RYVKIN, S. M.

FD-2818

USSR/Physics - Semiconductors

Card 1/1 Pub. 153-1/30

Author : Ryvkin, S. M. and Khar'yozov, R. V.

Title : Method of Determining the Mobility of "Non-Basic" Current Carriers Injected by Light

Periodical : Zhur. Tekh. Fiz, 25, 563-568, 1955

Abstract : Photoelectric behavior of semiconductors is studied by applying constant photoinjection to a rod-shaped sample [cf. J R Haynes and and W. Schocklly, Phys. Rev. 81, 835 (1951)]. The equipment used is described and results showing mobility of holes and electrons in germanium are illustrated in graphs. Gratitude for cooperation is expressed to D. N. Nasledov, V. M. Tuchkevich, Zh. I. Alferov, and A. A. Lebedev. One USSR and 6 foreign references.

Institution :

Submitted :

FD-3186

USSR/Physics - Modulators

Card 1/1 Pub. 153-16/21

Author : Ryvkin, S. M.

Title : Mechanical modulator for obtaining light impulses with large gaps in the case of a steep front

Periodical: Zhur. tekh. fiz., 25, No 8 (August), 1955, 1471-1476

Abstract : The author describes a new two-disk modulator of normal dimensions which makes it possible to obtain light impulses with steep fronts which are separated by comparatively large intervals of time. It is an improvement of the older single disk type. The author gives its dimensions and describes all the components. He discusses its operating characteristics in detail. He describes all the types of impulses which can be obtained with the new modulator.

Submitted : February 16, 1955

FD-3127

USSR/Physics - Superconductors

RYVKIN SM

Card 1/2 Pub. 153 - 2/19

Author : Mashovets, T. V.; Ryvkin, S. M.

Title : Influence of heat treatment upon lifetime of non-ground current carriers in germanium (the kinetics of the formation of defects during heat treatment)

Periodical : Zhur. tekh. fiz., 25, No 9 (September), 1955, 1530-1543

Abstract : The authors investigated the influence of heat treatment at relative "low" temperatures (400-550°C) upon the lifetime of non-ground current carriers in germanium. The lifetime decreases with increase of temperature and duration of the heat treatment, which is explained by the occurrence of defects that play the role of centers of recombination. On the basis of a study of the kinetics governing the process of the occurrence the authors obtain data on their energy structure. They show that the process governing the occurrence of defects in the investigated region of temperatures differs from the process governing the occurrence of "thermal defects" ordinarily appearing in germanium at higher temperatures. The authors' aim has been to investigate the occurrence during heat treatment of so called thermal traps (recombination centers) and also the nature (i.e. energy structure) of defects associated with these

traps. They thank D. N. Nasledov for his interest and also V. M. Tuchkevich and A. A. Lebedev for preparation of specimens for measurement. Fourteen references, mostly Western.

Institution : --

Submitted : February 28, 1955

Ryvkin, S.M.

Chem 4 6.08

537.312.5

5868. PHOTOELECTRIC CHARACTERISTICS OF SOME COMPOUNDS WITH THE STRUCTURE OF ZINC BLENDE. N.A.Goryunova, V.S.Grigor'eva, B.M.Konovalenko and S.M.Ryvkin. Zh. tekh. Fiz., Vol. 25, No. 10, 1675-82 (1965). In Russian.

All the compounds investigated, viz. Ga_2Se_3, Ga_2Te_3, $Ga_2Te_3.ZnTe$, $Ga_2Te_3.3ZnTe$, $Ga_2Te_3.9ZnTe$, β-Ga_2S_3, GaSe, GaTe, are semiconductors and are photosensitive. On transition from one substance to another of the same structural type the long-wave limit of the photoconductivity shifts in a regular way and, therefore, also the energy interval corresponding to the width of the prohibited zone. The ever more prevalent ionic character of the bond explains the phenomena.

Electrical Research Association

Name: RYVKIN, Solomon Meyerovich

Dissertation: Study of the behavior of non-equilibrium current carriers in semi-conductors

Degree: Doc Phys Math Sci

Affiliation: /Not indicated/

Defense Date, Place: 24 Dec 56, Council of Physico-Technical Inst, Acad Sci USSR

Certification Date: 8 Jun 57

Source: BMVO 16/57

SUBJECT USSR / PHYSICS
AUTHOR RYVKIN, S.M.
TITLE On the So-Called "Secondary" and "Passing-Through" Photocurrent in Semiconductors.
PERIODICAL Zurn.techn.fis, 26, fasc. 11, 2439-2447 (1956)
Issued: 12 / 1956

By the present work the attempt is made to show that putting the secondary photocurrent equal to that which passes through is wrong. The terminology using the terms "primary" and "secondary" photocurrent is described as irrational if used for describing photoelectric phenomena in semiconductors.
On the kinetics of the photocurrent: If the semiconductor sample is irradiated by a constant light current from a certain moment onwards, the relaxation-like process of transition to a new stationary concentration of charge carriers, which occurs as a result of ionization, is determined in the general case by two phenomena: 1.) By a change of concentration by electron transitions in the "energy space", i.e. on the occasion of ionization and recombination. 2.) By modification as a result of the motion of the carriers in the coordinate space, i.e. by diffusion and drive in the electric field. Both processes take place simultaneously and with reciprocal interaction. However, when evaluating the influence exercised upon the effective relaxation time of each process, the eigentimes of both processes may be investigated separately.
On the so-called "primary" photocurrent: The transition current (more exactly its initial stage) according to the terminology used by GUDDEN and POHL,

corresponds to the so-called "primary" current. On the occasion of the occurrence of diffusion-drive-equilibrium, FERMI'S quasi-level in the semiconductor is reduced, and the relative influence exercised by the carriers moving from the cathode into the crystal increases. Hereby the basic condition for the "primary" character of the current is gradually abolished. If equilibrium in the energy space is rapidly established, the relaxation process occurring on the occasion of illumination is reduced to the fact that the transition current goes over into the passing-through current. Thus the establishment of equilibrium in the coordinate space is fully characterized. On the so-called "secondary" photocurrent: If no particular assumptions are introduced (if, e.g., the barrier layers at the contacts, very strong fields, etc. are not taken into account), the photocurrent occurring immediately after illumination can only diminish by the establishment of diffusion equilibrium with the electrons. The photocurrent observed by GUDDEN and POHL on ZnS cannot be put equal to the passing-through current. In conclusion several technological problems are discussed. According to the author's opinion the old terminology must be dropped. It is necessary either to introduce new terms which characterize occurring phenomena correctly or to change old terms accordingly.

INSTITUTION:

RYVKIN, S.M.

CARD 1 / 3 PA - 1821

SUBJECT USSR / PHYSICS

AUTHOR RYVKIN, S.M.

TITLE The Forming Mechanism of Impulses in Crystalline Semiconductor Counters. (The Motion of Charges on the Occasion of an Impulse Ionization in Semiconductors).

PERIODICAL Zurn.techn.fis, 26, fasc.12, 2667-2683 (1956)

Issued: 1 / 1957

The present work intends to determine the basic qualitative properties of the forming mechanism of impulses in crystalline semiconductor counters, as well as to carry out an approximated quantitative investigation of this problem. At first several questions relating to schemes were dealt with in a precise form. From the point of view of the processes which take place in the sample, the real scheme can be replaced by another in the case of which the voltage on the sample is kept constant. At the same time, computation of the charge in the impulse in the real scheme can be replaced by computation of the excess electricity which is a result of ionization in the outer chain of the second scheme. In this connection investigation of the problem is confined to computing the additional current Δi in the exterior chain of the scheme on the basis of the investigation of the processes that take place on the occasion of ionization inside the sample. The semiconductor mechanism of impulse formation is then examined. The process is analyzed which takes place in a crystal with finite conductivity before excitation immediately after ionization. A very simple"flat" case is investigated on the assumption that the domain in which ionization took place has the shape of a parallelepiped.

It is assumed that the current carriers produced on the occasion of ionization will within short have an energy distribution corresponding to lattice temperature as a result of the collision, and will hardly be distinguishable from the thermally ionized current carriers. Ionization and the establishment of quasi-equivalent distribution are assumed to exist at the moment.
In the following an exact analysis of the question as to the mechanism of impulse formation is given mainly in order to determine the criteria for the transition of a formation according to the scheme of primary current into such according to the scheme of a passing-through current, as well as to compute the dependence of the amount of the impulse on the conductivity of the sample and other of its parameters. Computation of Δi passing through and θ (diffusion-deviation-equilibrium) is for a general case very difficult. Therefore only some special cases - of the weak, medium, and strong field - are investigated, and for these cases criteria are set up. Besides, the case for $\tau \ll \theta$ is investigated. τ is the life of the nonequivalent current carriers. In conclusion it is pointed out that at $\tau \gg \theta$ the character of the process taking place after ionization is in many respects similar to those processes which occur in electric circuits that consist of resistances and capacities in the case of a considerable modification of some parameters of this circuit. In the case of ionization in insulators and semiconductors phenomena are complicated by the drift and the

diffusion of carriers over considerable distances. As to the "primary current", this is only the initial stage of the transition process of the current described by the author as "passing-through current". The criteria and the charge are determined by the two basic material characteristic marks τ and σ_o. σ_o is the specific conductivity of the sample before ionization. In the mechanism of the passing through current the amount of impulse grows with increasing σ_o. In conclusion it is stated that the most effective crystalline counters are obtained on the basis of the use of semiconductors and not of insulated materials.

INSTITUTION: Leningrad Physical-Technical Institute of the Academy of Sciences in the USSR.

RYVKIN, S.M.

CARD 1 / 2 PA - 1834

SUBJECT USSR / PHYSICS
AUTHOR RYVKIN,S.M., HANSEVAROV,R.JU.
TITLE The Dependence of the Spectral Distribution of the Photoconductivity of Selenides and Tellurides of Gallium on Temperature.
PERIODICAL Žurn.techn.fis,26, fasc.12, 2780-2783 (1956)
Issued: 1 / 1957

In the course of the present work the experimental results obtained on the dependence of the spectral distribution of the photoconductivity of GaSe and GaTe on temperature are described. The samples used were polycrystalline rods on which the electrodes were fastened by powdering the metal in a vacuum. The conductivity of both materials fluctuated between 10^{-4} and 10^{-3} $Ohm^{-1}.cm^{-1}$. The samples were illuminated with a modulated light from a monochromator ZMP-2 and with a quartz optic. The change-signal was amplified by means of a synchronous detector and rectified, and was registered by means of a self-recording potentiometer. The curves of the spectral distribution of photoconductivity were worked out for equal energies. The distribution of energy on the spectrum was determined by means of a bolometer. The curves of the spectral distribution of photoconductivity for both substances are each shown in form of a curve. A further diagram shows the dependence of the length of the boundary wave $\lambda_{\frac{1}{2}}$ as well as that of the wave length λ_m on temperature. From these curves it may be seen that with the decrease of temperature the longwave boundary and the maximum of

SUBJECT USSR / PHYSICS
AUTHOR RYVKIN,S.M.
TITLE Survey of Works submitted during the Sessions of the Department for "Photoelectric Phenomena in Semiconductors".
PERIODICAL Usp.fis.nauk, 60,fasc.2, 225-248 (1956)
Issued: 12 / 1956

The detailed experimental investigation of photoconductivity with separate determination of the phenomenological parameters of photoconductivity is a characteristic feature of post-war works (e.g. "quantum yield", "life", etc.), i.e. the investigation of stationary photoconductivity is being more and more replaced by the study of the kinetics of photoconductivity, and it is just by this that the discovery of new and interesting rules is made possible. It is further of great importance that investigations are extended to purely electric phenomena, and that radiations other than by light are being used. The current carriers liberated in the crystal lattice by light and other radiations differ but little from one another. The processes occurring in semiconductors on the occasion of ionization may be subdivided into two groups, viz. into independent ionization processes (i.e. the production of free current carriers) and into processes of the motion and recombination of the liberated carriers. The injection of unreal carriers makes the investigation of unsteady electron processes in semiconductors possible. Essentially, all works belong to the following fields: 1.) Photoconductivity and optical properties. 2.) Photoelectromotoric forces. Furthermore, several lectures dealt with the exterior photo-

electric effect in semiconductors as well as with some questions relating to method.

Lectures were delivered, among others, on the following topics: The properties of exitons, the structure of absorption spectra in semiconductors, the photoconductivity of red and yellow HgJ_2, the"exiton mechanism" of photoconductivity, the diffusion of exitons, the "long-lasting" component of photoconductivity, the photoelectric and optical properties of polycrystalline and amorphous layers of antimony trisulphide and of antimony triselenide, the theoretical and the experimental investigation of some problems of collision ionization in semiconductors, the influence exercised by various metal admixtures on the electric and photoelectric properties of pressed polycrystalline samples of cadmium sulphide, the importance of taking the influence exercised by the exciting light on recombination processes into account, the kinetics of photoconductivity in silver chloride, the semiconductor properties of coloring substances, the sensibilization of photoelectromotoric force (e.g. in the case of anorganic semiconductors, by organic substances), etc.

Many works deal with the photoelectromotoric forces in semiconductors; the contents of these works is discussed in short. In spite of all the successes achieved, much still remains to be done in many fields.

INSTITUTION:

USSR/ Physics - Technical physics

Card 1/1 Pub. 22 - 21/54

Authors : Ryvkin, S. M.

Title : On the mechanism of pulse formation in semi-conductor crystal counters

Periodical : Dok. AN SSSR 106/2, 250-253, Jan 11, 1956

Abstract : A brief analysis is presented of the causes of pulse formation in semi-conducting crystal counters, namely, the so-called primary current, $\Delta i_p = (dQ/dt)_{t=0}$, and the through current, $\Delta i_{th} = (dQ/dt)_{t=\theta}$; where the Q is a total electric charge ($Q = Q_p + Q_{th}$) on the electrodes of a counter and the θ is a time of the primary current duration (pulse duration). Six references: 2 USA, 2 USSR, 2 Germ., (1948-1954). Diagrams.

Institution : Acad. of Scs., USSR, Leningrad Physical-Technical Institute

Presented by: Academician A. F. Ioffe, July 11, 1955

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

AUTHOR: [illegible]

TITLE: Germanium Electron-Hole Alpha Counter Characteristics and Operation Mechanism. (Kharakteristiki i mechnism deystviya germaniyecykh elektronno-dyrochnykh al'fa-schetnikov, Russian)

PERIODICAL: Zhurnal Tekhn.Fiz. 1957, Vol 27, Nr 1, pp 95-105 (U.S.S.R.)
Received: 2 / 1957 Reviewed: 4 / 1957

ABSTRACT: This paper deals with the results of the study of counting properties and of the mechanism of impulse-production in n-p-α counters. The wiring circuit of the counter is demonstrated by a drawing. The mode of operation of such a counter does not differ essentially from the mode of operation of a photodiode in the case of a "photo-diode-like" circuit. The n-p transition is connected in the barred direction. The α-particle forms electron-hole-couples in germanium. The unreal carriers (here the holes) diffuse to the n-p transition and are drawn into the p-domain by the field existing in this transition. An additional current hereby occurs in the exterior circuit and furthermore a voltage drop at the resistance R. This voltage drop is recorded. Since the unreal carriers occurring momentarily in the n-domain on the occasion of ionization rapidly flow off or recombine as a result of n-p transition, the duration of the signal occurring at the resistance R is not long.

The following conclusions can be drawn from the investigations carried out: Germanium n-p transitions of the here described

Germanium Electron-Hole Alpha Counter Characteristics and Operation Mechanism.

construction can successfully be used as counters for α-particles and obviously also for other heavy charged particles. Such counters have the following characteristic features: The germanium n-p transition corresponds according to its amount to a common dielectric counter. The counter characteristic of the n-p transition has a good "plateau". The duration of increase of the impulse fluctuates in the case of various samples between 2-3 and 10 microseconds. The n-p transition can be used at room temperature, whereas the dielectric crystal counter, as a rule, can only be used at low temperatures. Also in the case of n-p-α germanium counters, however, the ratio signal/noise increases to a great extent with a reduction of temperature. This facilitates their application in the domain of extremely low temperatures. The germanium n-p transition lacks the main disadvantage of crystal counters, i.e. the so-called polarization. The experimental investigation of the dependence of the impulse and its front on the parameters of the exterior circuit and on the thickness of the basis confirms the assumptions concerning the mode of operation of the here discussed counters made in this paper. (12 illustrations).

ASSOCIATION: Physical-Technical Institute, Leningrad
PRESENTED BY:
SUBMITTED: 16.5.1956
AVAILABLE: Library of Congress

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

PA - 2117

On the Mechanism of the Influence of Illumination with Visible Light on the Strength of Impulses in Sulphur-Cadmium-α-Counters.

Measuring results: In many cases the amount of charge in the impulse $\Delta Q = vC$ is considerably greater than the maximum possible charge which can immediately be liberated by an α-particle on the occasion of ionization. This maximum possible charge was computed as ratio of the energy of the α-particle and the breadth of the forbidden zone of the CdS. From this fact it can be concluded that the impulses in the CdS monocrystals used here were formed according to the "semi-conductor-scheme" of the current passing through. The verification of these considerations carried out by the authors and discussed here confirms, according to the authors' opinion, the semi-conductor-like character of the production mechanism of impulses in CdS monocrystals. Agreement of experimentally and theoretically found dependences of the amount of impulses in sulphur-cadmium obviously confirm the correctness of the general considerations concerning the character of the formation of impulses in semiconductors.

ASSOCIATION: Physical-Technical Institute, Leningrad
PRESENTED BY:
SUBMITTED:
AVAILABLE: Library of Congress

Card 2/2

RYVKIN, S.M.

PA - 2118

AUTHOR MASHOVETS, T.V., RYVKIN, S.M.

TITLE On the Nature of Recombination Centers created in Germanium on the Occasion of Heat Treatment at "Low Temperatures" (O prirode tsentrov rekombinatsii, voznikayushchikh v germanii pri "nizkotemperaturnoy" termoobrabotke).

PERIODICAL Zhurnal Tekhn.Fiz., 1957, Vol 27, Nr 2, pp 238-241 (U.S.S.R.)

Received 3/1957 Reviewed 3/1957

ABSTRACT

First reference is made to the authors' work in Zhurn.Tekhn.Fiz., 1955, Vol 25, p 1530 and its results are summarized. It was found that the processes of the creation of thermodefects in Germanium within the range of "higher" and "lower" temperatures differ. It remained unexplained with what (the admixtures or with structural defects) the low temperature thermocenters of recombination investigated by the authors are connected. To find this out was the task of the present work. Above all it was necessary to determine the position of the levels of the low temperature thermocenters of recombination in the energetical scheme of germanium. This was accomplished by investigating the dependence of life on temperature. It may be concluded that the defects, with which the low temperature recombination centers are connected, are copper atoms. The connection between the defects and the copper atoms was checked in the course of a further series. Results obtained for two samples are shown in form of a table. Summary: 1) The low temperature thermocenters of recombination which are created in consequence of heating at 450 - 550°C and of a subsequent hardening, are connected with a copper-lead admixture.

Card 1/2

PA - 2531

AUTHOR: RYVKIN,S.M., and MAKHALOV,YU.A.

TITLE: Minority Carriers Distribution by Injection Region Movement and in Presence of a Field. (Raspredeleniye kontsentratsii neosnovnykh nositeley toka pri dvizhenii oblasti in''yektsii i nalichii polya, Russian)

PERIODICAL: Zhurnal Tekhn. Fiz., 1957, Vol 27, Nr 3, pp 441 - 451 (U.S.S.R.)
Received: 4 / 1957 Reviewed: 5 / 1957

ABSTRACT: With reference to G.Adam's paper from 1954 (Physika, 1954, Vol 20, 1037) the present paper suggests a "zero"-method for the determination of the mobility of the unreal (minority) current-carriers. The results of investigation of the character of the process in the case of the existence of a movable injection region are shown as well as also of an electric field. In particular the possibility is found to "compensate" the asymmetry-effect by the electric field. The existence of such a compensation can be used for the determination of mobility by means of the "zero" method. First, the theory of the problem, the experimental system, and then results are dealt with. The scheme differs from that of Adam only by the possibility of from-ing and measuring a field in the sample, as well as by the utilization of some special types of development. In the case of the measuring method for mobility the so called "lambda-develop-ment" was used (the deveoped signal is shaped like the Greek

Card 1/2

RYVKIN, S. M.

57-27-7-29/40

AUTHORS: Ayrapetyants, A. V., Kogan, A. V., Reynov, N. M., Ryvkin, S. M., Sckolov, I. A.

TITLE: Concerning the Use of Germanium n-p-α-Counters at Low Temperatures (Ob ispol'zovanii germaniyevykh n-p-α-schetchikov pri nizkikh temperaturakh).

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1957, Vol. 27, Nr 7, pp. 1599-1600 (USSR)

ABSTRACT: With reference to the paper in Zhurnal Tekhnicheskoy Fiziki, 1955, Vol. 25, Nr 11 and 1957, Vol. 27, Nr 1 some preliminary results on the investigation of the counter-properties of germanium n-p-counters at helium temperatures are reported here. The scheme of the device is described. From the table of the comparative characteristics of the n-p counters at room temperature and at helium temperature is to be seen that at the temperature of liquid helium the signal-noise ratio strongly increases. At helium temperature (as well as at room temperature) the n-p counters have a good plateau in the counter-characteristic, as well as a saturation in the curve of the dependence of the amount of the impulse on the applied voltage. There are 2 figures, 1 table and 2 references, all of which are Slavic.

Card 1/2

Physico Tech Inst AS USSR

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

57-27-7-30/40

AUTHORS: Ryvkin, S. M., Bogomazov, A. P., Konovalenko, B. M., Matveyev, O. A.

TITLE: A Semiconductor Transmitter for Gamma-Ray Indication (Poluprovodnikovyy datchik dlya indikatsii gamma-izlucheniya).

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1957, Vol. 27, Nr 7, pp. 1601-1602 (USSR)

ABSTRACT: As there exists a great want of cheap and simple devices, particularly of gamma-ray indicators, and as promising results were obtained in this respect with semiconductor-materials, such as CdS and CdSe, whose conductivity substantially changes upon irradiation, the investigations were here performed in this direction. In Zhurnal Tekhnicheskoy Fiziki, 1954, Vol. 24, p. 961 the authors showed that semicrystalline layers may form upon sublimation of CdS powder. The high temperature of the base, however, leads to the diffusion of the base-substance into the CdS-layer by which fact its properties with regard to sensitivity in the case of irradiation are greatly deteriorated. This difficulty was now overcome at the expense of a great increase in the speed of sublimation.

Card 1/2

A Semiconductor Transmitter for Gamma-Ray Indication 57-27-7-30/40

It was possible to obtain, on the conductive base, layers with a comparatively high sensitivity toward gamma-rays with an inertia not exceeding that of CdS-crystals. The preliminary tests showed that τ_1 (time of current-rise up to 80 % of the stationary value) can be much reduced by means of previous weak illumination of the sample. The obtained data show that the transmitters worked out here can in a number of cases be used in the simplest schemes as indicators of gamma-rays.
There are 1 table and 9 references, 5 of which are Soviet.

ASSOCIATION: Physico-Technical Institute AS USSR, Leningrad
(Fiziko-tekhnicheskiy institut AN SSSR, Leningrad)

SUBMITTED: March 3, 1957

AVAILABLE: Library of Congress

1. Gamma rays-Detection 2. Semiconductors-Applications 3. Cadmium selenide-Applications 4. Cadmium sulfide-Applications

Card 2/2

Ryvkin, S.M.

57-8-7/36

AUTHOR Ryvkin S.M.

