AUTHOR: Vol'kenshteyn, F.F. (Wolkenstein, F.F.)

TITLE: On the Problems of Semiconductor Theory in Connection
               with the Catalysis Theory (O zadachakh, stoyashchikh
               pered teoriyey poluprovodinikov v svyazi s problemoy
               kataliza)

PERIODICAL: Izvestiya Akademii Nauk SSSR, Vol. XXI, #2, pp 176-178
               1957, USSR, Seriya fizicheskaya

ABSTRACT: The surface of a semiconductor possesses a specific
               property to catalyze many chemical reactions. The
               phenomenon is reduced to the following process: mole-
               cules of reacting gases are absorbed on the surface
               of a semiconductor, then being in the absorbed state
               react with each other, and the reaction products are
               desorbed again. Thus the reaction is transferred
               from the gas phase to the semiconductor surface.
               The problem is why this leads to its substantial ac-
Card 1/3   celeration (sometimes in tens of thousands of times)?

TITLE:

On the Problems of Semiconductor Theory in Connection with the Catalysis Theory (O zadachakh, stoyashchikh pered teoriyey poluprovodinikov v svyazi s problemoy kataliza)

The other problems awaiting their theoretical clarification are as follows:
1. The mechanism of catalytic property of a semiconductor is hidden within the semiconductor itself. The problem is to discover this mechanism.
2. Adsorption in question is a so-called "khemosorbtsiya", chemical adsorption, caused by the forces of chemical nature. What is the mechanism of the chemical adsorption, that is the mechanism of forming a chemical connection between a crystal and a gas molecule?
3. What is the origin of the potential barrier on the adsorption curve, the origin of the activation energy?
4. Molecules are often dissociated during the chemical adsorption. What is the mechanism of this dissociation?

Card 2/3

TITLE: On the Problems of Semiconductor Theory in Connection
with the Oatalysis Theory (O zadachakh, stoyashchikh
pered teoriyey poluprovodinikov v svyazi s problemoy
kataliza)

5. The catalytic activity of a semiconductor essentially
depends on the character and concentration of admixtures
contained _ within its volume. By what a way do admixtures
so considerably affect chemical processes taking place
on the semiconductor surface?
6. Why is the activity of a semiconductor connected
with the concentration of free electrons and holes
contained in it?
These problems have been the subject of theoretical
investigations in the Catalysis Laboratories of the
Institute of Physical Chemistry. No references are cited.

INSTITUTION: Institute of Physical Chemistry of the USSR Academy of
Sciences

PRESENTED BY:

SUBMITTED: No date

AVAILABLE: At the Library of Congress

Card 3/3

AUTHOR: Vol'kenshteyn, F.F. (Wolkenstein, F.F.)

TITLE: On Some Problems of Semiconductor Catalysis (O nekoto-
               rykh voprosakh poluprovodnikovogo kataliza)

ABSTRACT: There are experimental facts which indicate a close
               correlation between electronic properties of a semi-
               conductor and its catalytic and adsorption qualities.
               Chemical adsorption results in charging the surface of
               a semiconductor. Therefore, energetic zones are being
               curved at the surface and the contact potential and
               electric conductivity of a semiconductor can change.
               These changes following adsorption have been actually
               observed by V. Lyashenko and I. Stepko.

               The probability for a chemically adsorbed molecule to
               be in a neutral or charged state depends on the level
               of the chemical potential or the concentration of free
Card 1/4   electrons and holes in the crystal.

TITLE:

On Some Problems of Semiconductor Catalysis (O nekoto-rykh voprosakh poluprovodnikovogo kataliza)

The dependence of the adsorption activity of mercury sulfide on its stoichiometric composition and the effect of lighting on the adsorption activity point out in this direction. Sometimes, however, the lighting leads to an opposite effect, i.e. decrease of the adsorption activity, as Terenin and Myasnikov experiments showed.

Another group of facts is concerned with effects of admixtures on the semiconductor catalytic activity. The latter is characterized by the constant of rate K which usually satisfy Arrhenius' law:

$$K = K_o \, e^{-E/kT}$$

where E is activation energy and T is temperature.

Card 2/4

The insertion of an admixture into a semiconductor leads to the change of both activation energy E and pre-exponential multiplier K_o.

TITLE: On Some Problems of Semiconductor Catalysis (O Nekoto-
            rykh voprosakh poluprovodnikovogo kataliza)

            Reaction of ethylene oxidation on catalyzer $MgO \cdot Cr_2O_3$
            with admixture of Na_2SO_3 studied by Krylov and
            Margolis showed that one and the same admixture, and
            used in the same quantity, expedites the reaction at
            low temperatures and dopes the catalyzer, i.e.,
            inhibits the reaction at high temperatures. Depending
            on its concentration, one and the same admixture, at
            the same temperature, can either promote a reaction or
            inhibit it.

            In the author's opinion, the insertion of admixtures
            changes the concentration of the electronic and hole
            gas in a semiconductor. This concentration determines
            the reaction activity of the molecules adsorbed on the
            semiconductor surface and catalytic activity of the
            molecules.

Card 3/4   Theories used at present are of a phenomenological

TITLE: On Some Problems of Semiconductor Catalysis (O Nekoto-
                rykh voprosakh poluprovodnikovogo kataliza)

                character. The future theory, the electronic catalysis
                theory, is in the beginning phase of its origination.
                The article contains 4 graphs. No references are
                given.

INSTITUTION: Institute of Physical Chemistry of the USSR Academy of
                Sciences

PRESENTED BY:

SUBMITTED: No date

AVAILABLE: At the Library of Congress

Card 4/4

Vol'Kenshteyn, F. F.

USSR/Physical Chemistry - Kinetics, Combustion, Explosions, Topo-
      chemistry, Catalysis.   B-9

Abs Jour: Referat. Zhurnal Khimiya, No 2, 1958, 3891.

Author : F.F. Vol'kenshteyn.
Inst   :
Title   : Some Questions Concerning Semiconductor Catalysis (According
        to Materials of International Catalysis Congress at Philadel-
        phia).

Orig Pub: Uspekhi khimii, 1957, 26, No 6, 659-672.

Abstract: No abstract.

Card   : 1/1   -21-

VOLKENSHTEYN, Fedor F. (Moscow)

"Towards the Electron Theory of Chemical Absorption in Semi-Conductors,"
(Plenary lecture).

  report submitted for Annual Meeting Eas German Chemical Society, 28 Oct -
1 Nov 1958, Leipzig, G.DR.

VOL'KENSHTEYN, F. F.

PHASE I BOOK EXPLOITATION   30V/1285

5(3)

Akademiya nauk Belorusskoy SSR. Institut khimii

Sbornik nauchnykh rabot, vyp. 6 (Collection of Scientific Works of the Institute
of Chemistry, Belorussian SSR Academy of Sciences, Nr. 6) Minsk, Izd-vo AN
Belorusskoy SSR, 1958. 271 p. 1,100 copies printed.

Ed.: Yerofeyev, B.V., Academician, BSSR Academy of Sciences; Tech. Ed.:
    Volokhanovich, I.

PURPOSE: The book is intended for chemists engaged in research in specialized
    fields.

COVERAGE: The book is a collection of scientific articles dealing with varied
    subjects, such as problems in electron theory of semiconductors, catalysis,
    autoxidation of abietic acid, thermodynamics of some reactions of sulfur
    organic compounds and reactions of alkyl, aryl, acyl-oxy radicals in the
    liquid phase. Personalities are mentioned in the individual articles.
    There are 331 references, of which 215 are Soviet, 75 English, 30 German,
    10 French, and 1 Finnish

Card 1/5

Collection of Scientific Works (Cont.)   SOV/1285

TABLE OF CONTENTS:

Card 2/5

VOL'KENSHTEYN, F.F.

