKay, K. G.
"The N-P-N Junction as a Model for Secondary Photoconductivity."
Phys. Rev. 84, 833 (1951).
44. McKay, K. G.
"Electron-Hole Production in Germanium by Alpha-Particles."
Phys. Rev. 84, 829 (1951).
Note: Very good article.
45. McKay, K. G.
"The Crystal Conduction Counter."
Phys. Today 6, No. 5, 10 (1953).
Note: A very good survey article.
46. McKay, K. G. and K. B. McAfee
"Electron Multiplication in Silicon and Germanium."
Phys. Rev. 91, 1079 (1953).
Note: Determines $\epsilon = 3.6 \pm 0.3$ Ev per electron-hole pair.
47. Orman, C., H. Y. Fan, G. J. Goldsmith, and K. Lark-Horvitz
"Germanium P-N Barriers as Counters."
Phys. Rev. 78, 646 (1950).

48. Pantchechnikoff, J. I.
"A Large Area Germanium Photocell."
Rev. Sci. Instrum. 23, 135 (1952).
Note: Gold-germanium surface barriers.
49. Patskevich, V. M., V. S. Vavilov, and L. S. Smirnov
"Energy of Ionization in Silicon Crystals by Electrons."
Soviet Physics-Journal of Exp'tl. Theoret. Phys. 6 (33), No. 3, 619.
English Trans. of Zh. Eksper. Noi I. Theoret. Fiz. 33, 804 (1957).
Note: $E = 4.2 \pm 0.6$ ev. A good article.
50. Ryder, E. J. and W. Shockley
"Mobilities of Electrons in High Electric Fields."
Phys. Rev. 81, 139 (1951).
51. Ryvkin, S. M., B. M. Konovalenko, and Yu. S. Smetannikova
"The Energy Dependence of the Conductivity Induced in Layers and
Single Crystals of CdS during Bombardment by Electrons."
Zh. Tekh. Fiz. 24, 961 (1954).
52. Ryvkin, S. M.
"On the Question of the Mechanism of Germanium Photodiode Action."
Zh. Tekh. Fiz. 25, 21 (1955).
53. Ryvkin, S. M.
"The So-Called 'Secondary' and 'Through' Photocurrent in Semi-
conductors."
Soviet Physics-Technical Physics 1, 11, 2357. English Trans. of
Zh. Tekh. Fiz. 26, No. 11, 2439 (1956).
54. Ryvkin, S. M.
"Mechanism of Pulse Formation in Semiconducting Crystal Counters."
Soviet Physics-Technical Physics 1, 12, 2580. English Trans. of
Zh. Tekh. Fiz. 26, 2667 (1956).
Note: Good with regard to pulse "amplification," light biasing, etc.
55. Ryvkin, S. M. et. al.
"A Semiconducting Device for Gamma Ray Detection."
Soviet Physics-Technical Physics 2, 7, 1484. English Trans. of Zh.
Tekh. Fiz. 27 1601 (1957).
Note: An evaporated-deposited film of CdS is used as a conduction
type indicator.
56. Ryvkin, S. M.
"On the Kinetics of Photodiodes."
Soviet Physics-Technical Physics 2, 8, 1558. English Trans. of Zh.
Tekh. Fiz. 27, No. 8, 1676 (1957).

57. Ryvkin, S. M.
"On the Mechanism of the Formation of Pulses in Semiconducting
Crystal Counters."
Dokl. Akad. Nauk SSSR 106, 250 (1956).
Note: Tries to explain charge multiplication and effect of light
bias in CdS.
58. Shive, J. N.
"The Properties of Germanium Phototransistors."
J. Opt. Soc. America 43, 239 (1953).
59. Simon, Edward
"Gold-Germanium Surface Barriers."
Ph.D. Thesis, Purdue Univ. (Jan. 1955).
60. Statz, H., G. DeMars, L. Davis, Jr., and A. Adams, Jr.
"Surface States on Silicon and Germanium Surfaces."
Phys. Rev. 106, 455 (1957).
61. Sullivan, M. H. and J. H. Eigler
"Electroless Nickel Plating for Making Contacts to Silicon."
J. Electrochem. Soc. 104, 226 (1957).
62. Svechnikov, S. V.
"Characteristics of the Additional Conductivity Induced in Single-
Crystal Cadmium Selenide by X-Irradiation."
I. Static Characteristics
II. Kinetic Aspects.
Soviet Physics-Technical Physics 2, 11, 2320 and 2328. English
Trans. of Zh. Tekh. Fiz. 27, 11 2492 and 2502 (1957).
63. Taft, E. A. and F. H. Horn
"Gold as a Donor in Silicon."
Phys. Rev. 93, 64 (1954).
Note: Gold produces a donor level at 0.33 Ev. ABOVE valence band
edge. At liquid nitrogen temperature, $\rho > 10^{10}$ ohm-cm. Good
reference.
64. Taylor, K. W.
"Alpha-Particle Counting Behavior of Diamond Conduction Counters at
Field Strengths up to 200 KV-cm⁻¹."
Proc. Phys. Soc. A 69, Pt. 8, 593 (1956).
65. Trott, N. G.
"Variations in the Beta-Particle Counting Properties of Diamond."
Proc. Roy. Soc. (London) A 220, 498 (1953).
66. Van Der Velden, H. A. and G. P. Freeman
"The Influence of Red and Infrared Light on a Crystal Counter."
Physica 16, 493 (1950).

67. Van Heerden, P. J.
The Crystal Counter, Thesis, Utrecht 1945.
68. Van Heerden, P. J.
The Crystal Counter (N. V. Noordhollandsche Uitgevers
Maatschappij, Amsterdam, 1945).
69. Van Heerden, P. J.
"The Crystal Counter for Beta and Gamma Rays," Parts I and II.
Physica 16, 505 and 517 (1950).
70. Van Heerden, P. J.
"Primary Photocurrent in CdS."
Phys. Rev. 106, 468 (1957).
Note: Uses light impulses and α -particles. Found 7.2 EV/E-H pair.
71. Vitovsky, N. A., P. I. Maleev, and S. M. Ryvkin
"The Mechanism of Pulse Formation in Crystalline Counters and the
Formation of a 'Through Conducting Channel'."
Zh. Tekh. Fiz. 28, No. 3, 460 (1958).
72. Vul, B. M., V. S. Vavilov, et. al.
"On the Transformation of Beta-Particle Energies to Electric Energy
in Germanium Crystals with p-n Junctions."
Atomnaya Energiya (Atomic Energy, USSR) 2, 533 (1957).
Note: See Consultants Bureau, Inc., Translation, p. 653.

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