TITLE On Kinetics of Photo-Diodes.
(O kinetike fotodiodov - Russian)

PERIODICAL Zhurnal Tekhn.Fiz., 1957, Vol 27, Nr 8, pp 1676 - 1685 (U.S.S.R.)

ABSTRACT

The qualitative considerations are given by means of which the difference between the characteristics of the relaxation curves in the case of an operation with photo-diodes and one with valves can be explained. The author shows that the difference between the characteristics of ascending and descending curves does not depend on a change of the characteristics of the same process. In either case the recombination is the determining process characterized by the same proper time τ. The φ(relaxation) measured during the experiment is variably connected with τ in the case of ascent and descent, and this leads to such essential differences between relaxation curves. Besides, the reasons and conditions for the development of complicated relaxation curves are given. Two voltampere characteristics of a photodiode are given. The one corresponds to the illuminated state the other to darkness. In the quadrant I the curve corresponds to an operation with photo-diodes, and in quadrant II to one with valves. Two straight lines correspond with two different load resistance R' and R" (R' $<$ R"). The points of intersection of the straight line with the voltampere curve in the darkness and in the case of illumination determine the steady voltage values at the photo-diodes φ_D and φ_B. If the resistance R' is

Card 1/2

57-8-7/36

On Kinetics of Photo-Diodes.

small the relaxation φ takes place between φ_D'' and φ_B'' under the conditions for the operation with photo-diodes. In the case of R" ,however, the relaxation between φ_D'' and φ_B'' is partly taking place under the conditions of an operation with photo-diodes and partly of one with idle valves. In connection herewith the relaxation curves acquire the complicated ("hybrid") characteristics. (7 illustrations and 3 Slavic references).

ASSOCIATION Leningrad Physical-Technical Institute. (Leningradskiy fiziko-tekhnicheskiy institut).

SUBMITTED March 28, 1957
AVAILABLE Library of Congress
Card 2/2

RYVKIN, S.M.

PHASE I BOOK EXPLOITATION SOV/1503

24(6) 9(3,4)
Akademiya nauk SSSR. Institut poluprovodnikov

Poluprovodniki v nauke i tekhnike, t. 2. (Semiconductors in Science and Technology, Vol 2) Moscow, Izd-vo AN SSSR, 1958. 658 p. 17,000 copies printed.

Resp. Ed.: A.F. Ioffe; Tech. Ed.: R.S. Fevzner.

PURPOSE: This collection of articles is intended for scientists, engineers and technicians.

COVERAGE: The collection, published by the Semiconductor Institute, Academy of Sciences, USSR, under the supervision of Academician A.F. Ioffe, contains Parts II and III of a two-volume work on semiconductors. Part II completes the material on semiconductor devices, begun in Volume I, and Part III describes various semiconductor materials. Lack of space did not permit inclusion of such subjects as crystal counters, thermoelectric generators, atomic batteries, luminophores, semiconductor catalyzers, materials for complex cathodes and various other applications of semiconductors. Ioffe points out that the article by the American scientists V. Johnson and K. Lark-Horovitz on semiconductors at low temperatures deals with a subject hardly covered in the Soviet literature. Similarly, the article by the Swiss scientists G. Busch and U. Winkler fills a gap in the Soviet literature on methods of investigating semiconductor characteristics. These subjects will be dealt with exclusively in a proposed third volume. References appear separately after each article.

TABLE OF CONTENTS:

Ch. 22. Ryvkin, S.M. Recombination in Semiconductors 463
The author explains the phenomenological theory of recombination in semiconductors, linear recombination, quadratic recombination and, in detail, the mechanism of recombination for various cases. There are 22 references, of which 17 are Soviet (including 8 translations), and 5 English.

Ch. 23. Mirlin, D.N. Electrical Fluctuations in Semiconductors 517
The author explains the origin of Johnson noise and the application of the Nyquist formula to determine the fluctuation voltage causing this noise. He then explains the application of the probability theory to this investigation and explains definitions and terminology. Experimental methods employed in this investigation are described in detail. There are 79 references, of which 54 are English, 21 Soviet and 4 German.

SOV/107-58-2-23/32

AUTHORS: Ryvkin, S., Konovalenko, B.

TITLE: A Photodiode Made of a Junction Transistor (Fotodiod iz ploskostnogo trioda)

PERIODICAL: Radio, 1958, Nr 2, p 41 (USSR)

ABSTRACT: The author describes the conversion of ordinary germanium junction transistors ("P1A", "P1B" and others) to photodiodes and phototriodes. For this purpose, the glass insulator is removed from the side of the emitter. Photodiodes obtained in this way should not be used under conditions of increased humidity.

1. Diodes--Design 2. Transistors--Applications

Card 1/1

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

57-28-3-4/33

AUTHORS: Vitovskiy, N. A., Maleyev, P. I., Ryvkin, S. M.

TITLE: The Mechanism of Pulse Formation in Crystal Counters at the Formation of a "Through Conducting Channel" (Mekhanizm formirovaniya impul'sov v kristallicheskikh schetchikakh pri obrazovanii "skvoznogo provodyashchego kanala")

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1958, Vol. 28, Nr 3, pp.460-469 (USSR)

ABSTRACT: The authors here investigate the peculiarities of the mechanism of pulse formation for the case where the ionization range extends from one electrode to the other. As ionizing agent the authors used α-particles of polonium (Po^{210}) with an energy of 5,3 MeV. In order to realize a "through" passage of the α-particles through the samples, thin CdS--monocrystals were selected. The investigations showed that the process of pulse formation according to the "through current" system may take place at least in two different forms. 1) The first variant can be realized by the construction with a one-sided application of the electrodes or in

Card 1/3

57-28-3-4/33

The Mechanism of Pulse Formation in Crystal Counters at the Formation of a "Through Conducting Channel"

thick crystals with electrodes applied on both sides. Here a through current which is limited by the resistance of the "dark sections" of the crystal flows in the pulse. In such a counting arrangement the "dark"-conductivity of the crystal plays the decisive part. A considerable increase in the pulse height can in this process be attained by an increase in σ_o ("dark"conductivity), e.g. by a rise of temperature. 2) The second variant can only be observed in sufficiently thin crystals in the case of "two-sided" application of electrodes. Here the passage of the α-particles through the crystal can take place and a "conducting channel" between the electrodes can be formed. The pulse height is in this case not dependent on the initial conductivity of the sample. It is to be expected that a similar mechanism of pulse formation will even occur in the case of some isolating crystals, in case the life of the current carriers not being in equilibrium in them (i.e. the crystals) will not be too small and electrodes forming anti-barrier--layers are selected. The authors performed an experimental investigation of the process of pulse formation in "thin" counters at the formation of a "conducting channel". It is

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Title: Mechanism of Pulse Formation in Crystal Counters at the Formation of a "Through Conducting Channel"

shown that in such a case the simplest variant for the formation of pulses can be realized according to the scheme of the passing current. The obtained experimental results are in good agreement with the prediction of theory. The high quality (from the point of view of pulse-height) of the counters with thin crystals and "two-sided" applied electrodes is pointed out. In this construction the pulse heights attain 20 V and amount to up to 90 % of the voltage applied. There are 11 figures, 1 table, and 3 references, 3 of which are Soviet.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut AN SSSR (Leningrad Physical-Technical Institute AS USSR)

SUBMITTED: November 20, 1957

1. Crystal counters--Analysis

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

57-28-3-6/33

AUTHORS: Khansevarov, R. Yu., Ryvkin, S. M., Ageyeva, I. N.

TITLE: On the Dependence of the Width of the Forbidden Zone on the Composition of Solid CdS-CdSe Solutions (O zavisimosti shiriny zapretnoy zony ot sostava v tverdykh rastvorakh CdS-CdSe)

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1958, Vol. 28, Nr 3, pp.480-483 (USSR)

ABSTRACT: The authors here give the results of the investigation made on the modifications of the limits of long waves, absorption and photoelectric effect, as well as of the constant lattice with the modification of the composition of mixed polycrystalline CdS-CdSe-layers. On the basis of these investigations conclusions are drawn on the dependence of the width of the forbidden zone on the relation of the CdS- and CdSe-components in their solid solution. It is shown that the constant lattices monotonously change with the increase in CdSe-content in the initial mixture. It can be assumed that in mixed

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57-28-3-6/33

On the Dependence of the Width of the Forbidden Zone on the Composition of Solid CdS-CdSe-Solutions

CdS-CdSe crystals the Vegard rule (Reference 4) is satisfied, i.e. that a linear dependence between the constant lattice and the composition is observed. From the data obtained here follows that CdS and CdSe form a continuous series of solid exchange-solutions. It is shown that with the increase of CdSe-content in the layer a monotonous shift of the curve of photoconductivity to the long-wave side is observed. It is further shown that on a modification of the composition of the solid CdS-CdSe-solution a monotonous modification of the width of the forbidden zone occurs. In contrast to the solid Ge-Si-solutions this dependence is almost linear.
V. S. Maydzinskiy and L. P. Bogomazov helped in the work.
There are 4 figures, 1 table, and 8 references, 4 of which are Soviet.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut, AN SSSR
(Leningrad Physical-Technical Institute, AS USSR)

SUBMITTED: August 21, 1957

Card 2/2

1. Cadmium-selenium-sulfur systems--Lattices 2. Cadmium-selenium-sulfur systems--Properties

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

57-28-4-14/39

AUTHORS: Ivanov, Yu. L., Ryvkin, S. M.

TITLE: The Formation of Current Oscillations in Germanium Samples in an Electric and Longitudinal Magnetic Field (Vozniknoveniye kolebaniy toka v obraztsakh germaniya, pomeshchennykh v elektricheskoye i prodol'noye magnitnoye pole)

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1958, Vol. 28, Nr 4, pp.774-775 (USSR)

ABSTRACT: The authors determined current fluctuations in some germanium-samples through which a direct current passed and which were placed in a constant magnetic longitudinal field (magnetic field parallel to the current). Under certain conditions the forming fluctuations had a shape near to the sinosoidal line with a frequency of 10 - 15 kilocycles per second. The fluctuation character depends on quite a number of circumstances. Thus fluctuations only formed at a current through the sample different from zero and increased according to amplitude and frequency with an increase in current. Analogous dependences were also observed on the magnitude of the

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57-28-4-14/39

The Formation of Current Oscillations in Germanium Samples in an Electric and Longitudinal Magnetic Field

magnetic field. In spite of zinc-contacts the voltampere characteristics in the investigated samples differed from a linear one. The fluctuations formed in one as well as the other current direction were more marked when the direction of current correspond to the lower resistance of the sample. Fluctuations only occurred in the case of an exact agreement of the direction of the magnetic field with the axis of the sample. An intensitve illumination of the samples led to an interruption of the fluctuations. A certain drop in temperature in the samples, however, led to an increase of their amplitude and frequency. An etching of the samples in hydrogen peroxide promoted the formation and the stability of the fluctuations. An increase or decrease of the amplitude of fluctuation connected with any change of the experimental conditions in all cases led to the corresponding increase or decrease respectively of the frequency of fluctuations. There are 3 figures and 1 reference, 1 of which is Soviet.

Card 2/2 Physics Tech Inst AS USSR

57-28-5-2/36

AUTHORS: Ryvkin, S. M., Khansevarov, R. Yu.

TITLE: On the Influence of Surface Treatment of Semiconductors on the Magnitude and the Spectral Distribution of Photoconductivity (O vliyanii obrabotki poverkhnosti poluprovodnikov na velichinu i spektral'noye raspredeleniye fotoprovodimosti)

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1958, Vol. 28, Nr 5, pp. 925-931 (USSR)

ABSTRACT: It is known that the spectral distribution of photoconductivity in numerous photoconductors exhibits an important property in the range of auto absorption: the photoconduction takes place only at the edge of the absorption band and is missing in its interior. In the present paper the authors investigated the extremely strong influence of some types of "treatment" of the surface of CdS and Cu_2O on the magnitude and the spectral distribution of photoconductivity. The influence of a treatment on the photoconductivity of the crystal surface was investigated by means of an intensive electron bombardment, heating in a

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On the Influence of Surface Treatment of Semiconductors on the Magnitude and the Spectral Distribution of Photoconductivity. 57-28-5-2/36

vacuum and in air, as well as by means of a short exposure to a gas discharge. The results of the investigations apparently permit to draw the following conclusions: The strong photosensitivity at the surface as well as a strong dependence of the sensitivity on the treatment of the surface are determined by the strong influence of the recombination processes near the surface. These recombination processes can influence the photoconductivity and modify the phenomenological emission. (fenomenologicheskiy vykhod). As an increase of photoconductivity is accompanied by an increase of dark conductivity, it can be assumed, that the investigated kinds of treatment primarily influence the magnitude and the sign of the zonal curvature near the surface. The experiments conducted, however, cannot furnish a basis for the evaluation of particular features of the mechanism. The rôle of the recombination processes at the surface is well investigated in germanium, silicon and similar substances, where the determination of carriers not in equilibrium is only possible after a special

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On the Influence of Surface Treatment of Semiconductors on the Magnitude and the Spectral Distribution of Photoconductivity

57-28-5-2/36

treatment of the surface. It appears, that the recombination processes also play an important rôle in other semiconductors. The experiments also proved the necessity of new effective methods for the cleaning of the surfaces of the semiconductors. This would presumably make it possible to increase the photosensitivity of numerous substances, which in spite of their strong absorption are considered not photosensitive or only weakly sensitive. Therefore the experimental results verify the fact, that the two basic anomalies in photoconductivity - the "inactive" absorption of light in some substances as well as the reduction of photoconductivity in the depth of the absorption band - can to a considerable degree be explained by one cause, that is to say by intensive recombination-type processes, which are considerably intensified near the surface. The authors express their gratitude to the student of Leningrad State University

Card 3/4

On the Influence of Surface Treatment of Semiconductors on the Magnitude and the Spectral Distribution of Photoconductivity 57-28-5-2/36

I. A. Dunayev for valuable help in the measurements.

Appendix: As a conclusion, a short report is given on the possible influence of sample shape of the semiconductors with low conductivity (i. g. CdS etc.) on the experimental results concerning their electrical properties.
There are 9 figures and 7 references, 5 of which are Soviet.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR, Leningrad (Physico-technical Institute, AS USSR, Leningrad)

SUBMITTED: September 23, 1957

1. Semiconductors--Photoconductivity

Card 4/4

57-28-6-5/34

AUTHORS: ~~Ryvkin, S. M.,~~ Strokan, N. B., Tuchkevich, V. M., Chelnokov, V. Ye.

TITLE: Silicon Photodiodes (Kremniyevyye fotodiody)

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1958, Vol. 28, Nr 6, pp. 1165-1168 (USSR)

ABSTRACT: In the present report the results obtained by investigating the possibility of utilizing silicon p-n photoelements for the purpose of transforming light signals into electric signals in the photodiode regime are described. It could be taken for granted from the very beginning that silicon photodiodes, which are of somewhat lower integral sensitivity, must offer some advantages compared to germanium photodiodes (reference 3), viz. a lower "dark current" and a lower degree of inertia. Further, the results obtained by investigating the basic properties of the silicon photodiodes LFTI produced in the laboratory are described. The sensitivity of samples to the light of the incandescent lamp with a color temperature of the filament of ~2850°C fluctated between 5 and 7 mm/lumen

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Silicon Photodiodes

(figure 1). The photodiodes have the same sensitivity along the entire illuminated surface (figure 2). The dependence of sensitivity on light intensity is linear (figure 3). The volt-ampère characteristics of the photodiodes are shown (figures 4a and 4b). Estimation of the time needed for "flying through" t_o resulted in the value

$t_o \simeq \frac{w^2}{2D} \approx 3 \cdot 10^{-8}$ sec. Finally, the authors endeavored to estimate the life of the minority carriers τ in the photodiodes investigated by studying the kinetics of the photoelectromotive valve force Φ. When measuring τ, $\tau \sim 1 \cdot 10^{-6}$ sec was obtained as a result. This amount must be considered to be merely the upper limit of the τ value as it corresponds to the duration of the front amplification of the light impulses. For $\Phi \ll \frac{kT}{e}$ the relaxation curve is an exponent with a time constant $R_e C$, in which case $\frac{1}{R_e} = \frac{1}{R_o} + \frac{1}{R}$. The value of the capacity, which was determined

Silicon Photodiodes

from $R_e C$, was found to be equal to approximately 2000 pf. This capacity value is greater than the one mentioned in the table, because it corresponds approximately to the zero-displacement on the n-p-transition. There are 5 figures, 1 table, and 7 references, 7 of which are Soviet.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut, AN SSSR (Leningrad Physical-Chemical Institute, AS USSR)

SUBMITTED: January 28, 1958

1. Silicon—Photoconductivity 2. Silicon—Photosensitivity 3. Silicon—Electrical properties 4. Silicon—Electron transitions 5. Mathematics

TITLE: Photodiodes

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

57-28-6-6/34

AUTHORS: Ryvkin, S. M., Strokan, N. B.

TITLE: On the Kinetics of Phototriodes (O kinetike fototriodov)

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1958, Vol. 28, Nr 6, pp. 1169-1173 (USSR)

ABSTRACT: Phototriodes can be used as highly photo-sensitive means transforming light signals into electric signals. It is therefore of particular interest to study their inertia. During the first months of 1957 the authors produced samples of germanium phototriodes in the laboratory, which had a sensitivity of 1 $\div$ 4 ampères/lumen, a dark current of 500 $\div$ 700 microampères (saturation remains up to $\sim$5V), and a sensitive surface of $\sim$4 mm^2 (reference 1). Besides the authors, also engineer N. F. Ragozina and laboratory worker I. A. Lebedeva assisted in producing the samples. The high sensitivity of phototriodes is known to be connected with the process of amplification of the photocurrent which takes place in them. The kinetics of phototriodes was investigated by means of an apparatus which is shown in form of a

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On the Kinetics of Phototriodes

schematical drawing (figure 2). Determination of the quality of the time constant was carried out by the method developed by Tolstoy and Feofilov (reference 2) on the basis of the principles of the substitution scheme (reference 3). Results are shown by a table. From the oscillogram worked out by V. V. Makarov, student of the LGU (reference 3) it may clearly be seen that the rapid relaxation of the collector current, to be expected on the strength of theoretical argumentation and a slower relaxation of the potential differences on the point of emitter transition actually take place. In conclusion it is mentioned that in the case of phototriodes a working regime which is analogous to the so-called "hybrid regime" of photodiodes (reference 5) is possible. In this case relaxation has 2 domains: a "phototriode" domain at low values of the photocurrent, and a "valve domain", which corresponds to high values of the photocurrent. Obviously, the "valve domain" is possible in phototriodes only in the case of "asymmetry" during generation of the photoelectromotive force in emitter- and collector transition. A typical

On the Kinetics of Phototriodes

oscillogram of the phototriode signal in the case of a hybrid regime is shown (figure 4). There are 4 figures, 1 table, and 5 references, 5 of which are Soviet.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut
(Leningrad Physical-Technical Institute)

SUBMITTED: December 23, 1957

1. Germanium—Electrical factors 2. Germanium—Photosensitivity
3. Germanium—Electron transitions 4. Germanium—Photoconductivity

TITLE: Phototriodes

SOV/57-28-9-2/33

AUTHORS: Ryvkin, S. M., Strokan, N. B., Makovskiy, L. L.

TITLE: On Problems of the Kinetics of Photovoltaic Cells With Electron-Hole Junctions (K voprosu o kinetike ventil'nykh fotoelementov s elektronno-dyrochnym perekhodom)

PERIODICAL: Zhurnal tekhnicheskoy fiziki, 1958, Nr 9, pp. 1871-1882 (USSR) Vol. 28

ABSTRACT: This is a study of the kinetics of the photovoltaic cell operating as a rectifier. No limitations are imposed on the ratio of the life τ and of R_0C (where C denotes the capacity of the n-p junction at zero voltage, and R_0 its resistance) and of arbitrary loads R. The downward-sloping branch of the relaxation curve is investigated. In the first section qualitative considerations bearing on the kinetics of a few special cases are presented. In section 2 this is investigated as to its quantitative aspects. In section 3 the experimental equipment is described and in section 4 the theoretical results are compared with those from experiments. The downward-sloping branch of the relaxation curve is computed assuming different conditions. Even if the conditions assumed in reference 3 (infinite load

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On Problems of the Kinetics of Photovoltaic Cells With Electron-hole Junctions

and small capacitive currents) are not satisfied, the illumination, however, is sufficiently high, a section of the relaxation curve is still determined only by relaxation. This section supplies the data for the determination of the life of the non-equilibrium carriers. These conclusions were substantiated by experiments. From the slope of the rectilinear sections in the oscillograms it was found, that the levels of recombination centers are removed by $\simeq$ 0,23 eV from the boundary of the permitted zone. There are 10 figures and 8 references, 7 of which are Soviet.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut,AN SSSR (Leningrad Physical and Technical Institute,AS USSR)

SUBMITTED: January 28, 1958

Ryvkin, S. M.

PHASE I BOOK EXPLOITATION SOV/3548

Akademiya nauk SSSR. Otdeleniye fiziko-matematicheskikh nauk

Fizika tverdogo tela; sbornik statey, II (Solid State Physics; Collection of Articles, II) Moscow, Izd-vo AN SSSR, 1959. 328 p. 3,500 copies printed.

Ed.: A.F.Ioffe, Academician; Ed. of Publishing House: V. B. Filipovich; Tech. Ed.: R.A. Zamarayeva.

PURPOSE: This collection of articles is intended for physicists investigating the structures and properties of solids.

COVERAGE: This volume II of a two-volume collection of articles dealing with problems of solid state physics, was prepared by the Department of Physics and Mathematics, Academy of Sciences, USSR. The authors report on the physical properties of semiconductors such as germanium, cadmium sulfide, cadmium telenide, gallium arsenide, silicon, and various metal alloys. The electrical conductivity of these substances is studied. The effects of irradiation and acoustic phonons on semiconductors are also investigated. Several articles are devoted to the theory of electrical breakdown. X-ray studies were made on polycrystalline substances, and one study of the gold-barium system was carried out. No personalities are mentioned. References accompany each article.

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Ryvkin, S.M.

24(4) SOV/3140

PHASE I BOOK EXPLOITATION

Akademiya nauk Ukrainskoy SSR. Institut fiziki

Poluprovodnikovyye i fotoelektricheskiye yavleniya v poluprovodnikakh; trudy pervogo vsesoyuznogo soveshchaniya po fotoelektricheskim i opticheskim yavleniyam v poluprovodnikakh. Pod obshchey red. K. Kiyeva, 20-26 noyabrya 1957 g. (Photoelectric and Optical Phenomena in Semiconductors; Transactions of the First Conference on Photoelectric and Optical Phenomena [Proceedings of the First Conference...]) Kiyev, 1959. 403 p. 4,000 copies printed.

Additional Sponsoring Agency: Akademiya nauk SSSR. Prezidium. Komissiya po poluprovodnikam.

Ed. of Publishing House: I. V. Kisina; Tech. Ed.: A. A. Matveyshuk

Resp. Ed.: V. Ye. Lashkarev, Academician, Ukrainian SSR, Academy of Sciences.

PURPOSE: This book is intended for scientists in the field of semiconductor physics, solid state spectroscopy, and semiconductor devices. The collection will be useful to advanced students in universities and institutes and technical application of semiconductors.