SOV/30-58-7-34/49

AUTHOR: Krylov, O. V., Candidate of Chemical Sciences

TITLE: Physics and Physical Chemistry of Catalysis (Fizika i fiziko-
-khimiya kataliza) Transactions of the All-Union Conference
(Vsesoyuznaya konferentsiya)

PERIODICAL: Vestnik Akademii nauk SSSR, 1958, Nr 7, pp. 119 - 122 (USSR)

ABSTRACT: This conference convened in Moscow between March 20th and
March 23rd. It was called by the Department of Chemical
Sciences and the Institute of Physical Chemistry of the AS
USSR (Otdeleniye khimicheskikh nauk i Institut fizicheskoy
khimii Akademii nauk SSSR). It was attended by more than 600
persons from different towns of the Soviet Union as well as
from countries of the people's democracies. Nearly 100 re-
ports were submitted, 78 of which were given to the parti-
cipants for discussion. The remainder was read. The follow-
ing reports were heard:
1) S. Z. Roginskiy, (Institute of Physical Chemistry, AS USSR),
spoke about the selective methods concerning semiconductor
catalysis.

Card 1/5

Physics and Physical Chemistry of Catalysis.   SOV/ 3o-58-7-34/49
Transactions of the All-Union Conference

2) V. V. Boldyrev, Tomsk University, used electron repre-
sentations for the explanation of the course of topo-
chemical reactions.

3) N. P. Keyyer, (Institute of Physical Chemistry, AS USSR),
used electron representations for the clarification of
the characteristics of heterogeneity of the active sur-
face of semiconductor contacts.

4) F. F. Vol'kenshteyn, V. B. Sandomirskiy and Sh. M. Kogan,
(Institute of Physical Chemistry, AS USSR), investigated
the influence of exposure as well as of an external elec-
tric field on the absorptive power of a semiconductor.

5) A. N. Terenin spoke about the investigation of the struc-
ture and the behavior of surface formations in the case
of adsorption and catalysis.

6) V. F. Kiselev (Moscow University), dealt with problems
concerning the elementary act of catalysis.

7) G. K. Boreskov, Physical-Chemical Institute imeni L. Ya.
Karpov (Fiziko-khimicheskiy institut im. L. Ya. Karpova),
reported on the dependence of the catalytic activity of
metals on their position in the periodic system of ele-
ments.

Card 3/5

·AUTHOR: Vol'kenshteyn, F.F. (Moscow)   SOV/74-27-11-2/5

TITLE: Present State of the Electron Theory of Catalysis on
                Semiconductors (Sovremennoye sostoyaniye elektronnoy teorii
                kataliza na poluprovodnikakh)

PERIODICAL: Uspekhi khimii, 1958, Vol 27, Nr 11, pp 1304-1320 (USSR)

ABSTRACT: A short summary of the results of a series of new theoretical
                publications in this field is given. One of the main problems
                treated is: What is the importance of the electron theory in
                     catalysis on semiconductors. The electron theory first
                explains the adsorption and desorption mechanisms. The particles
                adsorbed at the surface are regarded as structural defects of
                the surface. Experiment carried out by the author in 1948 (Ref 1).
                The adsorbed particle enters the adsorbing lattice and partici-
                pates in the electron household of the lattice. Two forms can be
                distinguished in the formations on the surface: 1) The "weak"
                chemosorption, particles and centre of adsorption are a whole,
                the particle remains electrically neutral. 2) "Solid" chemosorp-
                tion, the adsorbed particle has a free electron (donor) or an
                electronic vacancy (acceptor). The two latter bonds may be of pure-
Card 1/4   ly ionic or purely homeopolar or also of mixed nature according

Present State of the Electron Theory of
Catalysis on Semiconductors

SOV/74-27-11-2/5

to the nature of the adsorbent, and the adsorbate. The chemical-
ly adsorbed particles i.e. the "solid" ones meet with other chemo-
sorbed particles or particles from the air and may enter in reac-
tion with them. Their appearance on the surface is responsible of
the catalytic process. The "weak" binding is based on the concept
of a couple of free valencies migrating on the surface. The re-
moval of one of the 2 bindings leads to a "solid" acceptor or
donor binding. All transitions from one type of binding into the
other are possible. The probability that a certain number of
particles is in one of these bindings is influenced by the posi-
tion of the Fermi level. The Fermi level is the length of the
distance between the zone of valencies and the zone of conduc-
tivity in the semiconductor. The position of the Fermi level thus
defines the reaction velocity (the Fermi level enters the energy
of activation as term of a sum). Boreskov and Popovskiy (Ref 12)
observed and investigated experimentally this dependence of the
Fermi level. Thus, the position of the Fermi level also determines
the catalytic activity. 1950 Vol'kenshteyn, finally also Boudart
(Ref 15) and Hauffe (Ref 16). The Fermi level proved to be the

Card 2/4

· Present State of. the **Electron Theory of**
Catalysis on Semiconductors

key for controlling the catalytic activity on semiconductors.
The "solid" acceptor binding causes a change of the potential of
the surface and a compensation layer of the screening length l
closely below. This changes the conductivity and thus also the
yield of catalysis. Sandomirskiy (Ref 18) theoretically in-
vestigated these dependences, Gray (Ref 19), Heiland (Ref 20),
Lyashenko, Stepko (Ref 21) as well as a number of foreign authors
carried out also experimental investigations. They are known under
the term of "marginal layer theory of adscrption". The position of
the Fermi level on the surface also depends on its position in the
interior of the semiconductor. This makes again possible a direct-
ing of the catalytic properties except in the case of a quasi-iso-
lated state. On the surface a sufficient density of structural
defects predominates. Catalytic activity increases in acceptor re--
actions, conductivity, however, decreases - vice versa in donor
reactions. Adsorbability changes only with the pressure in the ex-
terior space. Also the photoelectric effect cannot change the elec-
trons or the electronic vacancy concentration. By the Fermi level
the semiconductors prove to belong, according to their properties
of adsorption and catalysis, to the crystals. There are 13 figures

Card 3/4

SOV/76-32-10-22/39

5(4)
AUTHOR: Vol'kenshteyn, F. F.

TITLE: The Charging of a Semiconductor Surface During Adsorption
               (O zaryazhenii poverkhnosti poluprovodnika pri adsorbtsii)

PERIODICAL: Zhurnal fizicheskoy khimii, 1958, Vol 32, Nr 10,
               pp 2383 - 2391 (USSR)

ABSTRACT: A representation of the adsorbed particles as "im-
               purities" at the crystal surface was given by the
               author of this paper in 1948 (Ref 1). Of late a number
               of scientists have dealt with the problem of the
               charging of the surface in chemisorption; there were,
               for instance, Aigrain and Dugas (Egren and Dyuga)
               (Ref 2), Germain (Zhermen)(Ref 3), and Engel and Hauffe
               (Engel' and Khauffe) (Ref 4). In their papers only
               one type of chemisorption is investigated under the
               term "boundary layer theory of adsorption". In the
               present case the charge of the surface is investigated
               taking into account various types of chemisorption.
               It is found that the surface charge formed in the
               chemisorption does not only depend on the nature

Card 1/3

The Charging of a Semiconductor Surface During Adsorption SOV/76-32-1o-22/39

of the adsorbed particles but also on the character
of their binding with the surface. The chemisorbed
particle can be regarded as a structural defect
which has at the same time a certain affinity to the
free electron as well as to the free hole (in the
surface). Two types of chemisorption can be
distinguished. The "weak", in which the particle
adsorbed remains electrically neutral, and the
"strong" chemosorption in which the particle has an
electron. The latter can a) have an acceptor binding
if the free electron participates in the binding of the
adsorbed particle, or b) a donor binding where the
free hole participates in the binding. In the con-
siderations of the surface charge of various forms
of chemisorption a paper by Sh.M.Kogan is mentioned
which is in publication, as well as an equation
according to the Fermi statistics. Under the same
conditions the various forms of the chemisorption and
therefore also the resulting electric charges of the
surface depend on the chemical potential of the surface.
Card 2/3   The papers by V.B.Sandomirskiy (Refs 12-14) and V.I.