COVERAGE: The collection contains reports and information bulletins (the latter are indicated by asterisk) read at the First All-Union Conference on Optical and Photoelectric Phenomena in Semiconductors. A wide scope of problems in semiconductor photoelectronics are considered: photoconductivity, photoelectric cells and photoelectric emf, optical properties, and corpuscular radiations, and technology of hard semiconductor systems, active forces, the actions of hard radiations, and complex semiconductor photoresistors, thin films and complex semiconductor systems, the properties of which were prepared for publication by Z. I. M. K. Rashboy, O. V. Snitko, K. B. Tolpygo, follow each article. The materials were prepared for A. P. Lubchenko, and etc. References and discussion follow each article. Sheynkman.

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24(4) PHASE I BOOK EXPLOITATION SOV/3140

Akademiya nauk Ukrainskoy SSR. Institut fiziki

Fotoelektricheskiye i opticheskiye yavleniya v poluprovodnikakh; trudy pervogo vsesoyuznogo soveshchaniya po fotoelektricheskim i opticheskim yavleniyam v poluprovodnikakh, g. Kiyev, 20-26 noyabrya 1957 g (Photoelectric and Optical Phenomena in Semiconductors; Transactions of the First Conference on Photoelectric and Optical Phenomena in Semiconductors...) Kiyev, 1959. 403 p. 4,000 copies printed.

Additional Sponsoring Agency: Akademiya nauk SSSR. Prezidium. Komissiya po poluprovodnikam.

Ed. of Publishing House: I. V. Kisina; Tech. Ed.: A. A. Matveychuk; Resp. Ed.: V. Ye. Lashkarev, Academician, Ukrainian SSR, Academy of Sciences.

PURPOSE: This book is intended for scientists in the field of semiconductor physics, solid state spectroscopy, and semiconductor devices. The collection will be useful to advanced students in universities and institutes of higher technical training specializing in the physics and technical application of semiconductors.

COVERAGE: The collection contains reports and information bulletins (the latter are indicated by asterisks) read at the First All-Union Conference on Optical and Photoelectric Phenomena in Semiconductors. A wide scope of problems in semiconductor physics and technology are considered: photoconductivity, photoelectromotive forces, optical properties, photoelectric cells and photoresistors, the actions of hard and corpuscular radiations, the properties of thin films and complex semiconductor systems, etc. The materials were prepared for publication by E. I. Rashboy, O. V. Snitko, K. B. Tolpygo, A. P. Lubchenko, and M. K. Sheynkman. References and discussion follow each article.

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S/058/62/000/004/060/160
A058/A101

9.4160

AUTHORS: Ryvkin, S. M., Strokan, N. B., Makovskiy, L. L.

TITLE: On the kinetics of p-n-junction phototubes

PERIODICAL: Referativnyy zhurnal, Fizika, no. 4, 1962, 23, abstract 4G187 (V sb."Fotoelektr. i optich. yavleniya v poluprovodnikakh". Kiev, AN USSR, 1959, 360-366)

TEXT: This is a continuation of the authors' work (RZhFiz, 1958, no. 10, 23378) dealing with the kinetics of valve operating regimes incident to photodiode illumination by rectangular light pulses. They examine the general case of connecting a photodiode in a circuit containing a finite load resistance and a capacitance.

[Abstracter's note: Complete translation]

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S/058/62/000/004/158/160
A061/A101

AUTHORS: Ryvkin, S. M., Bogomazov, L. P., Konovalenko, B. M., Matveyev, O. A.

TITLE: Semiconductor gamma detectors

PERIODICAL: Referativnyy zhurnal, Fizika, no. 4, 1962, 15, abstract 4-4-291 (V sb. "Fotoelektr. i optich. yavleniya v poluprovodnikakh", Kiyev, AN USSR, 1959, 386 - 388)

TEXT: The prospects of CdS crystals used as gamma detectors are considered. The low sensitivity and the considerable lag of such pickups are noted. There are 6 references.

P. L.

[Abstracter's note: Complete translation]

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~~24(3), 24(6)~~ SOV/181-1-9-8/31

AUTHORS: Ryvkin, S. M., Ivanov, Yu. L., Grinberg, A. A., Novikov, S.R., Potekhina, N. D.

TITLE: A New Longitudinal Magnetostriction Effect and Its Application to the Determination of the Ratio Between the Concentrations of Heavy and Light Holes

PERIODICAL: Fizika tverdogo tela, 1959, Vol 1, Nr 9, pp 1372 - 1375 (USSR)

ABSTRACT: When investigating the diffusion of the nonequilibrium carrier in the magnetic field, the appearance of electrical fields is usually studied (e.g. the photomagnetic Kikoin-Noskov effect). The present paper offers the results obtained from an investigation of the concentration distribution of the minority carrier in the magnetic field, and in particular, the results of an investigation of the longitudinal magnetostriction effect in the longitudinal magnetic field. A plane-parallel semiconductor plate was arranged perpendicularly to a homogenous magnetic field. On the plate, a point light probe exactly faced a point collector. The injected nonequilibrium carriers diffused through the plate and the collector determined the concentration of the minority carrier. The concentration

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A New Longitudinal Magnetostriction Effect and Its Application to the Determination of the Ratio Between the Concentrations of Heavy and Light Holes

recorded thereby increased with H. Figure 1 shows a schematic representation of the measuring arrangement, a description of which is given. Theoretically, one obtains for the concentration of the injected carrier on the z-axis

$(\vec{H} \| z)$: $\Delta n_H = \frac{i_o \beta e^{-z/l_D}}{2\pi D_n z\, I(\gamma_\nu)}$, where $i_o\beta$ is the electron-hole pair production rate, l_D the diffusion length, D_n the electron diffusion coefficient. Figure 2 shows the result obtained by an attempt of experimentally verifying this formula for electron injection into hole-type germanium. The best agreement is obtained with a microscopic drift mobility of the electrons $\mu_n^o = 3650$ cm^2/v.sec. When investigating the hole diffusion in n-type germanium, a considerable divergence between theory and experiment is observed, which, however, can be explained when taking into account the existence of

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

A New Longitudinal Magnetostriction Effect and Its Application to the Determination of the Ratio Between the Concentrations of Heavy and Light Holes

heavy and light holes. The theoretical curve drawn for this case nicely describes the experimental results. The concentration ratio between heavy and light holes is deduced from measuring results as being 57; this value approaches the result (50.0) obtained by an other way (Ref 1). There are 2 figures and 2 references.

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SUBMITTED: March 7, 1959

67392

SOV/181-1-9-10/31

24.7700
~~24(3), 24(6)~~

AUTHORS: Arkad'yeva, Ye. N., Ryvkin, S. M.

TITLE: Investigation of the Adhesion Levels in Polycrystalline Sb_2S_3 and in Single Se Crystals by the Method of the Thermostimulated Current

PERIODICAL: Fizika tverdogo tela, 1959, Vol 1, Nr 9, pp 1379 - 1380 (USSR)

ABSTRACT: In continuation of a previous paper (Ref 1) the present article offers some experimental results. Figure 1 shows the temperature dependence of the thermostimulated current in Sb_2S_3, figure 2 shows the same in selenium. Both samples have p-type conductivity. The heating rate was 0.5 deg/sec for the former and 0.2 deg/sec for the latter. The thermostimulated current in the former exhibits two maxima at T_1 = 150°K and T_2 = 180°K, and three in selenium (115°K, 165°K, and 180°K). An evaluation of the adhesion level position yields for Sb_2S_3: ΔE_1 = 0.33, and ΔE_2 = 0.39 ev, when assuming the effective mass of the holes to be equal to the mass of free

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Investigation of the Adhesion Levels in Polycrystalline Sb_2S_3 and in Single Se Crystals by the Method of the Thermostimulated Current

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electrons and the mobility to be $u = 20\ cm^2/v.sec$. If temperature is decreased from +20 to $-150^{\circ}C$, the photoelectric sensibility drops to about one hundredth. In this case, the lifetime changes only slightly and amounts to $\sim 40\ \mu sec$. With u independent of temperature and equal to 1 $cm^2/v.sec$, one obtains for selenium, according to the three maxima: $\Delta E_1 \simeq 0.10$ ev, $\Delta E_2 \simeq 0.14$ ev, and $\Delta E_3 \simeq 0.17$ ev. An evaluation of the carrier concentration yields for $Sb_2S_3 \simeq 10^{16}\ cm^{-3}$ and for $Se \simeq 10^{20}\ cm^{-3}$.

The authors thank B. T. Kolomiyets for supplying Sb_2S_3 and P. T. Kozyrev for selenium crystals samples. There are 2 figures and 2 Soviet references.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut AN SSSR (Leningrad Institute of Physics and Technology of the AS USSR)

SUBMITTED: April 24, 1959

24.7700
24(6), 21(8)

67393
SOV/181-1-9-11/31

AUTHORS: Vitovskiy, N. A., Mashovets, T. V., Ryvkin, S. M.

TITLE: Determination of the Number of Acceptor Levels of Defects Occurring in Germanium Under the Action of Gamma Irradiation

PERIODICAL: Fizika tverdogo tela, 1959, Vol 1, Nr 9, pp 1381 - 1387 (USSR)

ABSTRACT: The radiation-induced formation of structural defects stable at room temperature had already been investigated several times, but not all the problems related therewith are as yet solved satisfactorily. The present paper offers a contribution by discussing the possibilities of a complete analysis of the energy levels of the defects and by publishing experimental results concerning the temperature dependence of the Hall coefficient R of n-type germanium irradiated by Co^{60}-γ-rays. An analysis of these results permits a precise determination of the number of acceptor levels belonging to one γ-radiative defect. To investigate the temperature dependence of the carrier concentration in the presence of multiple-charged centers, the authors theoretically investigated a level scheme of a defect (Fig 1), with n in the conduction band considered to be composed of four parts (Fig 2a). In this connection the

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Determination of the Number of Acceptor Levels of Defects Occurring in Germanium Under the Action of Gamma Irradiation

following was assumed: every defect produced by radiation has l acceptor- and k donor levels; "ordinary" donors (atoms of the V group) and M defects exist in such a way in germanium with the concentration N_d, that $N_d > Ml$. n_1 : n rises weakly in consequence of transitions of electrons from donor levels to the conduction band; n_2: full ionization of the donor levels, $n_2 = N_d - Ml\, n_3$; stronger rising of n in consequence of transitions of electrons from higher defect levels to the conduction band $n_3 = \sqrt{N_c M}\, e^{-\Delta E_{M_1}/2kT}$ n_4: full ionization of the upper levels, $n_4 = N_d - N(l-1)$. The temperature dependence of n can thus be represented by the function $\lg n = f(\frac{1}{T})$ (theoretically in Fig 2a, experimentally in 2b). A table gives the results of several measuring series. It is found that for γ-induced defects $l = 4$, with ΔE_{M_1} being 0.18 ev. The defect formation cross section was found to be $\sigma \simeq 4.0 \cdot 10^{-27}$ cm^2.

Determination of the Number of Acceptor Levels of Defects SOV/181-1-9-11/31
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Directives for further investigations are briefly shown. Finally, the authors thank B. M. Konovalenko and I.D.Yaroshetskiy for exposure of the samples and Sh. M. Mirianashvili for his assistance in measurements. There are 2 figures, 1 table, and 3 references, 1 of which is Soviet.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut AN SSSR (Leningrad Institute of Physics and Technology of the AS USSR)

SUBMITTED: March 24, 1959

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

24.7700
~~24(6)~~

67399
SOV/181-1-9-23/31

AUTHORS: Arkad'yeva, Ye. N., Ryvkin, S. M.

TITLE: Investigation of Adhesion Levels in Sb_2Se_3 by the Method of the Thermostimulated Current

PERIODICAL: Fizika tverdogo tela, 1959, Vol 1, Nr 9, pp 1460 - 1463 (USSR)

ABSTRACT: If adhesion levels are occupied by carriers at low temperatures, this condition is conserved for a long time. With slow heating the carrier concentration rises in the allowed zone, in the same way as the current (if a field is applied). This boost current which is higher than dark current is defined as thermostimulated. An investigation of thermostimulated currents allows the estimation of position and concentration of the adhesion levels. This method is specially applicable to poorly conductive and photosensitive semiconductors. It had already been utilized for the investigation of CdS, CdSe, HgJ_2, and ZnS (Refs 1-11). The present paper offers the results obtained for the single Sb_2Se_3 crystals. Investigations were conducted in the temperature range of from -180 to

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Investigation of Adhesion Levels in Sb_2Se_3 by the Method SOV/181-1-9-23/31
of the Thermostimulated Current

+20°C. Figures 1 and 2 show samples 1 and 2 as to the temperature dependence of the thermostimulated current (solid curve) and the dark current (dashed curve). The curves were recorded by means of a recording device of the type EPPV-51, which exhibits a sensitivity varied within wide limits ($\sim 10^{-12}$ - $\sim 10^{-7}$ a/mm). The thermostimulated current shows characteristic fluctuations with maximum at 115, 150, and 190°K. An estimation of the energetic position (ΔE_M) and the concentration (M) of the adhesion levels is made on the assumption of the very slow heating having a quasiequilibrium character, so that the Fermi quasilevels for adhesion levels and zone are the same. It can be assumed furthermore that this quasilevel coincides with the adhesion level in the case of temperature T_M corresponding to the thermostimulated current maximum. $\Delta E_M = kT_M \ln \frac{P_v}{P} = kT_M \ln \frac{P_v eu}{\sigma}$ holds, where P_v is the effective level density in the valence band, P is the hole concentration in the valence

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band at T_M, u the hole mobility at T_M, σ the conductivity at T_M. Thus one obtains for the 3 maxima of crystal Nr 2:0.28, 0.32, and 0.36 ev. For M one obtains according to Khartsiyev (Ref 13)

$$M = \frac{P_v \Delta E_M \left(\frac{kT_M}{\Delta E_M}\right)^2 e^{=\Delta E_M / kT_M}}{kS\tau\left(1+\frac{3}{2}\frac{kT_M}{\Delta E_M}\right)}$$

, where S is the heating rate and τ is the carrier lifetime. For $T = 155^\circ K$ $\tau \simeq 10^{-8}$ sec holds, for $150^\circ K \simeq 10^{-7}$ sec, and for $180^\circ K \simeq 10^{-6}$ sec. M is then found to be 10^{16}, 3.10^{16}, and 5.10^{16} cm^{-3}. A few more details are finally discussed. The names of A. Kh. Zeynally, B. T. Kolomiyets, and M. V. Kot (who supplied the single crystals) and N. B. Strokan (who made a calculation) are mentioned in footnotes. There are 2 figures and 13 references, 1 of which is Soviet.

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Physico Tech Inst. AS USSR

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

66287

~~24 (6)~~ 24.7700 SOV/181-1-11-22/27

AUTHORS: Ryvkin, S. M., Konovalenko, B. M.

TITLE: On the Dependence of Induced Conductivity of Cadmium Sulfide on the Energy of the Exciting Electrons

PERIODICAL: Fizika tverdogo tela, 1959, Vol 1, Nr 11, pp 1757-1761 (USSR)

ABSTRACT: According to reference 1 it was jointly established with Yu. S. Smetannikova that for 2 to 30 kev electrons with increasing electron energies, but with a total electron current intensity, which remains at the same level, the induced conductivity of the CdS reaches a saturation value, i.e. that this does not increase any more starting from a certain electron energy. The initial point of the "saturation" is not identical for different samples. Additional investigations (Ref 2) established that with small electron energies the decrease of the induced conductivity is related to the fact that the electrons do not deeply penetrate into the crystals and therefore the recombination processes occurring on the surface of the crystals have an increasingly important influence. Other authors (Ref 3) carried out similar investigations on "voluminous" mono-crystals with 30 to 60 kev-electrons. Their measuring results

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On the Dependence of Induced Conductivity of Cadmium Sulfide on the Energy of the Exciting Electrons

contradict data in references 1 and 2, if these are extrapolated to the range 30 to 60 kev. The present study proves that this concept is incorrect and that the dependences found in references 1 and 2 are in qualitative accordance with those derived in reference 3. Certain quantitative differences can unequivocally be explained by the different methods of measuring. There are 2 figures and 4 references, 2 of which are Soviet.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR, Leningrad (Physico-technical Institute of the AS USSR, Leningrad)

SUBMITTED: June 19, 1959

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9,4160

SOV/109-4-8-27/35

AUTHORS: Vitovskiy, N.A., Maleyev, P.I. and Ryvkin, S.M.

TITLE: Optimum Operating Conditions for the Photo-diodes Used With Small Signals

PERIODICAL: Radiotekhnika i elektronika, 1959, Vol 4, Nr 8, pp 1387 - 1392 (USSR)

ABSTRACT: The characteristic of a photo-diode can be expressed by (Ref 2):

$$I = I_s\left(e^{\frac{q\varphi}{kT}} - 1\right) + I_f + \frac{\varphi}{R'} \qquad (5)$$

where I is the current flowing through the photo-diode, R' is the leakage resistance of the diode and φ is the voltage across the n-p junction. I_s is the "dark" saturation current, q is an electron charge, k is the Boltzmann constant and T is the absolute temperature. Eq (5) was employed to plot the voltage-current characteristics shown in Figure 1. Curves I_{T1} and I_{T2} show the "dark" characteristics at temperatures

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of +20 °C and -78 °C, while Curves I_{f1} and I_{f2} are the "illumination" characteristics at the same temperatures. The curves are calculated for a photo-diode which has a "dark" current of 8 μA and the resistance $R' > 10^8$ Ω at room temperature. The quantity R_o is represented by ctg α, where α is the slope of the "dark" current-voltage characteristics at $\varphi = 0$. This angle α_2 at the room temperature is equal to 90 °, while at low temperatures $\alpha = \alpha_1$ and tends to zero. If the device works as a photo-diode with a load characteristic $R = \text{ctg } \beta$, the load line intersects the characteristics I_T and I_f in the saturation region; consequently, at both the low and the room temperatures, the output signal taken from the device is the same. On the other hand, if the diode is operated as a photo-electric source, the intersection of the load line with the characteristic occurs in the saturation region only at the low temperature.

Optimum Operating Conditions for the Photo-diodes Used with Small Signals

In this case, again, the output signal is equal to that obtainable in the photo-diode operation. From the above, it follows that the photo-diode can be operated as a photo-electric source, provided it is maintained at a low temperature. Under these conditions, it should be expected that the noise level would be very low. The above conclusion was checked experimentally. The principal experimental characteristic was the relative sensitivity P which was defined as the ratio of the output signal obtained from the device as a photo source and as a photo-diode. This ratio can be defined by Eq (10). The experimental dependence of P on temperature is shown by the solid curve in Figure 3. The dependence of P on temperature for large signals is illustrated by the obtained line in Figure 3. The noise in the device when employed as a photo-diode was 0.5 mV, while when used as a photo-electric source, the noise was 10 μV. The inertia effects in the diode are illustrated in Figure 5, where the first oscillogram refers to the photo-diode operation, while the

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next four oscillograms show the photo-electric response at various temperatures; this effect is further illustrated in Figure 4, which shows that provided the temperature is about -80 °C, the time constant of the device is the same for both the photo-diode and photo-electric operation. There are 5 figures, 1 table and 7 Soviet references.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR (Physico-engineering Institute of the Ac.Sc.USSR)

SUBMITTED: June 4, 1958

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24(3)

AUTHORS: Ryvkin, S. M., Strokan, N. B.

SOV/20-124-5-20/62

TITLE: On the Problem of the Relaxation of Non-equilibrium Conductivity in Recombination Through Traps (K voprosu o relaksatsii neravnovesnoy provodimosti pri rekombinatsii cherez lovushki)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 124, Nr 5, pp 1034-1037 (USSR)

ABSTRACT: The present paper describes the results of an experimental investigation of the theory for the case of few traps for arbitrary injection levels. The first part of this paper deals with the theoretical investigation, in the course of which the authors determine the time-dependence of the non-equilibrium concentration of the carriers for semiconductors with a type of simple traps M. The scheme of transitions corresponding to this case is described in form of a schematical drawing, after which the 3 kinetic equations and the neutrality condition are written down. If the total change Δm of the concentration of electrons in the traps is negligibly small as against Δn and Δp

(in the present paper the system of notation of W. Shockley (Ref 1) is used), it holds qualitatively that during the main part of the monotonous relaxation process also dn/dt and dp/dt must be practically equal to each other. In the here investigated case of a small number of traps lifetime depends only on the concentration of the non-equilibrium carriers, and the value of lifetime at that instant is equal to the steady lifetime at the same steady concentration. A diagram shows the relaxation curve for the injection level $\Delta n_{steady}/(n_o + p_o) = 4$ for the case $\tau_3/\tau_\infty = 5$ (Shockley's system of notation). At the beginning of relaxation the relaxation curve is similar to the function e^{-t/τ_o}, but with increasing recombination it becomes ever more similar to the function e^{-t/τ_∞}. This transition takes place gradually without any salient point. The second part of this paper deals with experimental checking. The experimentally found curves for the decrease of photoconductivity agree qualitatively with theoretical results. In the case of a sufficiently

high injection level they have non-exponential character and are between 2 exponential functions, which correspond to the limiting values of lifetime. For the purpose of a qualitative checking of theoretical results the curves of photoconductivity relaxation were photographed, and $d\Delta n/dt$ and Δn were determined at some points of the declining branches of the oscillograms. All experimental results agree well with theoretical relations. There are 4 figures and 6 references, 4 of which are Soviet.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk SSSR (Physico-Technical Institute of the Academy of Sciences, USSR)

PRESENTED: October 25, 1958, by A. F. Ioffe, Academician

SUBMITTED: October 23, 1958

81369
S/181/60/002/03/28/028
B006/B017

24.7700

AUTHORS: Paritskiy, L. G., Ryvkin, S. M.

TITLE: The Influence of Adhesion Levels on the Relaxation of Photoconductivity in CdS Single Crystals

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 3, pp. 547-557

TEXT: The aim of the present paper was to investigate experimentally the initial stages of the increase of photoconductivity in CdS single crystals during some ten microseconds. As has been demonstrated by V. Ye. Lashkarev et al. in several papers, the characteristic features of photoconductivity in these crystals may be explained by the complex two-stage character of electron excitation in the conduction band. Here, the quantum yield depends on the excitation level. Other authors explained these characteristic features of photoconductivity by the complex character of recombination processes, which leads to a change in lifetime. Here, the quantum yield is constant and equal to unity. Hence, an explanation of the actual mechanism of the photoeffect in CdS can be

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obtained by investigating the "true" quantum yield of the photocurrent in CdS as dependent on the excitation level. The initial stages of the increase of the photocurrent were examined by means of an instrument schematically represented in Fig. 1. The instrument and the measuring technique are described. Fig. 2 shows the shape of the photocurrent curves during the first 50 msec for various irradiation intensities. The higher the intensity, the steeper the rise of the curves and the higher the relative yield. Fig. 3 shows a typical oscillogram for one of the samples. Fig. 4 shows the growth of a curve with a pulse duration of 10 μsec. It indicates that the steep rise takes place during the first microseconds. Hence, rapid processes proceed at the first stages of formation of the photocurrent. The results obtained in the experiments concerning the characteristic features of photocurrent relaxation can be explained in the simplest way by assuming the capture of carriers by α-type adhesion levels. Since the lifetime of the conduction electrons with respect to their adhesion levels is much shorter than with respect to their recombination, the adhesion levels are first filled up within a very

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short time, and only then the slow establishment of recombination equilibrium starts. This is theoretically investigated in the following. Fig. 5 shows the dependence of the concentration of free electrons on t/θ_{min} for different adhesion level densities. The higher the level density, the flatter the rise of n. In the following, the influence exercised by constant exposure on the first stages of the increase of photoconductivity is investigated. The existence of rapid capturing processes influences the change of photoconductivity in time and, especially, the phenomenological yield and the effective lifetime of non-equilibrium carriers. Also the character of the dependence of these quantities on constant irradiation and its intensity is considerably influenced by these processes. Hence, the characteristic features of photoconductivity of CdS are rather to be connected with the complex character of recombination processes than with the excitation process. In an appendix, the influence exercised by constant exposure on the relaxation of monopolar photoconductivity in the presence of a) α-type and b) β-type adhesion levels is investigated. A. B. Berezin, O. A.

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The Influence of Adhesion Levels on the Relaxation of Photoconductivity in CdS Single Crystals

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B006/B017

Matveyev, L. V. Maslova, and G. A. Fedorus are mentioned. There are 12 figures and 17 references: 8 Soviet, 6 US, and 2 German.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR Leningrad (Institute of Physics and Technology of the AS USSR, Leningrad)

SUBMITTED: June 14, 1959

Card 4/4

S/181/60/002/04/02/034
B002/B063

24.7700

AUTHORS: Konopleva, R. F., Ryvkin, S. M., Yaroshetskiy, I. D.

TITLE: The Problem of the Trapping Cross Section of Holes in Germanium by Defects Formed by Gamma Irradiation

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 4, pp. 566-568

TEXT: The trapping cross section of holes by defects formed by neutron bombardment was found to be $\sim 10^{-15}$ cm^2 (Refs. 1-3). The trapping cross section for gamma irradiation was $4 \cdot 10^{-16}$ cm^2. The present paper shows that this difference is due to a false assumption: A defect formed by gamma irradiation has not two but four acceptor levels in the forbidden band. The dependence of the lifetime on the irradiation with gamma quanta was determined on 11 specimens, wherefrom the trapping cross section of the holes was calculated (Table). A Co^{60} preparation with an activity of 400 gram-equivalent Ra was used as gamma source. The authors used the photomagnetic method, the method of photodiffusion, and the examination of the relaxation curves of photoconductivity to measure the lifetime. The mean value of the trapping cross section was found to be $3.8 \cdot 10^{-15}$ cm^2. This is close to the value obtained for the neutron

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The Problem of the Trapping Cross Section of Holes in Germanium by Defects Formed by Gamma Irradiation

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B002/B063

bombardment ($3 \cdot 10^{-15}$ cm^2 in Ref. 1). There are 1 table and 7 references: 4 Soviet, 1 American, and 2 British.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut AN SSSR (Leningrad Physicotechnical Institute of the AS USSR)

SUBMITTED: October 14, 1959

Card 2/2

Ryvkin, S. M.

S/181/60/002/04/05/034
B002/B063

24.7700

AUTHORS: Ryvkin, S. M., Grinberg, A. A., Ivanov, Yu. L., Novikov, S. R., Potekhina, N. D.

TITLE: Investigation of the Diffusion of Minority Carriers in a Magnetic Field

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 4, pp. 575-590

TEXT: The distribution of the concentration of minority carriers introduced into a magnetic field by "point" injection was theoretically and experimentally studied. A light spot was focused onto a germanium sheet cut out of a single crystal. The occurring emf was measured by means of an ЛВ-9 (LV-9) tube voltmeter. The setup is schematically represented in Fig. 1. Thus, the longitudinal magnetostriction effect (Fig. 5) was measured on p-type and n-type germanium. Such measurements may be used to determine such semiconductor parameters as the microscopic drift mobility of carriers and the concentration ratio between carriers of equal sign but different effective mass. The concentration ratio between light and heavy holes in germanium was about 2 per cent. Mention is made of

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Investigation of the Diffusion of Minority Carriers in a Magnetic Field

S/181/60/002/04/05/034
B002/B063

I. K. Kikoin, Noskov, and Pikus. There are 7 figures and 18 references: 7 Soviet, 1 American, 9 British, and 1 French.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut AN SSSR (Leningrad Physicotechnical Institute of the AS USSR)

SUBMITTED: July 24, 1959

Card 2/2

81634

S/181/60/002/06/22/050
B006/B056

24.7700

AUTHORS: Arkad'yeva, Ye. N., Paritskiy, L. G., Ryvkin, S. M.

TITLE: Investigation of the Kinetics of Infrared Impurity Photoconduction in CdS Induced by Previous Illumination

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 6, pp. 1160-1168

TEXT: The fact is already known that photoconductivity may be produced in CdS single crystals at low temperatures (77°K) by infrared light of wavelengths up to 6 μ. The authors investigated the kinetics of this conduction in crystals into which impurities were not purposely introduced. In this connection it is assumed that the photoconductivity of CdS is caused by the fact that the light transfers electrons from α-type adhesion levels into the conduction band; the adhesion levels are assumed to be filled up with electrons, which is a consequence of previous illumination. Investigations of kinetics make it possible to acquire knowledge of the interaction between light and adhesion levels and to estimate the main parameters of the adhesion levels. The results obtained by experimental investigation of the induced impurity

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B006/B056

photoconduction in CdS are discussed in part 1. All investigations were carried out at 77°K on CdS single crystals onto which indium contacts were sputtered in vacuo. Above all, the spectral distribution of photoconductivity and the time-dependence of the photocurrent were investigated. Fig. 1 shows the spectral photocurrent distribution, recorded under various conditions; without previous illumination (Curve 1) with previous irradiation by green light, by leaving the sample in the dark for a longer period of time (Curve 2 - photoconductivity is found beginning at 3.5 μ), and under simultaneous constant irradiation with white light (Curve 3 - which produces exactly the same effect). In the latter case, distinct photocurrent extinction with a maximum at 0.9 μ could be observed. Further, the time dependence of infrared photoconductivity after previous illumination with green light of various intensities was investigated. Between the previous illumination and the beginning of infrared irradiation the sample was left in the dark for 40-60 minutes. The results are shown in Fig. 2. The photocurrent relaxation at the beginning of infrared irradiation was found to depend upon previous illumination (Curve a - high intensity, curve b - low

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B006/B056

intensity). In part 2 of this paper, these experimental results are analyzed on the basis of a model with one adhesion level, and the infrared photoconductivity kinetics is calculated for the case of a so-called "quasi-steady" excited state of the crystal. Fig. 3 shows the scheme of electronic transitions upon which the analysis is based. In part 3, the results obtained by experimental investigation of the kinetics of infrared photoconductivity in a quasi-steady excited state are given and the parameters of the adhesion level are determined. The dependence of the growth and drop times as well as of the steady photocurrent are shown in Figs. 4 and 5. Several particular features of infrared photocurrent relaxation in the unsteady state are discussed in part 3. Further investigations in this field are to follow. The crystals investigated were produced by O. A. Matveyev and L. V. Maslova. There are 6 figures and 11 references: 4 Soviet, 4 American, and 3 German.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR, Leningrad (Physico-technical Institute of the AS USSR, Leningrad)

SUBMITTED: October 26, 1959

Card 3/3

82546

S/181/60/002/007/026/042
B006/060

24.7700

AUTHORS: Grinberg, A. A., Paritskiy, L. G., Ryvkin, S. M.

TITLE: The Influence of Adhesion Levels in Semiconductors on the Steady Photoconductivity and the Lifetime of the Minority Carriers

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 7, pp. 1545-1561

TEXT: The present bulky article deals with a comprehensive study of the influence exerted by adhesion levels introduced into a crystal upon the carrier recombination in the steady state (thus, upon τ_p, τ_n, and $\Delta\sigma$) taking place above other traps located in the forbidden band. The study is extended to cover the influence of filling of adhesion levels on the dependence of τ_n and τ_p on temperature and light intensity. In the introduction, the authors discuss a number of relevant publications. In the first section of the paper, the influence of adhesion levels on τ_n and τ_p in the steady state is qualitatively examined by means of an example

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The Influence of Adhesion Levels in Semiconductors on the Steady Photoconductivity and the Lifetime of the Minority Carriers

of a high injection level. This is done on the model of a semiconductor in whose forbidden band there exist two types of local levels with sharply differing properties (Fig. 1): the S levels are assumed to be traps for the minority electrons from the conduction band and the holes from the valency band, i.e., they are recombination centers for the light-produced minority charges. The M levels are, due to electron exchange, connected with the conduction band (the electron exchange with the valency band is forbidden), and therefore they are adhesion levels for the electrons. It is shown that the electron and hole concentrations in the S centers are closely related to the electron and hole concentrations in the bands. E. g., if the electron concentration in the conduction band is changed anyhow, the electron lifetime $\tau_n = 1/\gamma_n p_s$ in this band is decreased, and the hole lifetime $\tau_p = 1/\gamma_p n_s$ in the valency band grows. This is the sense in which the introduction of adhesion levels acts. (γ_n and γ_p are the trapping factors; n_s and p_s the electron and hole concentrations in the S centers; $n_s + p_s = S$, the concentration of the recombination centers). In the following

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sections of the paper the authors first examine in a general way the influence exerted by adhesion levels in the case of a high injection level at a low concentration of the recombination centers, and then the same is done for a semiconductor with two types of injection levels. In this semiconductor the forbidden band contains, besides the recombination centers S and the adhesion levels M for the electrons, adhesion levels L for the holes from the valency band (Fig. 7). Section 4 again treats, for a semiconductor with one adhesion level in the forbidden band, the case of a high injection level, but at a high concentration of the recombination centers S. Finally, section 5 deals with the case of a low injection level at an arbitrary concentration of the recombination centers. Here, the Fermi quasi-levels of electrons and holes practically coincide, and the traps may be classified into adhesion levels and recombination centers only on the basis of the various trapping cross sections. (5.9) and (5.10) are first generally derived for τ_n and τ_p; for M = 0 they go over to (5.11). The latter formulas are then further treated for the special cases of an n-type and a p-type semiconductor.

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The Influence of Adhesion Levels in Semiconductors on the Steady Photoconductivity and the Lifetime of the Minority Carriers

S/181/60/002/007/026/042
B006/B060

S. G. Kalashnikov is mentioned. There are 10 figures and 19 references: 5 Soviet, 9 US, and 3 German.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR Leningrad (Institute of Physics and Technology of the AS USSR, Leningrad)

SUBMITTED: November 27, 1959

Card 4/4

83010
S/181/60/002/008/029/045
B006/B063

24,2600

AUTHORS: Arkad'yeva, Ye. N., Ryvkin, S. M.

TITLE: Induced Infrared Photosensitivity of Some Semiconductors

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 8, pp. 1889 - 1890

TEXT: In CdS single crystals activated with silver, Lambe and Klick (Ref. 1) observed infrared photosensitivity induced at 77°K in the range 2 - 6 μ. This phenomenon was studied by the authors of the present paper in Ref. 2. This kind of infrared photosensitivity also occurs in other semiconductors such as CdSe, CdTe, Sb_2Se_3. Fig. 1 shows the typical spectral distribution curves obtained for these substances at 85°K. These substances show no infrared photosensitivity without previous illumination with visible light. All three substances are photosensitive in the range 2 - 4 μ after preceding illumination with light whose frequency is in the range of natural absorption. Fig. 2 illustrates the time dependence of induced photoconduction. As in the case of CdS, the infrared photoconduction rises steeply when light is switched on, and then drops

83020
S/181/60/002/008/039/045
B006/B063

24.7700

AUTHORS: Berkovskiy, F. M., Ryvkin, S. M., Strokan, N. B.

TITLE: The Current-voltage Characteristics of the Blocking Layer of a Germanium p-n Junction in the Permeable Direction

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 8, pp. 1956 - 1961

TEXT: The purpose of the present paper was to verify Shockley's relation for the current-voltage characteristic of a planar p-n junction: $I = \beta I_s [\exp(q\Phi/kT)-1]$, where $\beta = 1 + p(0)/(p(0)+n_o)$; Φ denotes the voltage applied to this junction, I_s - saturation current, q - electron charge, p(0) - hole concentration in the base on the p-n junction, and n_o - equilibrium concentration of electrons in the base. The correction factor β considers the voltage drop occurring in the semiconductor. The authors first discuss the theory and the method of measurement, and describe the apparatus that is schematically represented in Fig. 2. The square-pulse generator used was designed by Engineer G. V. Khozov. The current-voltage

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The Current-voltage Characteristics of the Blocking Layer of a Germanium p-n Junction in the Permeable Direction

characteristics of the p-n junctions were taken in forward direction and at current densities of up to 800 - 1000 a/cm^2. For this purpose, the authors used the method of dividing the voltages into those in the semiconductor and the volume charge region according to their relaxation rates. A correction for the Dember emf is carried out (it takes into account the different mobilities of electrons and holes). The voltage-current characteristics measured on diodes and intrinsic p-n junctions are shown in diagrams. Furthermore, the authors examined molten germanium diodes with a high-resistivity starting material ($n_o \simeq 4 \div 6.10^{13}$ cm^{-3}), for which $\beta = 2$ at a voltage of 100 - 150 mv on the p-n junction. Theoretical studies have shown that the functions $\ln I = f(\Phi)$ should be straight lines, and that the cotangent of their angle of slope should be equal to kT/q; thus a voltage of 25.6 mv is obtained for t = 20°C. The theory is well confirmed by experiments: 26.5 ± 0.5 mv was obtained. Fig. 4 shows the characteristics obtained for a sample of $n = 4.10^{13}$ cm^{-3} at different temperatures between -77° and +70°C. The numerical values

The Current-voltage Characteristics of the Blocking Layer of a Germanium p-n Junction in the Permeable Direction

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pertaining to this diagram are compiled in a table. Shockley's formula is well satisfied in this temperature range at current densities of 0.1 - 100 a/cm^2. From $\sim$ 100 a/cm^2 onward, the voltage on the p-n junctions is saturated. Its maximum value is 60 - 70 mv lower than the contact potential difference. The authors thank V. I. Stafeyev for his discussions. Yu. A. Kontsevyy is also mentioned. There are 5 figures, 1 table, and 13 references: 6 Soviet and 5 US.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR Leningrad (Institute of Physics and Technology of the AS USSR, Leningrad)

SUBMITTED: February 1, 1960

830222

S/181/60/002/008/041/045
B006/B063

24.7700

AUTHORS: Ryvkin, S. M., Yaroshetskiy, I. D.

TITLE: The Influence of Adhesion Levels on the Relaxation of Non-equilibrium Conductivity in Germanium Irradiated With Gamma Rays

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 8, pp. 1966 - 1977

TEXT: In order to study the mechanism of recombination processes of defects, the authors made a number of experiments which are described here and whose results are discussed in detail. The main purpose of the experiments was to determine the effect of γ-induced defects on the temperature dependence of the relaxation time of the conductivity of n-type germanium. First, the method and the experimental arrangement are discussed. n-type Ge single crystals of $5 \cdot 5 \cdot 15$ mm^3, etched with CP-4 (SR-4) to reduce the rate of surface recombination, served as samples. They were exposed to γ-rays of 120 r/sec (Co^{60}) at 20°C. The concentration of the resulting structural defects was determined from

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B006/B063

formula $N_t = \sigma N_{Ge} \Phi$, where Φ ist the γ-flux per cm^2 of the sample surface, N_{Ge} the concentration of the germanium atoms, and σ the cross section of defect formation which was assumed to be $\sigma = 4.3 \cdot 10^{-27} cm^2$ according to Ref. 6. The experimental arrangement is schematically shown in Fig. 1. The sample is placed in a cryostat between the poles of an electromagnet which can generate a field of up to 4,000 oersteds. This cryostat permits a change in temperature from room temperature to that of liquid nitrogen. Fig. 2 shows the temperature dependence of the relaxation time, τ', of non-equilibrium conductivity as the function $\ln\tau' = f(1/T)$. The six curves refer to six different N_t-values between zero and $1.0 \cdot 10^{13} cm^{-3}$. With increasing irradiation, a dropping slope of the curves having a minimum could be observed. After passing through this minimum, they steeply rose again. Thus, the relaxation time first decreased with dropping temperature and again increased with further dropping temperature. Fig. 3 again shows $\ln\tau' = f(1/T)$ for the same sample, however, for

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B006/B063

The Influence of Adhesion Levels on the Relaxation of Non-equilibrium Conductivity in Germanium Irradiated With Gamma Rays

$N_t = 1.5 \cdot 10^{13} cm^{-3}$ in a wide temperature range. The curve starts in the minimum, rises linearly and quickly, and after having passed through a peak, it slowly drops. Next, the results are discussed in detail and compared with theory. The curves $\ln\tau' = f(1/T)$ may be well represented in three characteristic parts (I - drop, II - rise, III - almost saturation) (cf. Fig. 5). The position ΔE_S of the recombination levels of these γ-induced defects in the forbidden band are determined (Fig. 4) from the slope of the curves (part I, Fig. 2). The authors found that $\Delta E_S = 0.2$ ev (distance of the S-level from the conduction band). The hole trapping cross section on the S-level at room temperature was determined to be $3.5 \cdot 10^{-15} cm^2$. The position of the second level (M) is determined by its distance from the valency band ΔE_M; it was found that $\Delta E_M = 0.24$ ev. The values found for the second sample deviate but little from those of the first sample; the second sample had a somewhat lower resistivity. The numerical values are compiled in a table (p. 1976). The S-levels are

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84083

S/181/60/002/009/024/036
B004/B056

9,4160 (1165, 1137, 1331)

AUTHORS: Ryvkin, S. M., Konopleva, R. F., Maslova, L. V., Matveyev, O. A., Strokan, N. B., Tarkhin, D. V., Khozov, G. V.

TITLE: Low-inertia Germanium Photodiodes

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 9, pp. 2199 - 2201

TEXT: Germanium photodiodes were developed in 1954 at the authors' institute; they are now being produced in industry, and have a time constant of about 10^{-5} sec. Now, the low-inertia photodiodes ФД-М1 (FD-M1) and ФД-М2 (FD-M2) were developed, which have a time constant of only $(1-3)\cdot10^{-8}$ sec. Inertia was measured by means of an apparatus schematically shown in Fig. 1. A Kerr cell fed by a ГСС-6 (GSS-6) alternating-current generator modulated light sinusoidally with a frequency, f, of 1Mc/sec. The light, which was amplified by an ФЭУ (FEU) photomultiplier, was recorded by an СИ-1 (SI-1) oscilloscope. Owing to the phase shift φ,

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the oscilloscope showed an ellipse. By means of an RC phase transformer, the ellipse was changed into a straight line. From the equation $\tan \varphi = 2\pi f\theta$ the time constant θ was calculated. Fig. 2a shows the function $\theta = f(R_1)$ (R_1 = load resistance). In Fig. 2b the new diodes are compared with an ФД-1 (FD-1) diode of the old type. The oscillogram shows that the new diodes precisely reproduce a ⊓-shaped light pulse. The authors thank I. A. Lebedeva, P. I. Gorshkov, collaborators of the laboratory, and F. M. Berkovskiy, student at LGU (Leningrad State University) for their assistance. There are 3 figures and 4 references: 3 Soviet.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut AN SSSR (Leningrad Institute of Physics and Technology of the AS USSR)

SUBMITTED: November 6, 1959

84588

9.4300 (1138, 1143)
24.7700 (1043 only)

S/181/60/002/010/010/051
B019/B070

AUTHOR: Ryvkin, S. M.

TITLE: The Real Lifetime and the Possible Mechanism of the Inelastic Scattering of Carriers in Semiconductors

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 10, pp. 2411-2420

TEXT: The lifetime of nonequilibrium carriers for the stationary state is known to be given by $\tau_{\Delta n} = \Delta n_{st}/U$ (1), where Δn_{st} is the steady concentration of the nonequilibrium electrons and U the intensity of the nonequilibrium process of generation of these electrons. $\tau_{\Delta n}$ is commonly supposed to have the significance of lifetime of the electron in the conduction band; it is shown here that this is really so only in some special cases. From a study of the dynamics of this process, it is shown that the time between two collisions with holes (each collision leading to the capture of an electron) has the sense of a real mean lifetime of electrons in the conduction band: $\tau_{real} = 1/\gamma_{nk} p_k$ (2), where p_k is the

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The Real Lifetime and the Possible Mechanism of the Inelastic Scattering of Carriers in Semiconductors

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concentration of holes of k-th kind, and γ_{nk} is the trapping coefficient. $\tau_{\Delta n}$ and τ_{real} can differ by some orders of magnitude. A detailed study is made for comparing these quantities in three special cases. First of all it is shown that for the impurity photoconductivity $\tau_{\Delta n} \leqslant \tau_{real}$, but the difference is not large. The intrinsic photoconductivity by recombination with traps is then investigated. It is found that for high injection level when $\Delta n \gg n_o$ and p_o (n_o - equilibrium concentration of electrons; p_o - equilibrium concentration of holes) and U considerably exceeds the number of electrons thermally scattered into the conduction band, $\tau_{real} = \tau_{\Delta n}$. This does not hold for "intermediate" or low injection levels. For low injection levels $\tau_{real} = \tau_{equilibr}$. The temperature dependence of these quantities is studied. Intrinsic photoconduction by recombination with traps in the presence of adhesion levels is discussed. A formula for τ_{real} is derived. From the cases considered here it is seen that $\tau_{\Delta n}$ may be

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The Real Lifetime and the Possible Mechanism of the Inelastic Scattering of Carriers in Semiconductors

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smaller or greater than τ_{real}, and the number of examples could be multiplied. In the last section of the paper, the inelastic scattering process is studied. It is concluded that the energy transfer does not take place by successive collisions of carriers with phonons; it is the result of the trapping of the carrier for a short time with a fast reemission in a band lying in the neighborhood of the normal energy. A. I. Ansel'm is mentioned (Ref. 5). A. A. Grinberg is thanked for interesting discussions. There are 4 figures and 6 references: 3 Soviet and 3 US.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR Leningrad (Institute of Physics and Technology of the AS USSR, Leningrad)

SUBMITTED: March 29, 1960

Card 3/3

84582

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24.7700 2407 only
26.1631

AUTHORS: Zhdanovich, N. S., Konopleva, R. F., Ryvkin, S. M.

TITLE: Annealing-out of Defects Formed by Gamma Rays in n-Type Germanium

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 10, pp. 2356-2358

TEXT: When the defects produced in n-type germanium by irradiation with γ rays are removed by annealing, the decrease shows a nonexponential character. For an explanation of this it is necessary to consider the diffusion of the interstitial atoms and vacancies (Refs. 2,3). Fig. 1 shows the fraction φ of the defects removed by annealing as a function of $\sqrt{t}$ for annealing temperatures of 120, 140, and 160°C, t being the annealing time. The experimental values are seen to agree with the theory mentioned in the introduction. Similar results are obtained on bombardment by electrons and neutrons. The activation energy for the diffusion of the defects is found to be 1.01 ev. For comparison, analogous values obtained on irradiation with neutrons (1.12 ev) and with electrons (1.36 and 1.3 ev) are given (Refs. 1,3,4,5). Fig. 2 shows φ as a function

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Annealing-out of Defects Formed by Gamma Rays in n-Type Germanium

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B019/B070

of $Z = (4Dt/r_o^2)^{1/2}$. It is found that the experimental and theoretical values agree well for $\lambda = 0.5$ and $D_o/r_o^2 = 1.3 \cdot 10^9$ per second. r_o is, thus, found to be $2.8 \cdot 10^{-7}$ cm, and so somewhat larger than that obtained in the case of neutron bombardment. Fig. 3 shows that by increasing the γ-quantum flux the removal of defects by annealing is more rapid. The linear part of the curve is also reduced. In the conclusion it is stated that the theory of the removal of defects by annealing which is confined to diffusion is unable to explain some important properties which are possibly connected with the interaction of defects with other structural perturbations. There are 3 figures and 6 references: 2 Soviet and 4 US.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR, Leningrad (Institute of Physics and Technology of the AS USSR, Leningrad)

SUBMITTED: March 17, 1960

RYVKIN, S. M.