The Charging of a Semiconductor Surface During Adsorption SOV/76-32-10-22/39

Lyashenko and I.I.Stepko (Ref 15) as well as by S.Yu. Yelovich and L.Ya.Margolis (Ref 18) are mentioned in the connection with the effects caused by the charging of the surface. The changes between the function donor versus acceptor are explained by the various coexisting types of chemisorption on the surface. There are 5 figures and 18 references, 14 of which are Soviet.

ASSOCIATION: Akademiya nauk SSSR, Institut fizicheskoy khimii, Moskva
                (AS USSR, Institute of Physical Chemistry, Moscow)

SUBMITTED: May 15, 1957

Card 3/3

20-118-4-34/61

AUTHORS: Ioffe, I. I., Vol'kenshteyn, F. F.

TITLE: The Trend of Contact Oxydation Reactions on
             Semiconducting Catalysts (Benzene Oxydation Serving as
             an Example)
             (K voprosu o napravlenii reaktsii kontaktnogo okisleniya
             na poluprovodnikovykh katalizatorakh (na primere okisleniya
             benzola))

PERIODICAL: Doklady Akademii Nauk SSSR, 1958, Vol. 118, Nr 4,
             pp. 747-750 (USSR)

ABSTRACT: The authors here examine the phenomena mentioned in the
             title, from the aspect of the theory of catalysis, which
             was developed by F. F. Vol'kenshteyn (reference 5,6,7).
             Convenient objects for the investigation of the mechanism
             of the process are the simplest aromatic compounds
             (benzene, naphtalene), because at them sharply marked
             trends in the heterogeneous-catalytic and homogeneous
             reactions are observed. The authors suppose that it is
             possible to make various assumptions on the possible
             mechanism of the oxydation of benzene on electron-

Card 1/4

The Trend of Contact Oxydation Reactions on Semiconducting 20-118-4-34/61
Catalysts (Benzene Oxydation Serving as an Example)

semiconductors and Hole-semiconductors (e.g. vanadium pentoxide and cupric oxide, or cuprous oxide). Here, the authors proceed from the assumption that in case of the adsorption of benzene one of the bindings in the benzene molecule is ruptured and that the valence which has become free in this way is saturated by the free valence of the catalyst. Here are two and only two possibilities: In case of the adsorption of the benzene molecule either a C-H-binding or a C-C-binding can be ruptured. As adsorber here a crystal of the type $M_m R_r$ is examined (M denoting a metal and R a metalloid), which is regarded to be built up of the ions M^{+p} and R^{-q} ($pm = rq$). Most of the semiconductors used as catalysts (oxides, sulfides) may have a lattice of this type. First the adsorption is investigated here, in the case of which a C-H-binding is ruptured. In this case the adsorption leads to the dissociation of the benzene molecule into 2 ions, as is illustrated here schematically. This mechanism is possible in case of electron-semiconductors and also of hole-semiconductors. The

Card 2/4

The Trend of Contact Oxydation Reactions on Semiconducting 20-118-4-34/61
Catalysts (Benzene Oxydation Serving as an Example)

difference between these types of semiconductors becomes
noticeable in case of the interaction of the compounds,
which form on the surface, with the vagrant (bluzhdat')
free valences of the catalyst. Thus the electrically
neutral radical which is located on the surface, forms
on the hole semiconductors, whereas it practically cannot
form on electron semiconductors. Then the adsorption of a
benzene molecule with the rupture of a C-C-binding is in-
vestigated. Also here the process of adsorption leads to
the production of a positive and of a negative valence on
the surface of the catalyst, whereon the negative valence
(hole) remains free and the positive valence (electron)
combines with the benzene molecule, retains it on the
surface, and transforms it into an electrically charged
radical. Such an ion radical, which is located on the
surface, practically forms only on electron semiconductors,
but on hole semiconductors. The here examined hypothetical
mechanism is very much schematized, it only shows the way
to the understanding of the action of semiconducting
catalysts in the oxydation benzene.

Card 3/4

The Trend of Contact Oxydation Reactions on Semiconducting 20-118-4-34/61
Catalysts (Benzene Oxydation Serving as an Example)

        There are 7 figures, and 15 references, 11 of which are
        Soviet

ASSOCIATION: Nauchno-issledovatel'skiy institut organicheskikh
           poluproduktov i krasiteley im. Voroshilova
           (Scientific Research Institute for Organic Semiproducts
           and Dyes imeni Voroshilov)
           Institut fizicheskoy khimii Akademii nauk SSSR
           (Institute for Physical Chemistry of the AS USSR)

PRESENTED: July 8, 1957, by P. A. Rebinder, Member, Academy of
           Sciences USSR

SUBMITTED: April 24, 1957

AVAILABLE: Library of Congress

Card 4/4

20-118-5-37/59

AUTHORS: Vol'kenshteyn, F. F. , Sandomirskiy, V. B.

TITLE: The Influence of an External Electric Field on the Adsorbing
                Power of a Semiconductor (O vliyanii vneshnego elektricheskogo
                polya na adsorbtsionnuyu sposobnost' poluprovodnika)

PERIODICAL: Doklady Akademii Nauk SSSR, 1958, Vol. 118, Nr 5, pp. 980-982
                (USSR)

ABSTRACT: Here the authors designated the increase and the decrease of
                the adsorbing power in an electric field as electroadsorption
                and electrode adsorption, respectively. The present work aims
                at the estimation of the experimental possibility of the ob-
                servation of this effect; this depends on the change of pres-
                sure in the reactor at the application of an electric field
                and on the field strength. The authors here investigate an
                adsorbent of the shape of a semiconductor plate of a thickness
                2L in the direction of the x-axis and with sufficiently great
                measures in the direction of the y and z-axis. The adsorp-
                tion of molecules to which the local surface levels E cor-
                respond takes place on the plane $x = \pm L$. For reasons of ex-

Card 1/4

The Influence of an External Electric Field on the Adsorbing Power of a
Semiconductor

20-118-5-37/59

actness the authors investigated the adsorption of acceptor
molecules on a semiconductor of the n-type. The crystal is
assumed to be in an outer homogeneous electric field of the
field strength F directed vertically to the surface of the
crystal. The following is assumed in order to simplify the
computation: a) the thickness of the crystal is much greater
than the length of screening l. b) the distribution of elec-
trons is Boltzmann-like on all energy levels in the volume
of the crystal; c) surface zones are lacking; d) there exist
only two kinds of bindings of the adsorbed molecules on the
surface, namely, "weak" and "solid" acceptor binding. The
schemes of the energy levels in the case of the lacking and
of the presence of an electric field are illustrated on a
diagram. The crystal is located in a reactor with the con-
stant volume v, which is filled by a gas with the pressure
p_0. After the application of the field F gas pressure assumes
the value p. The problem consists in determining the depend-
ence of the quotient p/p_0 on F. The expression obtained for
this quotient from the equation of state of the ideal gas
is given here. In the case of a lacking field most of the

Card 2/4

20-118-5-37/59

The Influence of an External Electric Field on the Adsorbing Power of a
Semiconductor

adsorbed molecules are in the state of the "weak" binding on
the surface. The expression for p_o/p corresponding for this
case is given here. Then $p_o/p \geqslant 1$, i.e. in the case of the
model selected here only electroadsorption is possible. The
authors especially investigated the case $p_o/p \gg 1$ which
corresponds to a strong effect. The dependence of the quo-
tient p_o/o on F is given explicitly. A numerical evaluation
is given at the end of this paper. There are 1 figure and
5 references, 5 of which are Soviet.