FD-2818

USSR/Physics - Semiconductors

Card 1/1 Pub. 153-1/30

Author : Ryvkin, S. M. and Khar'yozov, R. V.

Title : Method of Determining the Mobility of "Non-Basic" Current Carriers Injected by Light

Periodical : Zhur. Tekh. Fiz, 25, 563-568, 1955

Abstract : Photoelectric behavior of semiconductors is studied by applying constant photoinjection to a rod-shaped sample [cf. J R Haynes and and W. Schocklly, Phys. Rev. 81, 835 (1951)]. The equipment used is described and results showing mobility of holes and electrons in germanium are illustrated in graphs. Gratitude for cooperation is expressed to D. N. Nasledov, V. M. Tuchkevich, Zh. I. Alferov, and A. A. Lebedev. One USSR and 6 foreign references.

Institution :

Submitted :

FD-3186

USSR/Physics - Modulators

Card 1/1 Pub. 153-16/21

Author : Ryvkin, S. M.

Title : Mechanical modulator for obtaining light impulses with large gaps in the case of a steep front

Periodical: Zhur. tekh. fiz., 25, No 8 (August), 1955, 1471-1476

Abstract : The author describes a new two-disk modulator of normal dimensions which makes it possible to obtain light impulses with steep fronts which are separated by comparatively large intervals of time. It is an improvement of the older single disk type. The author gives its dimensions and describes all the components. He discusses its operating characteristics in detail. He describes all the types of impulses which can be obtained with the new modulator.

Submitted : February 16, 1955

FD-3127

USSR/Physics - Superconductors

RYVKIN SM

Card 1/2 Pub. 153 - 2/19

Author : Mashovets, T. V.; Ryvkin, S. M.

Title : Influence of heat treatment upon lifetime of non-ground current carriers in germanium (the kinetics of the formation of defects during heat treatment)

Periodical : Zhur. tekh. fiz., 25, No 9 (September), 1955, 1530-1543

Abstract : The authors investigated the influence of heat treatment at relative "low" temperatures (400-550°C) upon the lifetime of non-ground current carriers in germanium. The lifetime decreases with increase of temperature and duration of the heat treatment, which is explained by the occurrence of defects that play the role of centers of recombination. On the basis of a study of the kinetics governing the process of the occurrence the authors obtain data on their energy structure. They show that the process governing the occurrence of defects in the investigated region of temperatures differs from the process governing the occurrence of "thermal defects" ordinarily appearing in germanium at higher temperatures. The authors' aim has been to investigate the occurrence during heat treatment of so called thermal traps (recombination centers) and also the nature (i.e. energy structure) of defects associated with these

traps. They thank D. N. Nasledov for his interest and also V. M. Tuchkevich and A. A. Lebedev for preparation of specimens for measurement. Fourteen references, mostly Western.

Institution : --

Submitted : February 28, 1955

Ryvkin, S.M.

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537.312.5

5868. PHOTOELECTRIC CHARACTERISTICS OF SOME COMPOUNDS WITH THE STRUCTURE OF ZINC BLENDE. N.A.Goryunova, V.S.Grigor'eva, B.M.Konovalenko and S.M.Ryvkin. Zh. tekh. Fiz., Vol. 25, No. 10, 1675-82 (1965). In Russian.

All the compounds investigated, viz. Ga_2Se_3, Ga_2Te_3, $Ga_2Te_3.ZnTe$, $Ga_2Te_3.3ZnTe$, $Ga_2Te_3.9ZnTe$, β-Ga_2S_3, GaSe, GaTe, are semiconductors and are photosensitive. On transition from one substance to another of the same structural type the long-wave limit of the photoconductivity shifts in a regular way and, therefore, also the energy interval corresponding to the width of the prohibited zone. The ever more prevalent ionic character of the bond explains the phenomena.

Electrical Research Association

Name: RYVKIN, Solomon Meyerovich

Dissertation: Study of the behavior of non-equilibrium current carriers in semi-conductors

Degree: Doc Phys Math Sci

Affiliation: /Not indicated/

Defense Date, Place: 24 Dec 56, Council of Physico-Technical Inst, Acad Sci USSR

Certification Date: 8 Jun 57

Source: BMVO 16/57

SUBJECT USSR / PHYSICS
AUTHOR RYVKIN, S.M.
TITLE On the So-Called "Secondary" and "Passing-Through" Photocurrent in Semiconductors.
PERIODICAL Zurn.techn.fis, 26, fasc. 11, 2439-2447 (1956)
Issued: 12 / 1956

By the present work the attempt is made to show that putting the secondary photocurrent equal to that which passes through is wrong. The terminology using the terms "primary" and "secondary" photocurrent is described as irrational if used for describing photoelectric phenomena in semiconductors.
On the kinetics of the photocurrent: If the semiconductor sample is irradiated by a constant light current from a certain moment onwards, the relaxation-like process of transition to a new stationary concentration of charge carriers, which occurs as a result of ionization, is determined in the general case by two phenomena: 1.) By a change of concentration by electron transitions in the "energy space", i.e. on the occasion of ionization and recombination. 2.) By modification as a result of the motion of the carriers in the coordinate space, i.e. by diffusion and drive in the electric field. Both processes take place simultaneously and with reciprocal interaction. However, when evaluating the influence exercised upon the effective relaxation time of each process, the eigentimes of both processes may be investigated separately.
On the so-called "primary" photocurrent: The transition current (more exactly its initial stage) according to the terminology used by GUDDEN and POHL,

corresponds to the so-called "primary" current. On the occasion of the occurrence of diffusion-drive-equilibrium, FERMI'S quasi-level in the semiconductor is reduced, and the relative influence exercised by the carriers moving from the cathode into the crystal increases. Hereby the basic condition for the "primary" character of the current is gradually abolished. If equilibrium in the energy space is rapidly established, the relaxation process occurring on the occasion of illumination is reduced to the fact that the transition current goes over into the passing-through current. Thus the establishment of equilibrium in the coordinate space is fully characterized. On the so-called "secondary" photocurrent: If no particular assumptions are introduced (if, e.g., the barrier layers at the contacts, very strong fields, etc. are not taken into account), the photocurrent occurring immediately after illumination can only diminish by the establishment of diffusion equilibrium with the electrons. The photocurrent observed by GUDDEN and POHL on ZnS cannot be put equal to the passing-through current. In conclusion several technological problems are discussed. According to the author's opinion the old terminology must be dropped. It is necessary either to introduce new terms which characterize occurring phenomena correctly or to change old terms accordingly.

INSTITUTION:

RYVKIN, S.M.

CARD 1 / 3 PA - 1821

SUBJECT USSR / PHYSICS

AUTHOR RYVKIN, S.M.

TITLE The Forming Mechanism of Impulses in Crystalline Semiconductor Counters. (The Motion of Charges on the Occasion of an Impulse Ionization in Semiconductors).

PERIODICAL Zurn.techn.fis, 26, fasc.12, 2667-2683 (1956)

Issued: 1 / 1957

The present work intends to determine the basic qualitative properties of the forming mechanism of impulses in crystalline semiconductor counters, as well as to carry out an approximated quantitative investigation of this problem. At first several questions relating to schemes were dealt with in a precise form. From the point of view of the processes which take place in the sample, the real scheme can be replaced by another in the case of which the voltage on the sample is kept constant. At the same time, computation of the charge in the impulse in the real scheme can be replaced by computation of the excess electricity which is a result of ionization in the outer chain of the second scheme. In this connection investigation of the problem is confined to computing the additional current Δi in the exterior chain of the scheme on the basis of the investigation of the processes that take place on the occasion of ionization inside the sample. The semiconductor mechanism of impulse formation is then examined. The process is analyzed which takes place in a crystal with finite conductivity before excitation immediately after ionization. A very simple"flat" case is investigated on the assumption that the domain in which ionization took place has the shape of a parallelepiped.

It is assumed that the current carriers produced on the occasion of ionization will within short have an energy distribution corresponding to lattice temperature as a result of the collision, and will hardly be distinguishable from the thermally ionized current carriers. Ionization and the establishment of quasi-equivalent distribution are assumed to exist at the moment.
In the following an exact analysis of the question as to the mechanism of impulse formation is given mainly in order to determine the criteria for the transition of a formation according to the scheme of primary current into such according to the scheme of a passing-through current, as well as to compute the dependence of the amount of the impulse on the conductivity of the sample and other of its parameters. Computation of Δi passing through and θ (diffusion-deviation-equilibrium) is for a general case very difficult. Therefore only some special cases - of the weak, medium, and strong field - are investigated, and for these cases criteria are set up. Besides, the case for $\tau \ll \theta$ is investigated. τ is the life of the nonequivalent current carriers. In conclusion it is pointed out that at $\tau \gg \theta$ the character of the process taking place after ionization is in many respects similar to those processes which occur in electric circuits that consist of resistances and capacities in the case of a considerable modification of some parameters of this circuit. In the case of ionization in insulators and semiconductors phenomena are complicated by the drift and the

diffusion of carriers over considerable distances. As to the "primary current", this is only the initial stage of the transition process of the current described by the author as "passing-through current". The criteria and the charge are determined by the two basic material characteristic marks τ and σ_o. σ_o is the specific conductivity of the sample before ionization. In the mechanism of the passing through current the amount of impulse grows with increasing σ_o. In conclusion it is stated that the most effective crystalline counters are obtained on the basis of the use of semiconductors and not of insulated materials.

INSTITUTION: Leningrad Physical-Technical Institute of the Academy of Sciences in the USSR.

RYVKIN, S.M.

CARD 1 / 2 PA - 1834

SUBJECT USSR / PHYSICS
AUTHOR RYVKIN,S.M., HANSEVAROV,R.JU.
TITLE The Dependence of the Spectral Distribution of the Photoconductivity of Selenides and Tellurides of Gallium on Temperature.
PERIODICAL Žurn.techn.fis,26, fasc.12, 2780-2783 (1956)
Issued: 1 / 1957

In the course of the present work the experimental results obtained on the dependence of the spectral distribution of the photoconductivity of GaSe and GaTe on temperature are described. The samples used were polycrystalline rods on which the electrodes were fastened by powdering the metal in a vacuum. The conductivity of both materials fluctuated between 10^{-4} and 10^{-3} $Ohm^{-1}.cm^{-1}$. The samples were illuminated with a modulated light from a monochromator ZMP-2 and with a quartz optic. The change-signal was amplified by means of a synchronous detector and rectified, and was registered by means of a self-recording potentiometer. The curves of the spectral distribution of photoconductivity were worked out for equal energies. The distribution of energy on the spectrum was determined by means of a bolometer. The curves of the spectral distribution of photoconductivity for both substances are each shown in form of a curve. A further diagram shows the dependence of the length of the boundary wave $\lambda_{\frac{1}{2}}$ as well as that of the wave length λ_m on temperature. From these curves it may be seen that with the decrease of temperature the longwave boundary and the maximum of

SUBJECT USSR / PHYSICS
AUTHOR RYVKIN,S.M.
TITLE Survey of Works submitted during the Sessions of the Department for "Photoelectric Phenomena in Semiconductors".
PERIODICAL Usp.fis.nauk, 60,fasc.2, 225-248 (1956)
Issued: 12 / 1956

The detailed experimental investigation of photoconductivity with separate determination of the phenomenological parameters of photoconductivity is a characteristic feature of post-war works (e.g. "quantum yield", "life", etc.), i.e. the investigation of stationary photoconductivity is being more and more replaced by the study of the kinetics of photoconductivity, and it is just by this that the discovery of new and interesting rules is made possible. It is further of great importance that investigations are extended to purely electric phenomena, and that radiations other than by light are being used. The current carriers liberated in the crystal lattice by light and other radiations differ but little from one another. The processes occurring in semiconductors on the occasion of ionization may be subdivided into two groups, viz. into independent ionization processes (i.e. the production of free current carriers) and into processes of the motion and recombination of the liberated carriers. The injection of unreal carriers makes the investigation of unsteady electron processes in semiconductors possible. Essentially, all works belong to the following fields: 1.) Photoconductivity and optical properties. 2.) Photoelectromotoric forces. Furthermore, several lectures dealt with the exterior photo-

electric effect in semiconductors as well as with some questions relating to method.

Lectures were delivered, among others, on the following topics: The properties of exitons, the structure of absorption spectra in semiconductors, the photoconductivity of red and yellow HgJ_2, the"exiton mechanism" of photoconductivity, the diffusion of exitons, the "long-lasting" component of photoconductivity, the photoelectric and optical properties of polycrystalline and amorphous layers of antimony trisulphide and of antimony triselenide, the theoretical and the experimental investigation of some problems of collision ionization in semiconductors, the influence exercised by various metal admixtures on the electric and photoelectric properties of pressed polycrystalline samples of cadmium sulphide, the importance of taking the influence exercised by the exciting light on recombination processes into account, the kinetics of photoconductivity in silver chloride, the semiconductor properties of coloring substances, the sensibilization of photoelectromotoric force (e.g. in the case of anorganic semiconductors, by organic substances), etc.

Many works deal with the photoelectromotoric forces in semiconductors; the contents of these works is discussed in short. In spite of all the successes achieved, much still remains to be done in many fields.

INSTITUTION:

USSR/ Physics - Technical physics

Card 1/1 Pub. 22 - 21/54

Authors : Ryvkin, S. M.

Title : On the mechanism of pulse formation in semi-conductor crystal counters

Periodical : Dok. AN SSSR 106/2, 250-253, Jan 11, 1956

Abstract : A brief analysis is presented of the causes of pulse formation in semi-conducting crystal counters, namely, the so-called primary current, $\Delta i_p = (dQ/dt)_{t=0}$, and the through current, $\Delta i_{th} = (dQ/dt)_{t=\theta}$; where the Q is a total electric charge ($Q = Q_p + Q_{th}$) on the electrodes of a counter and the θ is a time of the primary current duration (pulse duration). Six references: 2 USA, 2 USSR, 2 Germ., (1948-1954). Diagrams.

Institution : Acad. of Scs., USSR, Leningrad Physical-Technical Institute

Presented by: Academician A. F. Ioffe, July 11, 1955

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

AUTHOR: [illegible]

TITLE: Germanium Electron-Hole Alpha Counter Characteristics and Operation Mechanism. (Kharakteristiki i mechnism deystviya germaniyecykh elektronno-dyrochnykh al'fa-schetnikov, Russian)

PERIODICAL: Zhurnal Tekhn.Fiz. 1957, Vol 27, Nr 1, pp 95-105 (U.S.S.R.)
Received: 2 / 1957 Reviewed: 4 / 1957

ABSTRACT: This paper deals with the results of the study of counting properties and of the mechanism of impulse-production in n-p-α counters. The wiring circuit of the counter is demonstrated by a drawing. The mode of operation of such a counter does not differ essentially from the mode of operation of a photodiode in the case of a "photo-diode-like" circuit. The n-p transition is connected in the barred direction. The α-particle forms electron-hole-couples in germanium. The unreal carriers (here the holes) diffuse to the n-p transition and are drawn into the p-domain by the field existing in this transition. An additional current hereby occurs in the exterior circuit and furthermore a voltage drop at the resistance R. This voltage drop is recorded. Since the unreal carriers occurring momentarily in the n-domain on the occasion of ionization rapidly flow off or recombine as a result of n-p transition, the duration of the signal occurring at the resistance R is not long.

The following conclusions can be drawn from the investigations carried out: Germanium n-p transitions of the here described

Germanium Electron-Hole Alpha Counter Characteristics and Operation Mechanism.

construction can successfully be used as counters for α-particles and obviously also for other heavy charged particles. Such counters have the following characteristic features: The germanium n-p transition corresponds according to its amount to a common dielectric counter. The counter characteristic of the n-p transition has a good "plateau". The duration of increase of the impulse fluctuates in the case of various samples between 2-3 and 10 microseconds. The n-p transition can be used at room temperature, whereas the dielectric crystal counter, as a rule, can only be used at low temperatures. Also in the case of n-p-α germanium counters, however, the ratio signal/noise increases to a great extent with a reduction of temperature. This facilitates their application in the domain of extremely low temperatures. The germanium n-p transition lacks the main disadvantage of crystal counters, i.e. the so-called polarization. The experimental investigation of the dependence of the impulse and its front on the parameters of the exterior circuit and on the thickness of the basis confirms the assumptions concerning the mode of operation of the here discussed counters made in this paper. (12 illustrations).

ASSOCIATION: Physical-Technical Institute, Leningrad
PRESENTED BY:
SUBMITTED: 16.5.1956
AVAILABLE: Library of Congress

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

PA - 2117

On the Mechanism of the Influence of Illumination with Visible Light on the Strength of Impulses in Sulphur-Cadmium-α-Counters.

Measuring results: In many cases the amount of charge in the impulse $\Delta Q = vC$ is considerably greater than the maximum possible charge which can immediately be liberated by an α-particle on the occasion of ionization. This maximum possible charge was computed as ratio of the energy of the α-particle and the breadth of the forbidden zone of the CdS. From this fact it can be concluded that the impulses in the CdS monocrystals used here were formed according to the "semi-conductor-scheme" of the current passing through. The verification of these considerations carried out by the authors and discussed here confirms, according to the authors' opinion, the semi-conductor-like character of the production mechanism of impulses in CdS monocrystals. Agreement of experimentally and theoretically found dependences of the amount of impulses in sulphur-cadmium obviously confirm the correctness of the general considerations concerning the character of the formation of impulses in semiconductors.

ASSOCIATION: Physical-Technical Institute, Leningrad
PRESENTED BY:
SUBMITTED:
AVAILABLE: Library of Congress

Card 2/2

RYVKIN, S.M.

PA - 2118

AUTHOR MASHOVETS, T.V., RYVKIN, S.M.

TITLE On the Nature of Recombination Centers created in Germanium on the Occasion of Heat Treatment at "Low Temperatures" (O prirode tsentrov rekombinatsii, voznikayushchikh v germanii pri "nizkotemperaturnoy" termoobrabotke).

PERIODICAL Zhurnal Tekhn.Fiz., 1957, Vol 27, Nr 2, pp 238-241 (U.S.S.R.)

Received 3/1957 Reviewed 3/1957

ABSTRACT

First reference is made to the authors' work in Zhurn.Tekhn.Fiz., 1955, Vol 25, p 1530 and its results are summarized. It was found that the processes of the creation of thermodefects in Germanium within the range of "higher" and "lower" temperatures differ. It remained unexplained with what (the admixtures or with structural defects) the low temperature thermocenters of recombination investigated by the authors are connected. To find this out was the task of the present work. Above all it was necessary to determine the position of the levels of the low temperature thermocenters of recombination in the energetical scheme of germanium. This was accomplished by investigating the dependence of life on temperature. It may be concluded that the defects, with which the low temperature recombination centers are connected, are copper atoms. The connection between the defects and the copper atoms was checked in the course of a further series. Results obtained for two samples are shown in form of a table. Summary: 1) The low temperature thermocenters of recombination which are created in consequence of heating at 450 - 550°C and of a subsequent hardening, are connected with a copper-lead admixture.

Card 1/2

PA - 2531

AUTHOR: RYVKIN,S.M., and MAKHALOV,YU.A.

TITLE: Minority Carriers Distribution by Injection Region Movement and in Presence of a Field. (Raspredeleniye kontsentratsii neosnovnykh nositeley toka pri dvizhenii oblasti in''yektsii i nalichii polya, Russian)

PERIODICAL: Zhurnal Tekhn. Fiz., 1957, Vol 27, Nr 3, pp 441 - 451 (U.S.S.R.)
Received: 4 / 1957 Reviewed: 5 / 1957

ABSTRACT: With reference to G.Adam's paper from 1954 (Physika, 1954, Vol 20, 1037) the present paper suggests a "zero"-method for the determination of the mobility of the unreal (minority) current-carriers. The results of investigation of the character of the process in the case of the existence of a movable injection region are shown as well as also of an electric field. In particular the possibility is found to "compensate" the asymmetry-effect by the electric field. The existence of such a compensation can be used for the determination of mobility by means of the "zero" method. First, the theory of the problem, the experimental system, and then results are dealt with. The scheme differs from that of Adam only by the possibility of from-ing and measuring a field in the sample, as well as by the utilization of some special types of development. In the case of the measuring method for mobility the so called "lambda-develop-ment" was used (the deveoped signal is shaped like the Greek

Card 1/2

RYVKIN, S. M.

57-27-7-29/40

AUTHORS: Ayrapetyants, A. V., Kogan, A. V., Reynov, N. M., Ryvkin, S. M., Sckolov, I. A.

TITLE: Concerning the Use of Germanium n-p-α-Counters at Low Temperatures (Ob ispol'zovanii germaniyevykh n-p-α-schetchikov pri nizkikh temperaturakh).

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1957, Vol. 27, Nr 7, pp. 1599-1600 (USSR)

ABSTRACT: With reference to the paper in Zhurnal Tekhnicheskoy Fiziki, 1955, Vol. 25, Nr 11 and 1957, Vol. 27, Nr 1 some preliminary results on the investigation of the counter-properties of germanium n-p-counters at helium temperatures are reported here. The scheme of the device is described. From the table of the comparative characteristics of the n-p counters at room temperature and at helium temperature is to be seen that at the temperature of liquid helium the signal-noise ratio strongly increases. At helium temperature (as well as at room temperature) the n-p counters have a good plateau in the counter-characteristic, as well as a saturation in the curve of the dependence of the amount of the impulse on the applied voltage. There are 2 figures, 1 table and 2 references, all of which are Slavic.

Card 1/2

Physico Tech Inst AS USSR

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

57-27-7-30/40

AUTHORS: Ryvkin, S. M., Bogomazov, A. P., Konovalenko, B. M., Matveyev, O. A.

TITLE: A Semiconductor Transmitter for Gamma-Ray Indication (Poluprovodnikovyy datchik dlya indikatsii gamma-izlucheniya).

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1957, Vol. 27, Nr 7, pp. 1601-1602 (USSR)

ABSTRACT: As there exists a great want of cheap and simple devices, particularly of gamma-ray indicators, and as promising results were obtained in this respect with semiconductor-materials, such as CdS and CdSe, whose conductivity substantially changes upon irradiation, the investigations were here performed in this direction. In Zhurnal Tekhnicheskoy Fiziki, 1954, Vol. 24, p. 961 the authors showed that semicrystalline layers may form upon sublimation of CdS powder. The high temperature of the base, however, leads to the diffusion of the base-substance into the CdS-layer by which fact its properties with regard to sensitivity in the case of irradiation are greatly deteriorated. This difficulty was now overcome at the expense of a great increase in the speed of sublimation.

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A Semiconductor Transmitter for Gamma-Ray Indication 57-27-7-30/40

It was possible to obtain, on the conductive base, layers with a comparatively high sensitivity toward gamma-rays with an inertia not exceeding that of CdS-crystals. The preliminary tests showed that τ_1 (time of current-rise up to 80 % of the stationary value) can be much reduced by means of previous weak illumination of the sample. The obtained data show that the transmitters worked out here can in a number of cases be used in the simplest schemes as indicators of gamma-rays.
There are 1 table and 9 references, 5 of which are Soviet.

ASSOCIATION: Physico-Technical Institute AS USSR, Leningrad
(Fiziko-tekhnicheskiy institut AN SSSR, Leningrad)

SUBMITTED: March 3, 1957

AVAILABLE: Library of Congress

1. Gamma rays-Detection 2. Semiconductors-Applications 3. Cadmium selenide-Applications 4. Cadmium sulfide-Applications

Card 2/2

Ryvkin, S.M.

57-8-7/36

AUTHOR Ryvkin S.M.

TITLE On Kinetics of Photo-Diodes.
(O kinetike fotodiodov - Russian)

PERIODICAL Zhurnal Tekhn.Fiz., 1957, Vol 27, Nr 8, pp 1676 - 1685 (U.S.S.R.)

ABSTRACT

The qualitative considerations are given by means of which the difference between the characteristics of the relaxation curves in the case of an operation with photo-diodes and one with valves can be explained. The author shows that the difference between the characteristics of ascending and descending curves does not depend on a change of the characteristics of the same process. In either case the recombination is the determining process characterized by the same proper time τ. The φ(relaxation) measured during the experiment is variably connected with τ in the case of ascent and descent, and this leads to such essential differences between relaxation curves. Besides, the reasons and conditions for the development of complicated relaxation curves are given. Two voltampere characteristics of a photodiode are given. The one corresponds to the illuminated state the other to darkness. In the quadrant I the curve corresponds to an operation with photo-diodes, and in quadrant II to one with valves. Two straight lines correspond with two different load resistance R' and R" (R' $<$ R"). The points of intersection of the straight line with the voltampere curve in the darkness and in the case of illumination determine the steady voltage values at the photo-diodes φ_D and φ_B. If the resistance R' is

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57-8-7/36

On Kinetics of Photo-Diodes.

small the relaxation φ takes place between φ_D'' and φ_B'' under the conditions for the operation with photo-diodes. In the case of R" ,however, the relaxation between φ_D'' and φ_B'' is partly taking place under the conditions of an operation with photo-diodes and partly of one with idle valves. In connection herewith the relaxation curves acquire the complicated ("hybrid") characteristics. (7 illustrations and 3 Slavic references).

ASSOCIATION Leningrad Physical-Technical Institute. (Leningradskiy fiziko-tekhnicheskiy institut).

SUBMITTED March 28, 1957
AVAILABLE Library of Congress
Card 2/2

RYVKIN, S.M.

PHASE I BOOK EXPLOITATION SOV/1503

24(6) 9(3,4)
Akademiya nauk SSSR. Institut poluprovodnikov

Poluprovodniki v nauke i tekhnike, t. 2. (Semiconductors in Science and Technology, Vol 2) Moscow, Izd-vo AN SSSR, 1958. 658 p. 17,000 copies printed.

Resp. Ed.: A.F. Ioffe; Tech. Ed.: R.S. Fevzner.

PURPOSE: This collection of articles is intended for scientists, engineers and technicians.

COVERAGE: The collection, published by the Semiconductor Institute, Academy of Sciences, USSR, under the supervision of Academician A.F. Ioffe, contains Parts II and III of a two-volume work on semiconductors. Part II completes the material on semiconductor devices, begun in Volume I, and Part III describes various semiconductor materials. Lack of space did not permit inclusion of such subjects as crystal counters, thermoelectric generators, atomic batteries, luminophores, semiconductor catalyzers, materials for complex cathodes and various other applications of semiconductors. Ioffe points out that the article by the American scientists V. Johnson and K. Lark-Horovitz on semiconductors at low temperatures deals with a subject hardly covered in the Soviet literature. Similarly, the article by the Swiss scientists G. Busch and U. Winkler fills a gap in the Soviet literature on methods of investigating semiconductor characteristics. These subjects will be dealt with exclusively in a proposed third volume. References appear separately after each article.

TABLE OF CONTENTS:

Ch. 22. Ryvkin, S.M. Recombination in Semiconductors 463
The author explains the phenomenological theory of recombination in semiconductors, linear recombination, quadratic recombination and, in detail, the mechanism of recombination for various cases. There are 22 references, of which 17 are Soviet (including 8 translations), and 5 English.

Ch. 23. Mirlin, D.N. Electrical Fluctuations in Semiconductors 517
The author explains the origin of Johnson noise and the application of the Nyquist formula to determine the fluctuation voltage causing this noise. He then explains the application of the probability theory to this investigation and explains definitions and terminology. Experimental methods employed in this investigation are described in detail. There are 79 references, of which 54 are English, 21 Soviet and 4 German.

SOV/107-58-2-23/32

AUTHORS: Ryvkin, S., Konovalenko, B.

TITLE: A Photodiode Made of a Junction Transistor (Fotodiod iz ploskostnogo trioda)

PERIODICAL: Radio, 1958, Nr 2, p 41 (USSR)

ABSTRACT: The author describes the conversion of ordinary germanium junction transistors ("P1A", "P1B" and others) to photodiodes and phototriodes. For this purpose, the glass insulator is removed from the side of the emitter. Photodiodes obtained in this way should not be used under conditions of increased humidity.

1. Diodes--Design 2. Transistors--Applications

Card 1/1

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

57-28-3-4/33

AUTHORS: Vitovskiy, N. A., Maleyev, P. I., Ryvkin, S. M.

TITLE: The Mechanism of Pulse Formation in Crystal Counters at the Formation of a "Through Conducting Channel" (Mekhanizm formirovaniya impul'sov v kristallicheskikh schetchikakh pri obrazovanii "skvoznogo provodyashchego kanala")

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1958, Vol. 28, Nr 3, pp.460-469 (USSR)

ABSTRACT: The authors here investigate the peculiarities of the mechanism of pulse formation for the case where the ionization range extends from one electrode to the other. As ionizing agent the authors used α-particles of polonium (Po^{210}) with an energy of 5,3 MeV. In order to realize a "through" passage of the α-particles through the samples, thin CdS--monocrystals were selected. The investigations showed that the process of pulse formation according to the "through current" system may take place at least in two different forms. 1) The first variant can be realized by the construction with a one-sided application of the electrodes or in

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57-28-3-4/33

The Mechanism of Pulse Formation in Crystal Counters at the Formation of a "Through Conducting Channel"

thick crystals with electrodes applied on both sides. Here a through current which is limited by the resistance of the "dark sections" of the crystal flows in the pulse. In such a counting arrangement the "dark"-conductivity of the crystal plays the decisive part. A considerable increase in the pulse height can in this process be attained by an increase in σ_o ("dark"conductivity), e.g. by a rise of temperature. 2) The second variant can only be observed in sufficiently thin crystals in the case of "two-sided" application of electrodes. Here the passage of the α-particles through the crystal can take place and a "conducting channel" between the electrodes can be formed. The pulse height is in this case not dependent on the initial conductivity of the sample. It is to be expected that a similar mechanism of pulse formation will even occur in the case of some isolating crystals, in case the life of the current carriers not being in equilibrium in them (i.e. the crystals) will not be too small and electrodes forming anti-barrier--layers are selected. The authors performed an experimental investigation of the process of pulse formation in "thin" counters at the formation of a "conducting channel". It is

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APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

Title: Mechanism of Pulse Formation in Crystal Counters at the Formation of a "Through Conducting Channel"

shown that in such a case the simplest variant for the formation of pulses can be realized according to the scheme of the passing current. The obtained experimental results are in good agreement with the prediction of theory. The high quality (from the point of view of pulse-height) of the counters with thin crystals and "two-sided" applied electrodes is pointed out. In this construction the pulse heights attain 20 V and amount to up to 90 % of the voltage applied. There are 11 figures, 1 table, and 3 references, 3 of which are Soviet.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut AN SSSR (Leningrad Physical-Technical Institute AS USSR)

SUBMITTED: November 20, 1957

1. Crystal counters--Analysis

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

57-28-3-6/33

AUTHORS: Khansevarov, R. Yu., Ryvkin, S. M., Ageyeva, I. N.

TITLE: On the Dependence of the Width of the Forbidden Zone on the Composition of Solid CdS-CdSe Solutions (O zavisimosti shiriny zapretnoy zony ot sostava v tverdykh rastvorakh CdS-CdSe)

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1958, Vol. 28, Nr 3, pp.480-483 (USSR)

ABSTRACT: The authors here give the results of the investigation made on the modifications of the limits of long waves, absorption and photoelectric effect, as well as of the constant lattice with the modification of the composition of mixed polycrystalline CdS-CdSe-layers. On the basis of these investigations conclusions are drawn on the dependence of the width of the forbidden zone on the relation of the CdS- and CdSe-components in their solid solution. It is shown that the constant lattices monotonously change with the increase in CdSe-content in the initial mixture. It can be assumed that in mixed

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57-28-3-6/33

On the Dependence of the Width of the Forbidden Zone on the Composition of Solid CdS-CdSe-Solutions

CdS-CdSe crystals the Vegard rule (Reference 4) is satisfied, i.e. that a linear dependence between the constant lattice and the composition is observed. From the data obtained here follows that CdS and CdSe form a continuous series of solid exchange-solutions. It is shown that with the increase of CdSe-content in the layer a monotonous shift of the curve of photoconductivity to the long-wave side is observed. It is further shown that on a modification of the composition of the solid CdS-CdSe-solution a monotonous modification of the width of the forbidden zone occurs. In contrast to the solid Ge-Si-solutions this dependence is almost linear.
V. S. Maydzinskiy and L. P. Bogomazov helped in the work.
There are 4 figures, 1 table, and 8 references, 4 of which are Soviet.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut, AN SSSR
(Leningrad Physical-Technical Institute, AS USSR)

SUBMITTED: August 21, 1957

Card 2/2

1. Cadmium-selenium-sulfur systems--Lattices 2. Cadmium-selenium-sulfur systems--Properties

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

57-28-4-14/39

AUTHORS: Ivanov, Yu. L., Ryvkin, S. M.

TITLE: The Formation of Current Oscillations in Germanium Samples in an Electric and Longitudinal Magnetic Field (Vozniknoveniye kolebaniy toka v obraztsakh germaniya, pomeshchennykh v elektricheskoye i prodol'noye magnitnoye pole)

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1958, Vol. 28, Nr 4, pp.774-775 (USSR)

ABSTRACT: The authors determined current fluctuations in some germanium-samples through which a direct current passed and which were placed in a constant magnetic longitudinal field (magnetic field parallel to the current). Under certain conditions the forming fluctuations had a shape near to the sinosoidal line with a frequency of 10 - 15 kilocycles per second. The fluctuation character depends on quite a number of circumstances. Thus fluctuations only formed at a current through the sample different from zero and increased according to amplitude and frequency with an increase in current. Analogous dependences were also observed on the magnitude of the

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APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

57-28-4-14/39

The Formation of Current Oscillations in Germanium Samples in an Electric and Longitudinal Magnetic Field

magnetic field. In spite of zinc-contacts the voltampere characteristics in the investigated samples differed from a linear one. The fluctuations formed in one as well as the other current direction were more marked when the direction of current correspond to the lower resistance of the sample. Fluctuations only occurred in the case of an exact agreement of the direction of the magnetic field with the axis of the sample. An intensitve illumination of the samples led to an interruption of the fluctuations. A certain drop in temperature in the samples, however, led to an increase of their amplitude and frequency. An etching of the samples in hydrogen peroxide promoted the formation and the stability of the fluctuations. An increase or decrease of the amplitude of fluctuation connected with any change of the experimental conditions in all cases led to the corresponding increase or decrease respectively of the frequency of fluctuations. There are 3 figures and 1 reference, 1 of which is Soviet.

Card 2/2 Physics Tech Inst AS USSR

57-28-5-2/36

AUTHORS: Ryvkin, S. M., Khansevarov, R. Yu.

TITLE: On the Influence of Surface Treatment of Semiconductors on the Magnitude and the Spectral Distribution of Photoconductivity (O vliyanii obrabotki poverkhnosti poluprovodnikov na velichinu i spektral'noye raspredeleniye fotoprovodimosti)

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1958, Vol. 28, Nr 5, pp. 925-931 (USSR)

ABSTRACT: It is known that the spectral distribution of photoconductivity in numerous photoconductors exhibits an important property in the range of auto absorption: the photoconduction takes place only at the edge of the absorption band and is missing in its interior. In the present paper the authors investigated the extremely strong influence of some types of "treatment" of the surface of CdS and Cu_2O on the magnitude and the spectral distribution of photoconductivity. The influence of a treatment on the photoconductivity of the crystal surface was investigated by means of an intensive electron bombardment, heating in a

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On the Influence of Surface Treatment of Semiconductors on the Magnitude and the Spectral Distribution of Photoconductivity. 57-28-5-2/36

vacuum and in air, as well as by means of a short exposure to a gas discharge. The results of the investigations apparently permit to draw the following conclusions: The strong photosensitivity at the surface as well as a strong dependence of the sensitivity on the treatment of the surface are determined by the strong influence of the recombination processes near the surface. These recombination processes can influence the photoconductivity and modify the phenomenological emission. (fenomenologicheskiy vykhod). As an increase of photoconductivity is accompanied by an increase of dark conductivity, it can be assumed, that the investigated kinds of treatment primarily influence the magnitude and the sign of the zonal curvature near the surface. The experiments conducted, however, cannot furnish a basis for the evaluation of particular features of the mechanism. The rôle of the recombination processes at the surface is well investigated in germanium, silicon and similar substances, where the determination of carriers not in equilibrium is only possible after a special

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On the Influence of Surface Treatment of Semiconductors on the Magnitude and the Spectral Distribution of Photoconductivity

57-28-5-2/36

treatment of the surface. It appears, that the recombination processes also play an important rôle in other semiconductors. The experiments also proved the necessity of new effective methods for the cleaning of the surfaces of the semiconductors. This would presumably make it possible to increase the photosensitivity of numerous substances, which in spite of their strong absorption are considered not photosensitive or only weakly sensitive. Therefore the experimental results verify the fact, that the two basic anomalies in photoconductivity - the "inactive" absorption of light in some substances as well as the reduction of photoconductivity in the depth of the absorption band - can to a considerable degree be explained by one cause, that is to say by intensive recombination-type processes, which are considerably intensified near the surface. The authors express their gratitude to the student of Leningrad State University

Card 3/4

On the Influence of Surface Treatment of Semiconductors on the Magnitude and the Spectral Distribution of Photoconductivity 57-28-5-2/36

I. A. Dunayev for valuable help in the measurements.

Appendix: As a conclusion, a short report is given on the possible influence of sample shape of the semiconductors with low conductivity (i. g. CdS etc.) on the experimental results concerning their electrical properties.
There are 9 figures and 7 references, 5 of which are Soviet.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR, Leningrad (Physico-technical Institute, AS USSR, Leningrad)

SUBMITTED: September 23, 1957

1. Semiconductors--Photoconductivity

Card 4/4

57-28-6-5/34

AUTHORS: ~~Ryvkin, S. M.,~~ Strokan, N. B., Tuchkevich, V. M., Chelnokov, V. Ye.

TITLE: Silicon Photodiodes (Kremniyevyye fotodiody)

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1958, Vol. 28, Nr 6, pp. 1165-1168 (USSR)

ABSTRACT: In the present report the results obtained by investigating the possibility of utilizing silicon p-n photoelements for the purpose of transforming light signals into electric signals in the photodiode regime are described. It could be taken for granted from the very beginning that silicon photodiodes, which are of somewhat lower integral sensitivity, must offer some advantages compared to germanium photodiodes (reference 3), viz. a lower "dark current" and a lower degree of inertia. Further, the results obtained by investigating the basic properties of the silicon photodiodes LFTI produced in the laboratory are described. The sensitivity of samples to the light of the incandescent lamp with a color temperature of the filament of ~2850°C fluctated between 5 and 7 mm/lumen

Card 1/3

Silicon Photodiodes

(figure 1). The photodiodes have the same sensitivity along the entire illuminated surface (figure 2). The dependence of sensitivity on light intensity is linear (figure 3). The volt-ampère characteristics of the photodiodes are shown (figures 4a and 4b). Estimation of the time needed for "flying through" t_o resulted in the value

$t_o \simeq \frac{w^2}{2D} \approx 3 \cdot 10^{-8}$ sec. Finally, the authors endeavored to estimate the life of the minority carriers τ in the photodiodes investigated by studying the kinetics of the photoelectromotive valve force Φ. When measuring τ, $\tau \sim 1 \cdot 10^{-6}$ sec was obtained as a result. This amount must be considered to be merely the upper limit of the τ value as it corresponds to the duration of the front amplification of the light impulses. For $\Phi \ll \frac{kT}{e}$ the relaxation curve is an exponent with a time constant $R_e C$, in which case $\frac{1}{R_e} = \frac{1}{R_o} + \frac{1}{R}$. The value of the capacity, which was determined

Silicon Photodiodes

from $R_e C$, was found to be equal to approximately 2000 pf. This capacity value is greater than the one mentioned in the table, because it corresponds approximately to the zero-displacement on the n-p-transition. There are 5 figures, 1 table, and 7 references, 7 of which are Soviet.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut, AN SSSR (Leningrad Physical-Chemical Institute, AS USSR)

SUBMITTED: January 28, 1958

1. Silicon—Photoconductivity 2. Silicon—Photosensitivity 3. Silicon—Electrical properties 4. Silicon—Electron transitions 5. Mathematics

TITLE: Photodiodes

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

57-28-6-6/34

AUTHORS: Ryvkin, S. M., Strokan, N. B.

TITLE: On the Kinetics of Phototriodes (O kinetike fototriodov)

PERIODICAL: Zhurnal Tekhnicheskoy Fiziki, 1958, Vol. 28, Nr 6, pp. 1169-1173 (USSR)

ABSTRACT: Phototriodes can be used as highly photo-sensitive means transforming light signals into electric signals. It is therefore of particular interest to study their inertia. During the first months of 1957 the authors produced samples of germanium phototriodes in the laboratory, which had a sensitivity of 1 $\div$ 4 ampères/lumen, a dark current of 500 $\div$ 700 microampères (saturation remains up to $\sim$5V), and a sensitive surface of $\sim$4 mm^2 (reference 1). Besides the authors, also engineer N. F. Ragozina and laboratory worker I. A. Lebedeva assisted in producing the samples. The high sensitivity of phototriodes is known to be connected with the process of amplification of the photocurrent which takes place in them. The kinetics of phototriodes was investigated by means of an apparatus which is shown in form of a

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

On the Kinetics of Phototriodes

schematical drawing (figure 2). Determination of the quality of the time constant was carried out by the method developed by Tolstoy and Feofilov (reference 2) on the basis of the principles of the substitution scheme (reference 3). Results are shown by a table. From the oscillogram worked out by V. V. Makarov, student of the LGU (reference 3) it may clearly be seen that the rapid relaxation of the collector current, to be expected on the strength of theoretical argumentation and a slower relaxation of the potential differences on the point of emitter transition actually take place. In conclusion it is mentioned that in the case of phototriodes a working regime which is analogous to the so-called "hybrid regime" of photodiodes (reference 5) is possible. In this case relaxation has 2 domains: a "phototriode" domain at low values of the photocurrent, and a "valve domain", which corresponds to high values of the photocurrent. Obviously, the "valve domain" is possible in phototriodes only in the case of "asymmetry" during generation of the photoelectromotive force in emitter- and collector transition. A typical

On the Kinetics of Phototriodes

oscillogram of the phototriode signal in the case of a hybrid regime is shown (figure 4). There are 4 figures, 1 table, and 5 references, 5 of which are Soviet.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut
(Leningrad Physical-Technical Institute)

SUBMITTED: December 23, 1957

1. Germanium—Electrical factors 2. Germanium—Photosensitivity
3. Germanium—Electron transitions 4. Germanium—Photoconductivity

TITLE: Phototriodes

SOV/57-28-9-2/33

AUTHORS: Ryvkin, S. M., Strokan, N. B., Makovskiy, L. L.

TITLE: On Problems of the Kinetics of Photovoltaic Cells With Electron-Hole Junctions (K voprosu o kinetike ventil'nykh fotoelementov s elektronno-dyrochnym perekhodom)

PERIODICAL: Zhurnal tekhnicheskoy fiziki, 1958, Nr 9, pp. 1871-1882 (USSR) Vol. 28

ABSTRACT: This is a study of the kinetics of the photovoltaic cell operating as a rectifier. No limitations are imposed on the ratio of the life τ and of R_0C (where C denotes the capacity of the n-p junction at zero voltage, and R_0 its resistance) and of arbitrary loads R. The downward-sloping branch of the relaxation curve is investigated. In the first section qualitative considerations bearing on the kinetics of a few special cases are presented. In section 2 this is investigated as to its quantitative aspects. In section 3 the experimental equipment is described and in section 4 the theoretical results are compared with those from experiments. The downward-sloping branch of the relaxation curve is computed assuming different conditions. Even if the conditions assumed in reference 3 (infinite load

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On Problems of the Kinetics of Photovoltaic Cells With Electron-hole Junctions

and small capacitive currents) are not satisfied, the illumination, however, is sufficiently high, a section of the relaxation curve is still determined only by relaxation. This section supplies the data for the determination of the life of the non-equilibrium carriers. These conclusions were substantiated by experiments. From the slope of the rectilinear sections in the oscillograms it was found, that the levels of recombination centers are removed by $\simeq$ 0,23 eV from the boundary of the permitted zone. There are 10 figures and 8 references, 7 of which are Soviet.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut,AN SSSR (Leningrad Physical and Technical Institute,AS USSR)

SUBMITTED: January 28, 1958

Ryvkin, S. M.

PHASE I BOOK EXPLOITATION SOV/3548

Akademiya nauk SSSR. Otdeleniye fiziko-matematicheskikh nauk

Fizika tverdogo tela; sbornik statey, II (Solid State Physics; Collection of Articles, II) Moscow, Izd-vo AN SSSR, 1959. 328 p. 3,500 copies printed.

Ed.: A.F.Ioffe, Academician; Ed. of Publishing House: V. B. Filipovich; Tech. Ed.: R.A. Zamarayeva.

PURPOSE: This collection of articles is intended for physicists investigating the structures and properties of solids.

COVERAGE: This volume II of a two-volume collection of articles dealing with problems of solid state physics, was prepared by the Department of Physics and Mathematics, Academy of Sciences, USSR. The authors report on the physical properties of semiconductors such as germanium, cadmium sulfide, cadmium telenide, gallium arsenide, silicon, and various metal alloys. The electrical conductivity of these substances is studied. The effects of irradiation and acoustic phonons on semiconductors are also investigated. Several articles are devoted to the theory of electrical breakdown. X-ray studies were made on polycrystalline substances, and one study of the gold-barium system was carried out. No personalities are mentioned. References accompany each article.

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APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

Ryvkin, S.M.

24(4) SOV/3140

PHASE I BOOK EXPLOITATION

Akademiya nauk Ukrainskoy SSR. Institut fiziki

Poluprovodnikovyye i fotoelektricheskiye yavleniya v poluprovodnikakh; trudy pervogo vsesoyuznogo soveshchaniya po fotoelektricheskim i opticheskim yavleniyam v poluprovodnikakh. Pod obshchey red. K. Kiyeva, 20-26 noyabrya 1957 g. (Photoelectric and Optical Phenomena in Semiconductors; Transactions of the First Conference on Photoelectric and Optical Phenomena [Proceedings of the First Conference...]) Kiyev, 1959. 403 p. 4,000 copies printed.

Additional Sponsoring Agency: Akademiya nauk SSSR. Prezidium. Komissiya po poluprovodnikam.

Ed. of Publishing House: I. V. Kisina; Tech. Ed.: A. A. Matveyshuk

Resp. Ed.: V. Ye. Lashkarev, Academician, Ukrainian SSR, Academy of Sciences.

PURPOSE: This book is intended for scientists in the field of semiconductor physics, solid state spectroscopy, and semiconductor devices. The collection will be useful to advanced students in universities and institutes and technical application of semiconductors.