ASSOCIATION: Institut fizicheskoy khimii Akademii nauk SSSR
                (Institute for Physical Chemistry AS USSR)

PRESENTED: July 25, 1957, by N. N. Semenov, Member, Academy of Sciences,
                USSR

SUBMITTED: July 18, 1957

Card 3/4

SOV/62-59-9-5/40

5(4)
AUTHORS: Vol'kenshteyn, F. F., Kogan, Sh. M.

TITLE: Influence of the Illumination on the Adsorptive Capacity and
               Catalytic Activity of Semiconductors

PERIODICAL: Izvestiya Akademii nauk SSSR. Otdeleniye khimicheskikh nauk,
               1959, Nr 9, pp 1536-1545 (USSR)

ABSTRACT: The adsorptive capacity of a semiconductor is expressed by the
               number N of the molecules adsorbed with the gas on the surface
               under conditions of equilibrium. This number varies at irradia-
               tion with rays which may be absorbed by the absorbent. The fol-
               lowing studies in this field are quoted: Terenin (Refs 2,6),
               Myasnikov (Ref 5), Pshezhetskiy (Ref 5), Solonitsyn (Refs 6,7),
               Kiselev, Krasil'nikov, Sysoyev (Ref 8). A variation of N can be
               determined by changing the pressure in the adsorption space
               when turning irradiation on and off. In this case photo-ad-
               sorption and photo-desorption may occur, irradiation, however,
               can also remain inactive. The conditions for the possible three
               reactions are mathematically developed by means of the electron
               theory of semiconductors. Adsorption and desorption may occur if
               light causes a chemical change of the adsorbent, an apparent

Card 1/3

Inst. Phys. Chem AS   USSR

SOV/62-59-9-5/40

Influence of the Illumination on the Adsorptive Capacity and Catalytic
Activity of Semiconductors

chemical change, if light causes a change in the adsorbed
molecule. The electron-theoretical investigation is carried out
on the example of an acceptor gas and free lattice electrons. It
was further assumed that adsorption is represented by solidly
bound particles and desorption only by weakly bound particles.
The adsorptive capacity "N" may be expressed by the probability
"η" with which a particle is in a solidly bound state on the
surface of the molecule. Irradiation causes a change in η.
Photoadsorption occurs with an increase of η, desorption with a
decrease of η (Fig 2). Value γ is introduced, which represents
the change of η, in the case of $\gamma > 1$ an adsorption, in case of
$\gamma < 1$ a desorption occurs; when $\gamma = 1$, however, the surface re-
mains inactive. Finally, γ is calculated as a function of the
change of the free electrons and holes of the semiconductor
surface lattice. This function is dependent on frequency and in-
tensity of the irradiated light. V. Ye. Lashkarev (Ref 13),
V. P. Zhuze, and S. M. Ryvkin (Ref 14) are mentioned. There are
3 figures and 21 references, 15 of which are Soviet.

Card 2/3

VOLKENSHTEYN, F. F.

"General Ideas on the Electronic Theory of Catalysis of Semiconductors."

report submitted for the Second International Congress on Catalysis, Paris,
4-9 July 1960.

PHASE I BOOK EXPLOITATION   SOV/5095

Vol'kenshteyn, Fedor Fedorovich

Elektronnaya teoriya kataliza na poluprovodnikakh (Electronic Theory of
    Semiconductor Catalysis) Moscow, Fizmatgiz, 1960. 187 p. 10,000 copies
    printed. (Series: Fizika poluprovodnikov i poluprovodnikovykh priborov)

Ed.: Ye. B. Kuznetsova; Tech. Ed.: A. P. Kolesnikova.

PURPOSE: This book is intended for physicists and chemists working in the
    field of catalysis, and for physicists concerned with semiconductors and
    the mechanism of their catalytic effect.

COVERAGE: The book is based on lectures delivered by the author at the Division
    of Chemistry, Moscow University, at the Jagielloński University (Poland)
    and at the University of Paris. It presents in concise form the present
    state of the electronic theory of semiconductor catalysis, emphasizing the
    physical rather than the mathematical fundamentals. The author thanks
    V. L. Bonch-Bruyevich and O. A. Golovina, who reviewed the book. There

Card 1/5

VOL'KENSHTEYN F. F.

PHASE I BOOK EXPLOITATION   SOV/3921

Akademiya nauk SSSR. Institut fizicheskoy khimii

Problemy kinetiki i kataliza. [t] 10: Fizika i fiziko-khimiya kataliza
    (Problems of Kinetics and Catalysis. [vol.] 10: Physics and Physico-
    Chemistry of Catalysis) Moscow, Izd-vo AN SSSR, 1960. 461 p. Errata
    slip inserted. 2,600 copies printed.

Eds.: S.Z. Roginskiy, Corresponding Member of the Academy of Sciences USSR,
    and O.V. Krylov, Candidate of Chemistry; Ed. of Publishing House: A.L.
    Bankvitser; Tech. Ed.: G.A. Astaf'yeva.

PURPOSE: This collection of articles is addressed to physicists and chemists
    and to the community of scientists in general interested in recent
    research on the physics and physical chemistry of catalysis.

COVERAGE: The articles in this collection were read at the conference on the
    Physics and Physical Chemistry of Catalysis organized by the Otdel khimicheskikh
    nauk AN SSSR (Section of Chemical Sciences, Academy of Sciences USSR) and by
Card 1/17

Problems of Kinetics and Catalysis (Cont.)   SOV/3921

the Academic Council on the problem of "the scientific bases for the selection
of catalysts." The Conference was held at the Institut fizicheskoy khimii AN
SSSR (Institute of Physical Chemistry of the AS USSR) in Moscow, March 20-23, 1958.
Of the great volume of material presented at the conference, only papers not
published elsewhere were included in this collection. The conference decided
not to publish the discussion material. Papers by the following authors were
excluded and replaced by a brief author's abstract: F.F. Vol'kenshteyn, "Sur-
face Charge of a Semiconductor During Adsorption", M.M. Kogan and V.B.
Sandomirskiy, two papers; Sh.M. Kogan, "Statistics of Adsorbed Particles in
the Electron Theory of Chemisorption"; F.F. Vol'kenshteyn and Sh. M. Kogan;
F.F. Vol'kenshteyn and V.B. Sandomirskiy; G.A. Korsunovskiy; A.M. Rubinshteyn,
V.M. Akimov and A.A. Slinkin; L.Kh. Freydlin; V.N. Filimonov and D.S. Bystrov.
The following two papers do not appear in any form in this collection because
the authors did not forward the abstracts requested: M.I. Temkin, E.I. Tsybina
and A.I. Gel'bshteyn," Kinetics of Catalysis of the Vapor Phase Hydration of
Acetylene by Electron Vapor Acceptors"; A.A. Babushkin, "Spectroscopic Investi-
gation of the Structure of the Molecular Compounds of Boron Trifluoride With
Nitrogen and Oxygen-Containing Molecules".Addresses to the conference by E. Kh.
Yenikeyev and Ya.B. Gorokhovatskiy, are included in the form of brief communi-
cations. They cover the results of recent experimental research which could
not be considered discussion material. A number of papers and communications,

Card 2/17

Problems of Kinetics and Catalysis (Cont.)   SOV/3921

for the most part dealing with problems in the preparation of catalysts, were
turned over for publication to the "Zhurnal fizicheskoy khimii". The papers
of several foreign researchers who participated in the conference and those of
researchers who could not participate in the conference are included in the collec-
tion: A.Bielański, G.Dereń and G. Gaber, W.K.Trzebiatowski , A.Krause (all
of Poland), Wu Yüeh and Hsi Hsiao- fang (China). The editors thank Academi-
cian A.A. Balandin and G.K. Boreskov and V.V. Voyevodskiy, Corresponding Members
of the AS USSR, for valuable suggestions during the compilation of the Collec-
tion. There is a bibliography of Soviet and non-Soviet sources at the end of
each article.