COVERAGE: The collection contains reports and information bulletins (the latter are indicated by asterisk) read at the First All-Union Conference on Optical and Photoelectric Phenomena in Semiconductors. A wide scope of problems in semiconductor photoelectronics are considered: photoconductivity, photoelectric cells and photoelectric emf, optical properties, and corpuscular radiations, and technology of hard semiconductor systems, active forces, the actions of hard radiations, and complex semiconductor photoresistors, thin films and complex semiconductor systems, the properties of which were prepared for publication by Z. I. M. K. Rashboy, O. V. Snitko, K. B. Tolpygo, follow each article. The materials were prepared for A. P. Lubchenko, and etc. References and discussion follow each article. Sheynkman.

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24(4) PHASE I BOOK EXPLOITATION SOV/3140

Akademiya nauk Ukrainskoy SSR. Institut fiziki

Fotoelektricheskiye i opticheskiye yavleniya v poluprovodnikakh; trudy pervogo vsesoyuznogo soveshchaniya po fotoelektricheskim i opticheskim yavleniyam v poluprovodnikakh, g. Kiyev, 20-26 noyabrya 1957 g (Photoelectric and Optical Phenomena in Semiconductors; Transactions of the First Conference on Photoelectric and Optical Phenomena in Semiconductors...) Kiyev, 1959. 403 p. 4,000 copies printed.

Additional Sponsoring Agency: Akademiya nauk SSSR. Prezidium. Komissiya po poluprovodnikam.

Ed. of Publishing House: I. V. Kisina; Tech. Ed.: A. A. Matveychuk; Resp. Ed.: V. Ye. Lashkarev, Academician, Ukrainian SSR, Academy of Sciences.

PURPOSE: This book is intended for scientists in the field of semiconductor physics, solid state spectroscopy, and semiconductor devices. The collection will be useful to advanced students in universities and institutes of higher technical training specializing in the physics and technical application of semiconductors.

COVERAGE: The collection contains reports and information bulletins (the latter are indicated by asterisks) read at the First All-Union Conference on Optical and Photoelectric Phenomena in Semiconductors. A wide scope of problems in semiconductor physics and technology are considered: photoconductivity, photoelectromotive forces, optical properties, photoelectric cells and photoresistors, the actions of hard and corpuscular radiations, the properties of thin films and complex semiconductor systems, etc. The materials were prepared for publication by E. I. Rashboy, O. V. Snitko, K. B. Tolpygo, A. P. Lubchenko, and M. K. Sheynkman. References and discussion follow each article.

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APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

S/058/62/000/004/060/160
A058/A101

9.4160

AUTHORS: Ryvkin, S. M., Strokan, N. B., Makovskiy, L. L.

TITLE: On the kinetics of p-n-junction phototubes

PERIODICAL: Referativnyy zhurnal, Fizika, no. 4, 1962, 23, abstract 4G187 (V sb."Fotoelektr. i optich. yavleniya v poluprovodnikakh". Kiev, AN USSR, 1959, 360-366)

TEXT: This is a continuation of the authors' work (RZhFiz, 1958, no. 10, 23378) dealing with the kinetics of valve operating regimes incident to photodiode illumination by rectangular light pulses. They examine the general case of connecting a photodiode in a circuit containing a finite load resistance and a capacitance.

[Abstracter's note: Complete translation]

Card 1/1

S/058/62/000/004/158/160
A061/A101

AUTHORS: Ryvkin, S. M., Bogomazov, L. P., Konovalenko, B. M., Matveyev, O. A.

TITLE: Semiconductor gamma detectors

PERIODICAL: Referativnyy zhurnal, Fizika, no. 4, 1962, 15, abstract 4-4-291 (V sb. "Fotoelektr. i optich. yavleniya v poluprovodnikakh", Kiyev, AN USSR, 1959, 386 - 388)

TEXT: The prospects of CdS crystals used as gamma detectors are considered. The low sensitivity and the considerable lag of such pickups are noted. There are 6 references.

P. L.

[Abstracter's note: Complete translation]

Card 1/1

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

67390

24.7700
~~24(3), 24(6)~~ SOV/181-1-9-8/31

AUTHORS: Ryvkin, S. M., Ivanov, Yu. L., Grinberg, A. A., Novikov, S.R., Potekhina, N. D.

TITLE: A New Longitudinal Magnetostriction Effect and Its Application to the Determination of the Ratio Between the Concentrations of Heavy and Light Holes

PERIODICAL: Fizika tverdogo tela, 1959, Vol 1, Nr 9, pp 1372 - 1375 (USSR)

ABSTRACT: When investigating the diffusion of the nonequilibrium carrier in the magnetic field, the appearance of electrical fields is usually studied (e.g. the photomagnetic Kikoin-Noskov effect). The present paper offers the results obtained from an investigation of the concentration distribution of the minority carrier in the magnetic field, and in particular, the results of an investigation of the longitudinal magnetostriction effect in the longitudinal magnetic field. A plane-parallel semiconductor plate was arranged perpendicularly to a homogenous magnetic field. On the plate, a point light probe exactly faced a point collector. The injected nonequilibrium carriers diffused through the plate and the collector determined the concentration of the minority carrier. The concentration

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APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

A New Longitudinal Magnetostriction Effect and Its Application to the Determination of the Ratio Between the Concentrations of Heavy and Light Holes

recorded thereby increased with H. Figure 1 shows a schematic representation of the measuring arrangement, a description of which is given. Theoretically, one obtains for the concentration of the injected carrier on the z-axis

$(\vec{H} \| z)$: $\Delta n_H = \frac{i_o \beta e^{-z/l_D}}{2\pi D_n z\, I(\gamma_\nu)}$, where $i_o\beta$ is the electron-hole pair production rate, l_D the diffusion length, D_n the electron diffusion coefficient. Figure 2 shows the result obtained by an attempt of experimentally verifying this formula for electron injection into hole-type germanium. The best agreement is obtained with a microscopic drift mobility of the electrons $\mu_n^o = 3650$ cm^2/v.sec. When investigating the hole diffusion in n-type germanium, a considerable divergence between theory and experiment is observed, which, however, can be explained when taking into account the existence of

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A New Longitudinal Magnetostriction Effect and Its Application to the Determination of the Ratio Between the Concentrations of Heavy and Light Holes

heavy and light holes. The theoretical curve drawn for this case nicely describes the experimental results. The concentration ratio between heavy and light holes is deduced from measuring results as being 57; this value approaches the result (50.0) obtained by an other way (Ref 1). There are 2 figures and 2 references.

4

SUBMITTED: March 7, 1959

67392

SOV/181-1-9-10/31

24.7700
~~24(3), 24(6)~~

AUTHORS: Arkad'yeva, Ye. N., Ryvkin, S. M.

TITLE: Investigation of the Adhesion Levels in Polycrystalline Sb_2S_3 and in Single Se Crystals by the Method of the Thermostimulated Current

PERIODICAL: Fizika tverdogo tela, 1959, Vol 1, Nr 9, pp 1379 - 1380 (USSR)

ABSTRACT: In continuation of a previous paper (Ref 1) the present article offers some experimental results. Figure 1 shows the temperature dependence of the thermostimulated current in Sb_2S_3, figure 2 shows the same in selenium. Both samples have p-type conductivity. The heating rate was 0.5 deg/sec for the former and 0.2 deg/sec for the latter. The thermostimulated current in the former exhibits two maxima at T_1 = 150°K and T_2 = 180°K, and three in selenium (115°K, 165°K, and 180°K). An evaluation of the adhesion level position yields for Sb_2S_3: ΔE_1 = 0.33, and ΔE_2 = 0.39 ev, when assuming the effective mass of the holes to be equal to the mass of free

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Investigation of the Adhesion Levels in Polycrystalline Sb_2S_3 and in Single Se Crystals by the Method of the Thermostimulated Current

SOV/181-1-9-10/31

electrons and the mobility to be $u = 20\ cm^2/v.sec$. If temperature is decreased from +20 to $-150^{\circ}C$, the photoelectric sensibility drops to about one hundredth. In this case, the lifetime changes only slightly and amounts to $\sim 40\ \mu sec$. With u independent of temperature and equal to 1 $cm^2/v.sec$, one obtains for selenium, according to the three maxima: $\Delta E_1 \simeq 0.10$ ev, $\Delta E_2 \simeq 0.14$ ev, and $\Delta E_3 \simeq 0.17$ ev. An evaluation of the carrier concentration yields for $Sb_2S_3 \simeq 10^{16}\ cm^{-3}$ and for $Se \simeq 10^{20}\ cm^{-3}$.

The authors thank B. T. Kolomiyets for supplying Sb_2S_3 and P. T. Kozyrev for selenium crystals samples. There are 2 figures and 2 Soviet references.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut AN SSSR (Leningrad Institute of Physics and Technology of the AS USSR)

SUBMITTED: April 24, 1959

24.7700
24(6), 21(8)

67393
SOV/181-1-9-11/31

AUTHORS: Vitovskiy, N. A., Mashovets, T. V., Ryvkin, S. M.

TITLE: Determination of the Number of Acceptor Levels of Defects Occurring in Germanium Under the Action of Gamma Irradiation

PERIODICAL: Fizika tverdogo tela, 1959, Vol 1, Nr 9, pp 1381 - 1387 (USSR)

ABSTRACT: The radiation-induced formation of structural defects stable at room temperature had already been investigated several times, but not all the problems related therewith are as yet solved satisfactorily. The present paper offers a contribution by discussing the possibilities of a complete analysis of the energy levels of the defects and by publishing experimental results concerning the temperature dependence of the Hall coefficient R of n-type germanium irradiated by Co^{60}-γ-rays. An analysis of these results permits a precise determination of the number of acceptor levels belonging to one γ-radiative defect. To investigate the temperature dependence of the carrier concentration in the presence of multiple-charged centers, the authors theoretically investigated a level scheme of a defect (Fig 1), with n in the conduction band considered to be composed of four parts (Fig 2a). In this connection the

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Determination of the Number of Acceptor Levels of Defects Occurring in Germanium Under the Action of Gamma Irradiation

following was assumed: every defect produced by radiation has l acceptor- and k donor levels; "ordinary" donors (atoms of the V group) and M defects exist in such a way in germanium with the concentration N_d, that $N_d > Ml$. n_1 : n rises weakly in consequence of transitions of electrons from donor levels to the conduction band; n_2: full ionization of the donor levels, $n_2 = N_d - Ml\, n_3$; stronger rising of n in consequence of transitions of electrons from higher defect levels to the conduction band $n_3 = \sqrt{N_c M}\, e^{-\Delta E_{M_1}/2kT}$ n_4: full ionization of the upper levels, $n_4 = N_d - N(l-1)$. The temperature dependence of n can thus be represented by the function $\lg n = f(\frac{1}{T})$ (theoretically in Fig 2a, experimentally in 2b). A table gives the results of several measuring series. It is found that for γ-induced defects $l = 4$, with ΔE_{M_1} being 0.18 ev. The defect formation cross section was found to be $\sigma \simeq 4.0 \cdot 10^{-27}$ cm^2.

Determination of the Number of Acceptor Levels of Defects SOV/181-1-9-11/31
Occurring in Germanium Under the Action of Gamma Irradiation

Directives for further investigations are briefly shown. Finally, the authors thank B. M. Konovalenko and I.D.Yaroshetskiy for exposure of the samples and Sh. M. Mirianashvili for his assistance in measurements. There are 2 figures, 1 table, and 3 references, 1 of which is Soviet.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut AN SSSR (Leningrad Institute of Physics and Technology of the AS USSR)

SUBMITTED: March 24, 1959

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24.7700
~~24(6)~~

67399
SOV/181-1-9-23/31

AUTHORS: Arkad'yeva, Ye. N., Ryvkin, S. M.

TITLE: Investigation of Adhesion Levels in Sb_2Se_3 by the Method of the Thermostimulated Current

PERIODICAL: Fizika tverdogo tela, 1959, Vol 1, Nr 9, pp 1460 - 1463 (USSR)

ABSTRACT: If adhesion levels are occupied by carriers at low temperatures, this condition is conserved for a long time. With slow heating the carrier concentration rises in the allowed zone, in the same way as the current (if a field is applied). This boost current which is higher than dark current is defined as thermostimulated. An investigation of thermostimulated currents allows the estimation of position and concentration of the adhesion levels. This method is specially applicable to poorly conductive and photosensitive semiconductors. It had already been utilized for the investigation of CdS, CdSe, HgJ_2, and ZnS (Refs 1-11). The present paper offers the results obtained for the single Sb_2Se_3 crystals. Investigations were conducted in the temperature range of from -180 to

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Investigation of Adhesion Levels in Sb_2Se_3 by the Method SOV/181-1-9-23/31
of the Thermostimulated Current

+20°C. Figures 1 and 2 show samples 1 and 2 as to the temperature dependence of the thermostimulated current (solid curve) and the dark current (dashed curve). The curves were recorded by means of a recording device of the type EPPV-51, which exhibits a sensitivity varied within wide limits ($\sim 10^{-12}$ - $\sim 10^{-7}$ a/mm). The thermostimulated current shows characteristic fluctuations with maximum at 115, 150, and 190°K. An estimation of the energetic position (ΔE_M) and the concentration (M) of the adhesion levels is made on the assumption of the very slow heating having a quasiequilibrium character, so that the Fermi quasilevels for adhesion levels and zone are the same. It can be assumed furthermore that this quasilevel coincides with the adhesion level in the case of temperature T_M corresponding to the thermostimulated current maximum. $\Delta E_M = kT_M \ln \frac{P_v}{P} = kT_M \ln \frac{P_v eu}{\sigma}$ holds, where P_v is the effective level density in the valence band, P is the hole concentration in the valence

Investigation of Adhesion Levels in Sb_2Se_3 by the Method SOV/181-1-9-23/31
of the Thermostimulated Current

band at T_M, u the hole mobility at T_M, σ the conductivity at T_M. Thus one obtains for the 3 maxima of crystal Nr 2:0.28, 0.32, and 0.36 ev. For M one obtains according to Khartsiyev (Ref 13)

$$M = \frac{P_v \Delta E_M \left(\frac{kT_M}{\Delta E_M}\right)^2 e^{=\Delta E_M / kT_M}}{kS\tau\left(1+\frac{3}{2}\frac{kT_M}{\Delta E_M}\right)}$$

, where S is the heating rate and τ is the carrier lifetime. For $T = 155^\circ K$ $\tau \simeq 10^{-8}$ sec holds, for $150^\circ K \simeq 10^{-7}$ sec, and for $180^\circ K \simeq 10^{-6}$ sec. M is then found to be 10^{16}, 3.10^{16}, and 5.10^{16} cm^{-3}. A few more details are finally discussed. The names of A. Kh. Zeynally, B. T. Kolomiyets, and M. V. Kot (who supplied the single crystals) and N. B. Strokan (who made a calculation) are mentioned in footnotes. There are 2 figures and 13 references, 1 of which is Soviet.

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Physico Tech Inst. AS USSR

APPROVED FOR RELEASE: Thursday, September 26, 2002 CIA-RDP86-00513R001446520001-8"

66287

~~24 (6)~~ 24.7700 SOV/181-1-11-22/27

AUTHORS: Ryvkin, S. M., Konovalenko, B. M.

TITLE: On the Dependence of Induced Conductivity of Cadmium Sulfide on the Energy of the Exciting Electrons

PERIODICAL: Fizika tverdogo tela, 1959, Vol 1, Nr 11, pp 1757-1761 (USSR)

ABSTRACT: According to reference 1 it was jointly established with Yu. S. Smetannikova that for 2 to 30 kev electrons with increasing electron energies, but with a total electron current intensity, which remains at the same level, the induced conductivity of the CdS reaches a saturation value, i.e. that this does not increase any more starting from a certain electron energy. The initial point of the "saturation" is not identical for different samples. Additional investigations (Ref 2) established that with small electron energies the decrease of the induced conductivity is related to the fact that the electrons do not deeply penetrate into the crystals and therefore the recombination processes occurring on the surface of the crystals have an increasingly important influence. Other authors (Ref 3) carried out similar investigations on "voluminous" mono-crystals with 30 to 60 kev-electrons. Their measuring results

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On the Dependence of Induced Conductivity of Cadmium Sulfide on the Energy of the Exciting Electrons

contradict data in references 1 and 2, if these are extrapolated to the range 30 to 60 kev. The present study proves that this concept is incorrect and that the dependences found in references 1 and 2 are in qualitative accordance with those derived in reference 3. Certain quantitative differences can unequivocally be explained by the different methods of measuring. There are 2 figures and 4 references, 2 of which are Soviet.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR, Leningrad (Physico-technical Institute of the AS USSR, Leningrad)

SUBMITTED: June 19, 1959

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9,4160

SOV/109-4-8-27/35

AUTHORS: Vitovskiy, N.A., Maleyev, P.I. and Ryvkin, S.M.

TITLE: Optimum Operating Conditions for the Photo-diodes Used With Small Signals

PERIODICAL: Radiotekhnika i elektronika, 1959, Vol 4, Nr 8, pp 1387 - 1392 (USSR)

ABSTRACT: The characteristic of a photo-diode can be expressed by (Ref 2):

$$I = I_s\left(e^{\frac{q\varphi}{kT}} - 1\right) + I_f + \frac{\varphi}{R'} \qquad (5)$$

where I is the current flowing through the photo-diode, R' is the leakage resistance of the diode and φ is the voltage across the n-p junction. I_s is the "dark" saturation current, q is an electron charge, k is the Boltzmann constant and T is the absolute temperature. Eq (5) was employed to plot the voltage-current characteristics shown in Figure 1. Curves I_{T1} and I_{T2} show the "dark" characteristics at temperatures

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Optimum Operating Conditions for the Photo-diodes Used With Small Signals

of +20 °C and -78 °C, while Curves I_{f1} and I_{f2} are the "illumination" characteristics at the same temperatures. The curves are calculated for a photo-diode which has a "dark" current of 8 μA and the resistance $R' > 10^8$ Ω at room temperature. The quantity R_o is represented by ctg α, where α is the slope of the "dark" current-voltage characteristics at $\varphi = 0$. This angle α_2 at the room temperature is equal to 90 °, while at low temperatures $\alpha = \alpha_1$ and tends to zero. If the device works as a photo-diode with a load characteristic $R = \text{ctg } \beta$, the load line intersects the characteristics I_T and I_f in the saturation region; consequently, at both the low and the room temperatures, the output signal taken from the device is the same. On the other hand, if the diode is operated as a photo-electric source, the intersection of the load line with the characteristic occurs in the saturation region only at the low temperature.

Optimum Operating Conditions for the Photo-diodes Used with Small Signals

In this case, again, the output signal is equal to that obtainable in the photo-diode operation. From the above, it follows that the photo-diode can be operated as a photo-electric source, provided it is maintained at a low temperature. Under these conditions, it should be expected that the noise level would be very low. The above conclusion was checked experimentally. The principal experimental characteristic was the relative sensitivity P which was defined as the ratio of the output signal obtained from the device as a photo source and as a photo-diode. This ratio can be defined by Eq (10). The experimental dependence of P on temperature is shown by the solid curve in Figure 3. The dependence of P on temperature for large signals is illustrated by the obtained line in Figure 3. The noise in the device when employed as a photo-diode was 0.5 mV, while when used as a photo-electric source, the noise was 10 μV. The inertia effects in the diode are illustrated in Figure 5, where the first oscillogram refers to the photo-diode operation, while the

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next four oscillograms show the photo-electric response at various temperatures; this effect is further illustrated in Figure 4, which shows that provided the temperature is about -80 °C, the time constant of the device is the same for both the photo-diode and photo-electric operation. There are 5 figures, 1 table and 7 Soviet references.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR (Physico-engineering Institute of the Ac.Sc.USSR)

SUBMITTED: June 4, 1958

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24(3)

AUTHORS: Ryvkin, S. M., Strokan, N. B.

SOV/20-124-5-20/62

TITLE: On the Problem of the Relaxation of Non-equilibrium Conductivity in Recombination Through Traps (K voprosu o relaksatsii neravnovesnoy provodimosti pri rekombinatsii cherez lovushki)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 124, Nr 5, pp 1034-1037 (USSR)

ABSTRACT: The present paper describes the results of an experimental investigation of the theory for the case of few traps for arbitrary injection levels. The first part of this paper deals with the theoretical investigation, in the course of which the authors determine the time-dependence of the non-equilibrium concentration of the carriers for semiconductors with a type of simple traps M. The scheme of transitions corresponding to this case is described in form of a schematical drawing, after which the 3 kinetic equations and the neutrality condition are written down. If the total change Δm of the concentration of electrons in the traps is negligibly small as against Δn and Δp

(in the present paper the system of notation of W. Shockley (Ref 1) is used), it holds qualitatively that during the main part of the monotonous relaxation process also dn/dt and dp/dt must be practically equal to each other. In the here investigated case of a small number of traps lifetime depends only on the concentration of the non-equilibrium carriers, and the value of lifetime at that instant is equal to the steady lifetime at the same steady concentration. A diagram shows the relaxation curve for the injection level $\Delta n_{steady}/(n_o + p_o) = 4$ for the case $\tau_3/\tau_\infty = 5$ (Shockley's system of notation). At the beginning of relaxation the relaxation curve is similar to the function e^{-t/τ_o}, but with increasing recombination it becomes ever more similar to the function e^{-t/τ_∞}. This transition takes place gradually without any salient point. The second part of this paper deals with experimental checking. The experimentally found curves for the decrease of photoconductivity agree qualitatively with theoretical results. In the case of a sufficiently

high injection level they have non-exponential character and are between 2 exponential functions, which correspond to the limiting values of lifetime. For the purpose of a qualitative checking of theoretical results the curves of photoconductivity relaxation were photographed, and $d\Delta n/dt$ and Δn were determined at some points of the declining branches of the oscillograms. All experimental results agree well with theoretical relations. There are 4 figures and 6 references, 4 of which are Soviet.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk SSSR (Physico-Technical Institute of the Academy of Sciences, USSR)

PRESENTED: October 25, 1958, by A. F. Ioffe, Academician

SUBMITTED: October 23, 1958

81369
S/181/60/002/03/28/028
B006/B017

24.7700

AUTHORS: Paritskiy, L. G., Ryvkin, S. M.

TITLE: The Influence of Adhesion Levels on the Relaxation of Photoconductivity in CdS Single Crystals

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 3, pp. 547-557

TEXT: The aim of the present paper was to investigate experimentally the initial stages of the increase of photoconductivity in CdS single crystals during some ten microseconds. As has been demonstrated by V. Ye. Lashkarev et al. in several papers, the characteristic features of photoconductivity in these crystals may be explained by the complex two-stage character of electron excitation in the conduction band. Here, the quantum yield depends on the excitation level. Other authors explained these characteristic features of photoconductivity by the complex character of recombination processes, which leads to a change in lifetime. Here, the quantum yield is constant and equal to unity. Hence, an explanation of the actual mechanism of the photoeffect in CdS can be

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The Influence of Adhesion Levels on the Relaxation of Photoconductivity in CdS Single Crystals

obtained by investigating the "true" quantum yield of the photocurrent in CdS as dependent on the excitation level. The initial stages of the increase of the photocurrent were examined by means of an instrument schematically represented in Fig. 1. The instrument and the measuring technique are described. Fig. 2 shows the shape of the photocurrent curves during the first 50 msec for various irradiation intensities. The higher the intensity, the steeper the rise of the curves and the higher the relative yield. Fig. 3 shows a typical oscillogram for one of the samples. Fig. 4 shows the growth of a curve with a pulse duration of 10 μsec. It indicates that the steep rise takes place during the first microseconds. Hence, rapid processes proceed at the first stages of formation of the photocurrent. The results obtained in the experiments concerning the characteristic features of photocurrent relaxation can be explained in the simplest way by assuming the capture of carriers by α-type adhesion levels. Since the lifetime of the conduction electrons with respect to their adhesion levels is much shorter than with respect to their recombination, the adhesion levels are first filled up within a very

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B006/B017

short time, and only then the slow establishment of recombination equilibrium starts. This is theoretically investigated in the following. Fig. 5 shows the dependence of the concentration of free electrons on t/θ_{min} for different adhesion level densities. The higher the level density, the flatter the rise of n. In the following, the influence exercised by constant exposure on the first stages of the increase of photoconductivity is investigated. The existence of rapid capturing processes influences the change of photoconductivity in time and, especially, the phenomenological yield and the effective lifetime of non-equilibrium carriers. Also the character of the dependence of these quantities on constant irradiation and its intensity is considerably influenced by these processes. Hence, the characteristic features of photoconductivity of CdS are rather to be connected with the complex character of recombination processes than with the excitation process. In an appendix, the influence exercised by constant exposure on the relaxation of monopolar photoconductivity in the presence of a) α-type and b) β-type adhesion levels is investigated. A. B. Berezin, O. A.