TABLE OF CONTENTS:

From the Editors

Problems of Kinetics and Catalysis (Cont.)   SOV/3921

Vol'kenshteyn, F.F., and Sh. and Sh. M. Kogan [Institute of Physical Chemistry
AS USSR, Department of Physics of Moscow State University] Effect of Illumina-
tion on the Adsorptive Capacity and the Catalytic Activity of a Semiconductor   60

Vol'kenshteyn, F.F., and V.B. Sandomirskiy [Institute of Physical Chemistry
AS USSR]. Effect of an External Electric Field on the Adsorptive Capacity
of a Semiconductor   61

Kogan, Sh. M., and V.B. Sandomirskiy [Institute of Physical Chemistry AS
USSR, Department of Physics of Moscow State University]. Measurement of
Contact Potential of a Semiconductor as a Method of Detecting the Various
Charge States of Particles Adsorbed on it   62

Popovskiy, V.V., and G.K. Boreskov [Moskovskiy khimiko-tekhnologicheskiy
institut imeni D.I. Mendeleyeva(Moscow Chemical Technology Institute imeni
D.I. Mendeleyev]. Catalytic Activity of the Metal Oxides of the 4th Period
in Relation to the Oxidation Reaction of Hydrogen   67

Keyyer, N.P. [Institute of Physical Chemistry AS USSR]. Nature of the
Heterogeneity of the Active Surface of Semiconductor Contacts   73
Card 5/17

S/195/60/001/001/001/007
B015/B060

AUTHOR: Vol'kenshteyn, F. F.

TITLE: Basic Concepts of the Electron Theory of Catalysis on
               Semiconductors

PERIODICAL: Kinetika i kataliz, 1960, Vol. 1, No. 1, pp. 32-44

TEXT: The present article is the reproduction of a lecture read at the .
Second International Congress for Catalysis and is a synopsis of the
present state of the electron theory of catalysis on semiconductors,
with special regard to the research work done by the author and his
collaborators. The main results of the theory and certain conclusions are
given, but the mathematical part of the theory is not discussed. A more
detailed survey has been supplied by the author in Vol. 12 of "Advances
in Catalysis". In the present article, the results are discussed in the
following sections: the electrically neutral and the charged forms of
chemosorption; valency-saturated and radical forms of chemosorption;
transitions among the various forms of chemosorption; equilibrium between
the various forms of chemosorption. The adsorption properties of the

Card 1/3

Inst. Phys, Chem AS USSR
Moscow State Univ.

Basic Concepts of the Electron Theory of   S/195/60/001/001/001/007
Catalysis on Semiconductors   BC15/B060

surface; the catalytic activity of the surface; the part played by the
Fermi level. Since the position of the Fermi level, which appears in all
equations of the electron theory, is of special importance, several
conclusions are made in this respect. Following the results of the
electron theory, the conclusions drawn therefrom are discussed in the
following sections: effect of chemosorption on the electrical conductivity
and work function; relationship between surface and volume; correlation
between catalytic activity and electrical conductivity; effect of ad-
mixtures on the catalytic activity; effect of illumination on adsorbability.
The author points out that the electron theory of catalysis can by no
means be regarded as final. It does not compete with the other theories
of catalysis from which it differs by its problems, since it studies the
elementary (microscopic) mechanism of phenomena and proceeds from this
point. S. Z. Roginskiy, A. N. Terenin, V. I. Lyashenko, I.A. Myasnikov,
and N. P. Keyer are mentioned in the text. There are 7 figures and 17
references: 15 Soviet, 2 US, 2 French and 1 German.

Card 2/3

89349

P/C16/6C/014/011/001/001
B103/B207

5.1190
5 4300

AUTHOR: Vol'kenshteyn, F. F., Doctor, Professor

TITLE: The principles of the electron theory of semiconductor catalysis

PERIODICAL: Wiadomości chemiczne, v. 14, no. 11 (161), 1960, 675-691

TEXT: The author gives a short survey of the present state of the electron theory of semiconductor catalysis. He refers to his more comprehensive study in "Advances in Catalysis", Vol. 12. The present paper was translated into Polish by: Jerzy Dereń, Doctor, Docent, and Jerzy Haber, Doctor, Docent, both Katedra Chemii Nieorganicznej Akademii Górniczo-Hutniczej w Krakowie (Department of Inorganic Chemistry of the Academy of Mining- and Metallurgy, Kraków). A paper by W. Romanowski, Doctor, appeared in this periodical, 1956, Vol. 10, p. 439 is recommended as introduction for the present paper. The author lays special emphasis upon the problems which he himself and his collaborators have studied. He lists two tasks of the afore-mentioned theory: 1. The discovery of the mechanism of electron processes to which, in the long run, every chemical reaction (also a

Card 1/6

89349

P/016/60/014/011/001/001
B103/B207

The principles of the electron...

catalytically heterogeneous one) is due. As long as the mechanism of
individual elementary acts of catalysis is not clarified, the science of
the mentioned processes will remain empirical. 2. The catalytic properties
of semiconductors are closely linked with the electron processes both in
the interior and on the surface of semiconductors. Since there must be an
interrelation between the electron properties of a semiconductor and its
catalytic properties, electron theory tries to discover the relations
between these two groups of properties. The author mentions the inventor
of the mentioned theory, L. W. Pisarzhevskiy (1916) and the following
Soviet researchers: S. Z. Roginskiy, A. N. Terenin, W. I. Lyashenko, and
I. A. Myasnikov as well as non-Soviet researchers. Modern electron theory
is based (in the author's view and that of his collaborators) on the
quantum-mechanical solution of the problem concerning the interaction
between a foreign particle and the crystal lattice of a solid. This
problem is solved by way of simple examples and, subsequently, generalized
by way of more complicated cases. The author neglects the entire mathe-
matical part and the discussion of the experimental data. The text is
subdivided as follows: "The Fundamental Results of the Theory", again
subdivided into: Various forms of chemosorption, chemosorption of

Card 2/6

89349

P/016/63/014/011/001/001
B103/B207

The principles of the electron...

particles with saturated valencies as well as of radicals, passing over
from one form of chemosorption to another, equilibrium between these forms,
adsorptive power of the surface, the capability of the surface of catalysis,
the role of the Fermi level. The next chapter: "Some Important conclu-
sions" contains the following sections: Effect of chemosorption upon the
electrical conductivity and upon the work function, interaction between
the surface and the interior of a crystal. Relation between the catalytic
activity and the electrical conductivity, effect of admixtures upon the
catalytic activity, effect of light upon the adsorptive power. Finally
the author describes the present state of this theory as follows: The
electron theory proves that both free electrons and semiconductor holes
take part in the formation of chemosorptive bonds: the electrons and holes
play the part of free valencies, in which case the strength of bonds and
the reactivity of the chemosorbed particles depends on the degree of parti-
cipation of electrons and holes. Therefore, the Fermi level occurs in all
formulas of the electron theory. The catalytic and absorption properties
of the semiconductor surface are, by the Fermi level, closely linked with
the state of the crystal as a whole. As this paper shows, the electron
theory may be interpreted in three ways: a. By illustrative models; b. By