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The Influence of Adhesion Levels on the Relaxation of Photoconductivity in CdS Single Crystals

S/181/60/002/03/28/028
B006/B017

Matveyev, L. V. Maslova, and G. A. Fedorus are mentioned. There are 12 figures and 17 references: 8 Soviet, 6 US, and 2 German.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR Leningrad (Institute of Physics and Technology of the AS USSR, Leningrad)

SUBMITTED: June 14, 1959

Card 4/4

S/181/60/002/04/02/034
B002/B063

24.7700

AUTHORS: Konopleva, R. F., Ryvkin, S. M., Yaroshetskiy, I. D.

TITLE: The Problem of the Trapping Cross Section of Holes in Germanium by Defects Formed by Gamma Irradiation

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 4, pp. 566-568

TEXT: The trapping cross section of holes by defects formed by neutron bombardment was found to be $\sim 10^{-15}$ cm^2 (Refs. 1-3). The trapping cross section for gamma irradiation was $4 \cdot 10^{-16}$ cm^2. The present paper shows that this difference is due to a false assumption: A defect formed by gamma irradiation has not two but four acceptor levels in the forbidden band. The dependence of the lifetime on the irradiation with gamma quanta was determined on 11 specimens, wherefrom the trapping cross section of the holes was calculated (Table). A Co^{60} preparation with an activity of 400 gram-equivalent Ra was used as gamma source. The authors used the photomagnetic method, the method of photodiffusion, and the examination of the relaxation curves of photoconductivity to measure the lifetime. The mean value of the trapping cross section was found to be $3.8 \cdot 10^{-15}$ cm^2. This is close to the value obtained for the neutron

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The Problem of the Trapping Cross Section of Holes in Germanium by Defects Formed by Gamma Irradiation

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B002/B063

bombardment ($3 \cdot 10^{-15}$ cm^2 in Ref. 1). There are 1 table and 7 references: 4 Soviet, 1 American, and 2 British.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut AN SSSR (Leningrad Physicotechnical Institute of the AS USSR)

SUBMITTED: October 14, 1959

Card 2/2

Ryvkin, S. M.

S/181/60/002/04/05/034
B002/B063

24.7700

AUTHORS: Ryvkin, S. M., Grinberg, A. A., Ivanov, Yu. L., Novikov, S. R., Potekhina, N. D.

TITLE: Investigation of the Diffusion of Minority Carriers in a Magnetic Field

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 4, pp. 575-590

TEXT: The distribution of the concentration of minority carriers introduced into a magnetic field by "point" injection was theoretically and experimentally studied. A light spot was focused onto a germanium sheet cut out of a single crystal. The occurring emf was measured by means of an ЛВ-9 (LV-9) tube voltmeter. The setup is schematically represented in Fig. 1. Thus, the longitudinal magnetostriction effect (Fig. 5) was measured on p-type and n-type germanium. Such measurements may be used to determine such semiconductor parameters as the microscopic drift mobility of carriers and the concentration ratio between carriers of equal sign but different effective mass. The concentration ratio between light and heavy holes in germanium was about 2 per cent. Mention is made of

81947

Investigation of the Diffusion of Minority Carriers in a Magnetic Field

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B002/B063

I. K. Kikoin, Noskov, and Pikus. There are 7 figures and 18 references: 7 Soviet, 1 American, 9 British, and 1 French.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut AN SSSR (Leningrad Physicotechnical Institute of the AS USSR)

SUBMITTED: July 24, 1959

Card 2/2

81634

S/181/60/002/06/22/050
B006/B056

24.7700

AUTHORS: Arkad'yeva, Ye. N., Paritskiy, L. G., Ryvkin, S. M.

TITLE: Investigation of the Kinetics of Infrared Impurity Photoconduction in CdS Induced by Previous Illumination

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 6, pp. 1160-1168

TEXT: The fact is already known that photoconductivity may be produced in CdS single crystals at low temperatures (77°K) by infrared light of wavelengths up to 6 μ. The authors investigated the kinetics of this conduction in crystals into which impurities were not purposely introduced. In this connection it is assumed that the photoconductivity of CdS is caused by the fact that the light transfers electrons from α-type adhesion levels into the conduction band; the adhesion levels are assumed to be filled up with electrons, which is a consequence of previous illumination. Investigations of kinetics make it possible to acquire knowledge of the interaction between light and adhesion levels and to estimate the main parameters of the adhesion levels. The results obtained by experimental investigation of the induced impurity

Investigation of the Kinetics of Infrared Impurity Photoconduction in CdS Induced by Previous Illumination

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photoconduction in CdS are discussed in part 1. All investigations were carried out at 77°K on CdS single crystals onto which indium contacts were sputtered in vacuo. Above all, the spectral distribution of photoconductivity and the time-dependence of the photocurrent were investigated. Fig. 1 shows the spectral photocurrent distribution, recorded under various conditions; without previous illumination (Curve 1) with previous irradiation by green light, by leaving the sample in the dark for a longer period of time (Curve 2 - photoconductivity is found beginning at 3.5 μ), and under simultaneous constant irradiation with white light (Curve 3 - which produces exactly the same effect). In the latter case, distinct photocurrent extinction with a maximum at 0.9 μ could be observed. Further, the time dependence of infrared photoconductivity after previous illumination with green light of various intensities was investigated. Between the previous illumination and the beginning of infrared irradiation the sample was left in the dark for 40-60 minutes. The results are shown in Fig. 2. The photocurrent relaxation at the beginning of infrared irradiation was found to depend upon previous illumination (Curve a - high intensity, curve b - low

Investigation of the Kinetics of Infrared Impurity Photoconduction in CdS Induced by Previous Illumination

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intensity). In part 2 of this paper, these experimental results are analyzed on the basis of a model with one adhesion level, and the infrared photoconductivity kinetics is calculated for the case of a so-called "quasi-steady" excited state of the crystal. Fig. 3 shows the scheme of electronic transitions upon which the analysis is based. In part 3, the results obtained by experimental investigation of the kinetics of infrared photoconductivity in a quasi-steady excited state are given and the parameters of the adhesion level are determined. The dependence of the growth and drop times as well as of the steady photocurrent are shown in Figs. 4 and 5. Several particular features of infrared photocurrent relaxation in the unsteady state are discussed in part 3. Further investigations in this field are to follow. The crystals investigated were produced by O. A. Matveyev and L. V. Maslova. There are 6 figures and 11 references: 4 Soviet, 4 American, and 3 German.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR, Leningrad (Physico-technical Institute of the AS USSR, Leningrad)

SUBMITTED: October 26, 1959

Card 3/3

82546

S/181/60/002/007/026/042
B006/060

24.7700

AUTHORS: Grinberg, A. A., Paritskiy, L. G., Ryvkin, S. M.

TITLE: The Influence of Adhesion Levels in Semiconductors on the Steady Photoconductivity and the Lifetime of the Minority Carriers

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 7, pp. 1545-1561

TEXT: The present bulky article deals with a comprehensive study of the influence exerted by adhesion levels introduced into a crystal upon the carrier recombination in the steady state (thus, upon τ_p, τ_n, and $\Delta\sigma$) taking place above other traps located in the forbidden band. The study is extended to cover the influence of filling of adhesion levels on the dependence of τ_n and τ_p on temperature and light intensity. In the introduction, the authors discuss a number of relevant publications. In the first section of the paper, the influence of adhesion levels on τ_n and τ_p in the steady state is qualitatively examined by means of an example

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The Influence of Adhesion Levels in Semiconductors on the Steady Photoconductivity and the Lifetime of the Minority Carriers

of a high injection level. This is done on the model of a semiconductor in whose forbidden band there exist two types of local levels with sharply differing properties (Fig. 1): the S levels are assumed to be traps for the minority electrons from the conduction band and the holes from the valency band, i.e., they are recombination centers for the light-produced minority charges. The M levels are, due to electron exchange, connected with the conduction band (the electron exchange with the valency band is forbidden), and therefore they are adhesion levels for the electrons. It is shown that the electron and hole concentrations in the S centers are closely related to the electron and hole concentrations in the bands. E. g., if the electron concentration in the conduction band is changed anyhow, the electron lifetime $\tau_n = 1/\gamma_n p_s$ in this band is decreased, and the hole lifetime $\tau_p = 1/\gamma_p n_s$ in the valency band grows. This is the sense in which the introduction of adhesion levels acts. (γ_n and γ_p are the trapping factors; n_s and p_s the electron and hole concentrations in the S centers; $n_s + p_s = S$, the concentration of the recombination centers). In the following

The Influence of Adhesion Levels in Semiconductors on the Steady Photoconductivity and the Lifetime of the Minority Carriers

sections of the paper the authors first examine in a general way the influence exerted by adhesion levels in the case of a high injection level at a low concentration of the recombination centers, and then the same is done for a semiconductor with two types of injection levels. In this semiconductor the forbidden band contains, besides the recombination centers S and the adhesion levels M for the electrons, adhesion levels L for the holes from the valency band (Fig. 7). Section 4 again treats, for a semiconductor with one adhesion level in the forbidden band, the case of a high injection level, but at a high concentration of the recombination centers S. Finally, section 5 deals with the case of a low injection level at an arbitrary concentration of the recombination centers. Here, the Fermi quasi-levels of electrons and holes practically coincide, and the traps may be classified into adhesion levels and recombination centers only on the basis of the various trapping cross sections. (5.9) and (5.10) are first generally derived for τ_n and τ_p; for M = 0 they go over to (5.11). The latter formulas are then further treated for the special cases of an n-type and a p-type semiconductor.

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The Influence of Adhesion Levels in Semiconductors on the Steady Photoconductivity and the Lifetime of the Minority Carriers

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B006/B060

S. G. Kalashnikov is mentioned. There are 10 figures and 19 references: 5 Soviet, 9 US, and 3 German.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR Leningrad (Institute of Physics and Technology of the AS USSR, Leningrad)

SUBMITTED: November 27, 1959

Card 4/4

83010
S/181/60/002/008/029/045
B006/B063

24,2600

AUTHORS: Arkad'yeva, Ye. N., Ryvkin, S. M.

TITLE: Induced Infrared Photosensitivity of Some Semiconductors

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 8, pp. 1889 - 1890

TEXT: In CdS single crystals activated with silver, Lambe and Klick (Ref. 1) observed infrared photosensitivity induced at 77°K in the range 2 - 6 μ. This phenomenon was studied by the authors of the present paper in Ref. 2. This kind of infrared photosensitivity also occurs in other semiconductors such as CdSe, CdTe, Sb_2Se_3. Fig. 1 shows the typical spectral distribution curves obtained for these substances at 85°K. These substances show no infrared photosensitivity without previous illumination with visible light. All three substances are photosensitive in the range 2 - 4 μ after preceding illumination with light whose frequency is in the range of natural absorption. Fig. 2 illustrates the time dependence of induced photoconduction. As in the case of CdS, the infrared photoconduction rises steeply when light is switched on, and then drops

83020
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B006/B063

24.7700

AUTHORS: Berkovskiy, F. M., Ryvkin, S. M., Strokan, N. B.

TITLE: The Current-voltage Characteristics of the Blocking Layer of a Germanium p-n Junction in the Permeable Direction

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 8, pp. 1956 - 1961

TEXT: The purpose of the present paper was to verify Shockley's relation for the current-voltage characteristic of a planar p-n junction: $I = \beta I_s [\exp(q\Phi/kT)-1]$, where $\beta = 1 + p(0)/(p(0)+n_o)$; Φ denotes the voltage applied to this junction, I_s - saturation current, q - electron charge, p(0) - hole concentration in the base on the p-n junction, and n_o - equilibrium concentration of electrons in the base. The correction factor β considers the voltage drop occurring in the semiconductor. The authors first discuss the theory and the method of measurement, and describe the apparatus that is schematically represented in Fig. 2. The square-pulse generator used was designed by Engineer G. V. Khozov. The current-voltage

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The Current-voltage Characteristics of the Blocking Layer of a Germanium p-n Junction in the Permeable Direction

characteristics of the p-n junctions were taken in forward direction and at current densities of up to 800 - 1000 a/cm^2. For this purpose, the authors used the method of dividing the voltages into those in the semiconductor and the volume charge region according to their relaxation rates. A correction for the Dember emf is carried out (it takes into account the different mobilities of electrons and holes). The voltage-current characteristics measured on diodes and intrinsic p-n junctions are shown in diagrams. Furthermore, the authors examined molten germanium diodes with a high-resistivity starting material ($n_o \simeq 4 \div 6.10^{13}$ cm^{-3}), for which $\beta = 2$ at a voltage of 100 - 150 mv on the p-n junction. Theoretical studies have shown that the functions $\ln I = f(\Phi)$ should be straight lines, and that the cotangent of their angle of slope should be equal to kT/q; thus a voltage of 25.6 mv is obtained for t = 20°C. The theory is well confirmed by experiments: 26.5 ± 0.5 mv was obtained. Fig. 4 shows the characteristics obtained for a sample of $n = 4.10^{13}$ cm^{-3} at different temperatures between -77° and +70°C. The numerical values

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pertaining to this diagram are compiled in a table. Shockley's formula is well satisfied in this temperature range at current densities of 0.1 - 100 a/cm^2. From $\sim$ 100 a/cm^2 onward, the voltage on the p-n junctions is saturated. Its maximum value is 60 - 70 mv lower than the contact potential difference. The authors thank V. I. Stafeyev for his discussions. Yu. A. Kontsevyy is also mentioned. There are 5 figures, 1 table, and 13 references: 6 Soviet and 5 US.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR Leningrad (Institute of Physics and Technology of the AS USSR, Leningrad)

SUBMITTED: February 1, 1960

830222

S/181/60/002/008/041/045
B006/B063

24.7700

AUTHORS: Ryvkin, S. M., Yaroshetskiy, I. D.

TITLE: The Influence of Adhesion Levels on the Relaxation of Non-equilibrium Conductivity in Germanium Irradiated With Gamma Rays

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 8, pp. 1966 - 1977

TEXT: In order to study the mechanism of recombination processes of defects, the authors made a number of experiments which are described here and whose results are discussed in detail. The main purpose of the experiments was to determine the effect of γ-induced defects on the temperature dependence of the relaxation time of the conductivity of n-type germanium. First, the method and the experimental arrangement are discussed. n-type Ge single crystals of $5 \cdot 5 \cdot 15$ mm^3, etched with CP-4 (SR-4) to reduce the rate of surface recombination, served as samples. They were exposed to γ-rays of 120 r/sec (Co^{60}) at 20°C. The concentration of the resulting structural defects was determined from

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formula $N_t = \sigma N_{Ge} \Phi$, where Φ ist the γ-flux per cm^2 of the sample surface, N_{Ge} the concentration of the germanium atoms, and σ the cross section of defect formation which was assumed to be $\sigma = 4.3 \cdot 10^{-27} cm^2$ according to Ref. 6. The experimental arrangement is schematically shown in Fig. 1. The sample is placed in a cryostat between the poles of an electromagnet which can generate a field of up to 4,000 oersteds. This cryostat permits a change in temperature from room temperature to that of liquid nitrogen. Fig. 2 shows the temperature dependence of the relaxation time, τ', of non-equilibrium conductivity as the function $\ln\tau' = f(1/T)$. The six curves refer to six different N_t-values between zero and $1.0 \cdot 10^{13} cm^{-3}$. With increasing irradiation, a dropping slope of the curves having a minimum could be observed. After passing through this minimum, they steeply rose again. Thus, the relaxation time first decreased with dropping temperature and again increased with further dropping temperature. Fig. 3 again shows $\ln\tau' = f(1/T)$ for the same sample, however, for

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$N_t = 1.5 \cdot 10^{13} cm^{-3}$ in a wide temperature range. The curve starts in the minimum, rises linearly and quickly, and after having passed through a peak, it slowly drops. Next, the results are discussed in detail and compared with theory. The curves $\ln\tau' = f(1/T)$ may be well represented in three characteristic parts (I - drop, II - rise, III - almost saturation) (cf. Fig. 5). The position ΔE_S of the recombination levels of these γ-induced defects in the forbidden band are determined (Fig. 4) from the slope of the curves (part I, Fig. 2). The authors found that $\Delta E_S = 0.2$ ev (distance of the S-level from the conduction band). The hole trapping cross section on the S-level at room temperature was determined to be $3.5 \cdot 10^{-15} cm^2$. The position of the second level (M) is determined by its distance from the valency band ΔE_M; it was found that $\Delta E_M = 0.24$ ev. The values found for the second sample deviate but little from those of the first sample; the second sample had a somewhat lower resistivity. The numerical values are compiled in a table (p. 1976). The S-levels are

Card 3/4

84083

S/181/60/002/009/024/036
B004/B056

9,4160 (1165, 1137, 1331)

AUTHORS: Ryvkin, S. M., Konopleva, R. F., Maslova, L. V., Matveyev, O. A., Strokan, N. B., Tarkhin, D. V., Khozov, G. V.

TITLE: Low-inertia Germanium Photodiodes

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 9, pp. 2199 - 2201

TEXT: Germanium photodiodes were developed in 1954 at the authors' institute; they are now being produced in industry, and have a time constant of about 10^{-5} sec. Now, the low-inertia photodiodes ФД-М1 (FD-M1) and ФД-М2 (FD-M2) were developed, which have a time constant of only $(1-3)\cdot10^{-8}$ sec. Inertia was measured by means of an apparatus schematically shown in Fig. 1. A Kerr cell fed by a ГСС-6 (GSS-6) alternating-current generator modulated light sinusoidally with a frequency, f, of 1Mc/sec. The light, which was amplified by an ФЭУ (FEU) photomultiplier, was recorded by an СИ-1 (SI-1) oscilloscope. Owing to the phase shift φ,

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the oscilloscope showed an ellipse. By means of an RC phase transformer, the ellipse was changed into a straight line. From the equation $\tan \varphi = 2\pi f\theta$ the time constant θ was calculated. Fig. 2a shows the function $\theta = f(R_1)$ (R_1 = load resistance). In Fig. 2b the new diodes are compared with an ФД-1 (FD-1) diode of the old type. The oscillogram shows that the new diodes precisely reproduce a ⊓-shaped light pulse. The authors thank I. A. Lebedeva, P. I. Gorshkov, collaborators of the laboratory, and F. M. Berkovskiy, student at LGU (Leningrad State University) for their assistance. There are 3 figures and 4 references: 3 Soviet.

ASSOCIATION: Leningradskiy fiziko-tekhnicheskiy institut AN SSSR (Leningrad Institute of Physics and Technology of the AS USSR)

SUBMITTED: November 6, 1959

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AUTHOR: Ryvkin, S. M.

TITLE: The Real Lifetime and the Possible Mechanism of the Inelastic Scattering of Carriers in Semiconductors

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 10, pp. 2411-2420

TEXT: The lifetime of nonequilibrium carriers for the stationary state is known to be given by $\tau_{\Delta n} = \Delta n_{st}/U$ (1), where Δn_{st} is the steady concentration of the nonequilibrium electrons and U the intensity of the nonequilibrium process of generation of these electrons. $\tau_{\Delta n}$ is commonly supposed to have the significance of lifetime of the electron in the conduction band; it is shown here that this is really so only in some special cases. From a study of the dynamics of this process, it is shown that the time between two collisions with holes (each collision leading to the capture of an electron) has the sense of a real mean lifetime of electrons in the conduction band: $\tau_{real} = 1/\gamma_{nk} p_k$ (2), where p_k is the

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concentration of holes of k-th kind, and γ_{nk} is the trapping coefficient. $\tau_{\Delta n}$ and τ_{real} can differ by some orders of magnitude. A detailed study is made for comparing these quantities in three special cases. First of all it is shown that for the impurity photoconductivity $\tau_{\Delta n} \leqslant \tau_{real}$, but the difference is not large. The intrinsic photoconductivity by recombination with traps is then investigated. It is found that for high injection level when $\Delta n \gg n_o$ and p_o (n_o - equilibrium concentration of electrons; p_o - equilibrium concentration of holes) and U considerably exceeds the number of electrons thermally scattered into the conduction band, $\tau_{real} = \tau_{\Delta n}$. This does not hold for "intermediate" or low injection levels. For low injection levels $\tau_{real} = \tau_{equilibr}$. The temperature dependence of these quantities is studied. Intrinsic photoconduction by recombination with traps in the presence of adhesion levels is discussed. A formula for τ_{real} is derived. From the cases considered here it is seen that $\tau_{\Delta n}$ may be

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smaller or greater than τ_{real}, and the number of examples could be multiplied. In the last section of the paper, the inelastic scattering process is studied. It is concluded that the energy transfer does not take place by successive collisions of carriers with phonons; it is the result of the trapping of the carrier for a short time with a fast reemission in a band lying in the neighborhood of the normal energy. A. I. Ansel'm is mentioned (Ref. 5). A. A. Grinberg is thanked for interesting discussions. There are 4 figures and 6 references: 3 Soviet and 3 US.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR Leningrad (Institute of Physics and Technology of the AS USSR, Leningrad)

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AUTHORS: Zhdanovich, N. S., Konopleva, R. F., Ryvkin, S. M.

TITLE: Annealing-out of Defects Formed by Gamma Rays in n-Type Germanium

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 10, pp. 2356-2358

TEXT: When the defects produced in n-type germanium by irradiation with γ rays are removed by annealing, the decrease shows a nonexponential character. For an explanation of this it is necessary to consider the diffusion of the interstitial atoms and vacancies (Refs. 2,3). Fig. 1 shows the fraction φ of the defects removed by annealing as a function of $\sqrt{t}$ for annealing temperatures of 120, 140, and 160°C, t being the annealing time. The experimental values are seen to agree with the theory mentioned in the introduction. Similar results are obtained on bombardment by electrons and neutrons. The activation energy for the diffusion of the defects is found to be 1.01 ev. For comparison, analogous values obtained on irradiation with neutrons (1.12 ev) and with electrons (1.36 and 1.3 ev) are given (Refs. 1,3,4,5). Fig. 2 shows φ as a function

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of $Z = (4Dt/r_o^2)^{1/2}$. It is found that the experimental and theoretical values agree well for $\lambda = 0.5$ and $D_o/r_o^2 = 1.3 \cdot 10^9$ per second. r_o is, thus, found to be $2.8 \cdot 10^{-7}$ cm, and so somewhat larger than that obtained in the case of neutron bombardment. Fig. 3 shows that by increasing the γ-quantum flux the removal of defects by annealing is more rapid. The linear part of the curve is also reduced. In the conclusion it is stated that the theory of the removal of defects by annealing which is confined to diffusion is unable to explain some important properties which are possibly connected with the interaction of defects with other structural perturbations. There are 3 figures and 6 references: 2 Soviet and 4 US.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN SSSR, Leningrad (Institute of Physics and Technology of the AS USSR, Leningrad)

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