Card 3/6

89349

P/016/60/014/011/001/001
B103/B207

The principles of the electron...

using the valencies lines, e.g., when describing the chemical part of the
phenomena (Figs. 2 and 3); c. On the basis of the energy zone scheme with
the aid of which the electron mechanism of the phenomena is studied
(example: Figs. 4a and 7). The author emphasizes that each problem may
be illustrated by one of the mentioned models. In his opinion, the theory
cannot be regarded as complete. He states furthermore that this theory
does not compete with any theory of catalysis. It differs by the manner in
which the problem is posed. The electron theory seeks to approach the
problem by detecting the elementary mechanism of the phenomenon. The
relation between the existing phenomenological theories on the one hand,
and the electron theory on the other, is the same as, e.g., that of the
theory of the chemical bond of the nineteenth century, which exclusively
used valency lines and the modern quantum-mechanical theory of the bond.
It was the modern theory which gave the valency lines their physical sense,
thus discovering the physical nature of the chemical forces. There are
7 figures and 19 references: 17 Soviet-bloc and 2 non-Soviet-bloc.

Card 4/6

89349

P/016/60/014/011/001/001
B103/B207

The principles of the electron...

ASSOCIATION: Institut fizicheskoy khimii Akademii nauk SSSR (Institute of Physical Chemistry of the Academy of Sciences USSR).Moskovskiy gosudarstvennyy universitet im. M. V. Lomonosova (Moscow State University imeni M. V. Lomonosov)
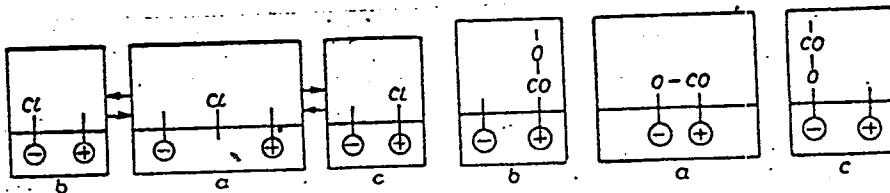
SUBMITTED: June 6, 1960

Fig. 2

Fig. 3

Card 5/6

The principles of the electron...

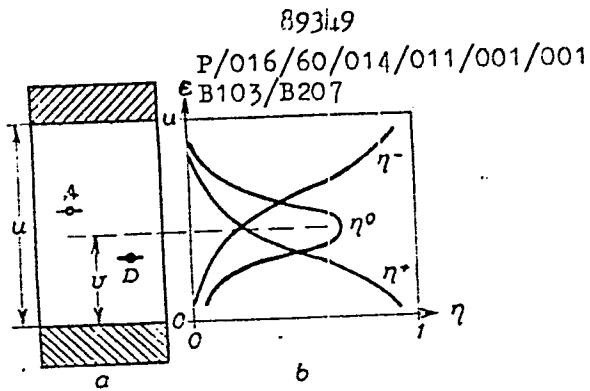Legend to Fig. 4a: A - donor level
D - acceptor level.

89349
P/016/60/014/011/001/001
B103/B207

Fig. ·4

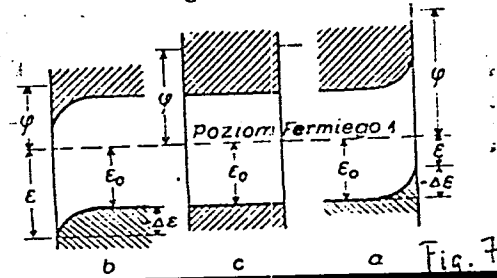Legend to Fig. 7: 1) Fermi level.

Poziom Fermiego 1

Fig. 7

Card 6/6

34250

S/076/60/034/009/012/022
B015/B056

24.7700   1153
5 4400   1355

AUTHORS: Vol'kenshteyn, F. F. and Kogan, Sh. M.

TITLE: The Concept of the "Quasi-insulated" Surface in the Theory
            of Chemisorption

PERIODICAL: Zhurnal fizicheskoy khimii, 1960, Vol. 34, No. 9,
            pp. 1996-2004

TEXT: This is a discussion on semiconductors in which the surface states
have a denser structure than the interior of the body, which is the case
if the semiconductor has a real and not an idealized surface. Besides, the
concentration of the electrons and holes which are localized on the sur-
face, may be very high. It is shown in this case the position of the
Fermi level F_S on the crystal surface is independent of the position of
the Fermi level F_V in the interior of the crystal, which means that also
the chemisorption- and catalytical properties of the semiconductor surface
are independent of the electronic properties in the interior of the
crystal. Surfaces of this kind are described by the authors as

Card 1/2

84250

The Concept of the "Quasi-insulated" Surface   S/076/60/034/009/012/022
in the Theory of Chemisorption   B015/B056

"quasi-insulated", and occur whenever the absolute value of the difference
between the positive and negative charges localized on the surface is
small in comparison to their sum. In the case of "quasi-insulated" sur-
faces, the influence of the crystal impurities upon the chemisorption
and catalytic properties vanishes, and only the structure of the surface
is significant. Several specific properties of the "quasi-insulated" sur-
face are explained, and three types of surface states are mentioned,
which lead to a "quasi-insulated" surface. There are 1 figure and 10
references: 9 Soviet and 1 US.

ASSOCIATION: Akademiya nauk SSSR Institut fizicheskoy khimii (Institute
               of Physical Chemistry of the Academy of Sciences USSR).
               Moskovskiy gosudarstvennyy universitet im. M. V. Lomonosova
               (Moscow State University imeni M. V. Lomonosov)

SUBMITTED: December 22, 1958

Card 2/2

5.4600
24.7400

31087
S/195/61/002/004/001/008
E036/E455

AUTHOR: Vol'kenshteyn, F.F.

TITLE: Influence of ionizing radiation on the adsorption and
           catalytic properties of semiconductors

PERIODICAL: Kinetika i kataliz, v.2, no.4, 1961, 481-489

TEXT: In this article the effect of ionizing radiation on the
adsorption and catalytic properties of semiconductors is examined
in the light of the electron theory of chemisorption and catalysis.
The mechanism by which the radiation influences the adsorption
equilibrium, the kinetics of adsorption and the rate of catalytic
reaction is analysed and is derived directly from the general
concept of electron theory.   The dependence of the radiation
effect on temperature and pressure and on the history of the
sample is considered.   The effect of radiation on catalytic
processes and adsorption has been well established by experimental
work over the last few years but the mechanism remains unknown.
The present article is limited to establishing some general laws
derived from electron theory.   The following three effects are
obtained during irradiation: (a) direct ionization; (b) change of

Card 1/8 7

Influence of ionizing ...

S/195/61/002/004/001/008
E036/E455

31087

degree of disorder in the lattice and (c) nuclear reactions.
All these give rise to a change in the concentration of free
carriers.   In the first of the three cases, this change is due to
non-equilibrium carriers and, in the other two cases, to
displacement of the electron equilibrium.   The first effect
disappears when irradiation ceases;   the second may be considered as
due to sample heating.   The third effect is irreversible and arises
from the introduction of chemically foreign impurities.   According
to the electron theory of catalysis and adsorption, the free
carriers participate directly in chemical processes at the surface.
The carriers behave as free valence electrons and thus the
concentration change gives rise to a change in adsorption and
catalytic properties.   Electrically, the surface particle may be
neutral or negatively or positively charged, exhibiting
correspondingly different bond characteristics, bond strengths and
reaction ability.   The various reaction abilities depend upon
whether the state is valence-satisfied or involves radicals or
ionic radicals.   The expressions for the relative concentrations
of these states in the unirradiated condition are written down for
equilibrium.   The negative- and the positively-charged particles
Card 2/8 ')

31087
S/195/61/002/004/001/008
Influence of ionizing ...   E036/E455

are considered as localized acceptor and donor levels respectively.
The expressions have been given by the author in Ref.1 (The
electron theory of catalysis in semiconductors, Fizmatgiz, M.,
1960) in terms of the difference between the levels and the
conduction or valence bands and the Fermi level at the surface.
Some simple expressions are then written down in terms of the
carrier concentrations in the presence and absence of irradiation.
In these expressions, the relative numbers of particles in the
three states of the radiated sample are related to those in the
unirradiated sample.   If the condition before equilibrium is
considered, quasi-Fermi levels must be introduced.   These
derivations have either been obtained by the author in previous
work (Ref.1: as quoted in text and Ref.3: Izv. AN SSSR Otd. khim,
n., 1959, 1536) or may be derived by analogy.   It is shown that
irradiation gives effects equivalent to displacement of the
localized acceptor and donor levels in the energy scheme.   The
amount of the displacement depends on the position of the level in
the energy scheme and on the conditions of irradiation.   The
change in the adsorbing properties of the surface during
irradiation is indicated by a change in the pressure ΔP in the

Card 3/8?

31087
S/195/61/002/004/001/008
E036/E455

Influence of ionizing ...

volume of the phase being adsorbed when the radiation is applied. $\triangle$P is related simply to the change in the total number of particles in the equilibrium conditions of the sample with and without irradiation. It is shown that the sign and relative magnitude of $\triangle$P depend on the position of the Fermi level in the original, unirradiated sample. The point at which the change of sign occurs - the change from desorption to adsorption or the reverse - is dependent on the conditions of irradiation. This simple treatment can be used to interpret the results given by Y.Fujita, T.Kwan (Ref.4: Bull. Chem. Soc. Japan, 31, 379, 1958) and by A.N.Terepin, Yu.P.Solonitsyn (Ref.5: Disc. Faraday Soc., v.28, 28, 1959). In general, the change of adsorbing properties due to irradiation depends on the nature of the radiation, on the pressure of the gaseous phase, on temperature and on the previous history of the sample. All these factors are evident from the analysis. For simplicity, only a small degree of filling of the levels is assumed, an assumption made in the analysis of the kinetics of adsorption. Here expressions are derived for the pressure in the volume of particles being adsorbed: the pressure is given as a function of time and in terms of the number of Card 4/8 ')

31087
S/195/61/002/004/001/008
E036/E455

Influence of ionizing ...

particles adsorbed.   The relative number of neutral particles
is the ratio of neutral particles to the total number of particles.
The ratio is assumed to be independent of the pressure which
implies that the change in surface charge due to adsorption may be
neglected and is due only to non-adsorption processes.   A similar
exponential expression is quoted for the irradiated case.   The
subsequent analysis is restricted to the case of acceptor
particles.   It is shown that the sensitivity of the kinetics -
the variation of pressure with time - can be varied by the impurity
content of the sample, which determines the position of the Fermi
level.   In addition to this simple case, where adsorption
commences at a time $t = 0$, the article considers adsorption on a
sample which first remains unirradiated up to time t_1, after
which the radiation is applied until $t = t_2$ and then ceases.
In Fig.4 the curves of pressure of the phase being adsorbed are
plotted as functions of time in some typical experiments of this
type.   Similar curves are observed experimentally.   The dotted
lines correspond to behaviour in the absence of irradiation.
Note that the subscript "o" denotes absence of irradiation.   The
light lines denote continuous irradiation from $t = 0$ to $t = \infty$.
Card 5/8

31087
S/195/61/002/004/001/008
Influence of ionizing ...   E036/E455

The various cases correspond to differing initial conditions of the
sample, the position of the Fermi level and to the differing nature
of the irradiation.   It is seen that both desorption (Fig.4a) and
slowing down of adsorption (Fig.4 б) are possible on commencing
irradiation and that the effects may be reversible (Fig.4 в)   or
irreversible (Fig.4 г).   The time at which the radiation is
applied is also important.   For catalytic effects the case of the
oxidation of CO is considered.   Again the analysis of Ref.1 is
quoted for donor- and acceptor-type actions, giving expressions for
reaction rates in terms of the Fermi level position and the levels
corresponding to the molecule CO_2 and the atom O .   The irradiation
conditions and the position of the Fermi level in the irradiated
specimen can enhance or reduce the reaction rate, but the ratio of
the partial pressures of O_2 and   CO   enter as a further variable.
Again the experimental results can be discussed qualitatively in
terms of this model.   Impurities in the semiconductor affect
catalysis: this action can also be described by the same model.
All the phenomena discussed depend on a parameter which is a function
of the acceptor energy level, the initial Fermi level and the quasi-
Card 6/8

31087

Influence of ionizing ...

S/195/61/002/004/001/008
E036/E455

Fermi levels for holes and electrons arising during irradiation.
A similar parameter is required for donor-like particles. At no
stage in the paper is a quantitative evaluation attempted. Among
the effects ignored is the possibility of impurities diffusing from
the semiconductor bulk towards the surface and reacting with the
adsorbed ions. There are 5 figures and 10 references: 5 Soviet-
bloc and 5 non-Soviet-bloc. The four most recent references to
English language publications read as follows:
Ref.4: as quoted in the text;
Ref.6: T.I.Barry, Report on the Second International Congress on
Catalysis, Paris, 1960;
Ref.7: F.Romero-Rossi, F.S.Stone, Report on the Second
International Congress on Catalysis, Paris, 1960;
Ref.10: T.I.Barry, F.S.Stone, Proc. Roy. Soc., A255, 124, 1960.

ASSOCIATION: Institut fizicheskoy khimii AN SSSR
             (Institute of Physical Chemistry AS USSR)

SUBMITTED: March 3, 1961

Card 7/8

VOL'KENSHTEYN, F.F., doktor fiziko-matematicheskikh nauk, prof.

Semiconductors as catalysts. Nauka i zhizn' 28 no.8:11-15
Ag '61.   (MIRA 14:8)
                    (Semiconductors) (Catalysts)

BALANDIN, A.A., akademik, red.; KOBOZEV, N.I., prof., red.; LEBEDEV,
   V.P., dots., zam. red.; MAL'TSEV, A.N., zam. red.; AGRONOMOV,
   A.Ye., dots., zam. red.; TOPCHIYEVA, K.V., prof., red.; YUR'YEV,
   Yu.K., prof., red. PANCHENKOV, G.M., prof., red.; SOKOL'SKIY,
   D.V., akademik, red.; VOL'KENSHTEYN, F.F., prof., red.;LAZAREVA,
   L.V., tekhn. red.

[Catalysis in the institutions of higher learning; papers of the
First Interuniversity Conference on Catalysis]Kataliz v vysshei
shkole; trudy. Moskva, Izd-vo Mosk. univ. No.1. Pt.2. 1962.
325 p.   (MIRA 15:10)

1. Mezhvuzovskoye soveshchaniye po katalizu. 1st, 1958. 2. Aka-
demiya nauk Kazakhskoy SSR (for Sokol'skiy). 3. Khimicheskiy fa-
kul'tet Moskovskogo gosudarstvennogo universiteta (for Yur'yev).
                    (Catalysis)

L 17927-63   EWT(1)/EWG(k)/BDS   AFFTC/ASD/ESD-3/IJP(C)   Pz-4   AT
ACCESSION NR: AT3002446   S/2935/62/000/000/0114/0127   65
                                                                                63

AUTHOR: Vol'kenshteyn, F. F.; Karpenko, I. V.

TITLE: Theory of photoadsorption effect on semiconductors [Report at the Conference
on Surface Properties of Semiconductors, Institute of Electrochemistry, AN SSSR,
Moscow, 5-6 June 1961]

SOURCE: Poverkhnostny*ye svoystva poluprovodnikov. Moscow, Izd-vo AN SSSR, 1962,
114-127

TOPIC TAGS: semiconductor, semiconductor theory, photoadsorption effect

ABSTRACT: A further development is offered of the theory of photoadsorption
effect (variation of adsorbability with illumination). Specifically, a criterion
is established which determines the sign (plus-minus) of photoadsorption effect
under various conditions: adsorbent and adsorbate nature, pressure, temperature,
specimen prehistory, etc. The sign depends on the position of the Fermi level and
on the degree of band bending. The theory is checked against the published
experimental data obtained by F. Romero-Rossi, F. S. Stone, T. I. Barry, Y. Fujita,
T. Kwan, A. N. Terenin, Y. P. Solonitzin, and others. Orig. art. has: 2 figures
and 22 formulas.

        ASSN: INSTITUTE OF PHYSICAL CHEMISTRY, AN SSSR; MOSCOW STATE UNIVERSITY.
Card 1/2

L 18992-63   EPF(c)/EWT(1)/EWP(q)/EWT(m)/BDS   AFFTC/ASD/ESD-3/
IJP(C)   Pr-4   GG/RM/WW/JD/MAY/JFW/JG

ACCESSION NR: AT3002452   S/2935/62/000/000/0179/0192

AUTHOR: Vol'kenshteyn, F. F.; Gorban', A. N.; Sokolov, V. A.

TITLE: Processes of recombination of free radicals on a semiconductor surface
and their role in luminescence [Conference on Surface Properties of Semiconductors,
Institute of Electrochemistry, AN SSSR, Moscow, 5-6 June, 1961]

SOURCE: Poverkhnostnyye svoystva poluprovodnikov. Moscow, Izd-vo AN SSSR,
1962, 179-192

TOPIC TAGS: semiconductor, semiconductor-surface characteristics,
luminescence, surface recombination

ABSTRACT: On the basis of the electronic theory of chemosorption and catalysis,
the radical-recombination mechanism of luminescence is examined, as well as
some consequences ensuing from that mechanism. A theoretical and experimen-
tal investigation is reported of the effect of an external transverse electric field
upon the intensity of candoluminescence. Luminescence is considered as
Card 1/2

L 18992-63

ACCESSION NR: AT3002452

consisting of two steps: ionization and neutralization of an activator atom; the accompanying phenomena are explained and pictorially represented. A new formula describing the intensity of luminescence is developed, and the effect of the Fermi level on the intensity is investigated. The effect of the electric field on candoluminescence was studied in a special device on a $ZnS \cdot CdS$ copper-activated phosphor placed in a low-temperature lighting-gas flame. Potentials -2kv and +2kv were applied to the electrodes producing the electric field in the phosphor zone, and the variation in the luminescence intensity was measured. The experiments are interpreted as corroborating the probability of the radical-recombination mechanism. Orig. art. has: 7 figures and 26 formulas.

ASSOCIATION: Institut khimicheskoy fiziki AN SSSR (Institute of Chemical Physics, AN SSSR); Institut fizicheskoy khimii AN SSSR (Institute of Physical Chemistry, AN SSSR)

SUBMITTED: 00   DATE ACQ: 15May63   ENCL: 00

SUB CODE: PH   NO REF SOV: 009   OTHER: 002

Card 2/2

L 18993-63   EWP(q)/EWT(m)/BDS   AFFTC/ASD   JD/AB

ACCESSION NR: AT3002453   S/2935/62/000/000/0192/0206

AUTHOR: Vol'kenshteyn F. F.; Kuznetsov, V, S.; Sandomirskiy, V. B.

TITLE: Chemosorptional and catalytic properties of semiconductor film on
metal [Conference on Surface Properties of Semiconductors, Institute of Electro-
chemistry, AN SSSR, Moscow, 5-6 June, 1961]

SOURCE: Poverkhnostny*ye svoystva poluprovodnikov. Moscow, Izd-vo AN SSSR,
1962, 192-206

TOPIC TAGS: chemosorption, semiconductor, catalysis, semiconductor-coated
metal

ABSTRACT: Since many metals are always coated with a binary-compound film,
chemosorption and catalytic processes actually transpire on the surface of a
semiconductor. A theoretical investigation is offered of these processes. A
rather thick semiconductor film that does not contain surface states and a posi-
tive contact potential difference are assumed; four energy schemes are

Card 1/2

L/ 18993-63

ACCESSION NR: AT3002453

3

considered. Qualitative properties of the film adsorbability and its catalytic activity are described by a set of differential equations. The effect of the film thickness on the work function is explored. It is found that: (1) With a specified nature and thickness of the film, its adsorbability with respect to a donor (acceptor) gas will be higher (lower) with a higher work function of the underlying metal, irrespective of the sign of the surface charge on the film; and (2) A similar relation exists between the catalytic film activity and the donor (acceptor) reaction. Orig. art. has: 3 figures and 36 formulas.

ASSOCIATION: Institut fizicheskoy khimii AN SSSR (Institute of Physical Chemistry, AN SSSR); Institut radioelektroniki AN SSSR (Institute of Radio and Electronics, AN SSSR); Institut kataliza AN SSSR (Institute of Catalysis, AN SSSR)

SUBMITTED: 00   DATE ACQ: 15May63   ENCL: 00

SUB CODE: PH   NO REF SOV: 002   OTHER: 001

Card 2/2

35063
S/195/62/003/001/004/010
E039/E136

24.7400 (1055, 1160, 1454)

AUTHORS: Vol'kenshteyn, F.F., and Karpenko, I.V.

TITLE: On the theory of the photoadsorption effect in
            semiconductors

PERIODICAL: Kinetika i kataliz, v.3, no.1, 1962, 72-80

TEXT: The exposure of semiconductors to light sometimes
stimulates a change in the adsorptive capacity of the surface;
in some cases there is an increase in adsorption and in others
a decrease. The existing experimental data appear to be
inconsistent, but in this paper a theory is advanced, based on
the electronic theory of chemisorption, which explains these
positive and negative adsorption effects. The concentrations
corresponding to free electrons and holes in the surface of a
semiconductor are represented by n_{os} and p_{os} in the absence
of light and the corresponding changes in concentration
stimulated by exposure to light are Δn_s and Δp_s. The authors use
the expression:

Card 1/7

On the theory of the photoadsorption... $\frac{S/195/62/003/001/004/010}{E039/E136}$.

$$\gamma = \frac{\Delta n_s}{n_{os}} \cdot \frac{p_{os}}{\Delta p_s} \cdot \exp\left[(\varepsilon - V_{os} + v)/kT\right] - 1 \qquad (1)$$

where the meanings of the values ε, V_{os} and v are evident from Fig.1, which represents an energy diagram for a semiconductor with a negatively charged surface.   The line FF is the Fermi level in the non-illuminated condition.   A is the local surface level (acceptor and donor) representing adsorption of particles. The sign of the photoadsorption effect depends on the sign of γ, and the problem reduces to a calculation of the quantities Δn_s and Δp_s.   The final expressions obtained are:

$$\Delta n_s = (I_o + j_s) \sqrt{\frac{\tau_i}{D_i}} \exp\left(- V_{os}/kT\right)$$

$$\Delta p_s = (I_o + j_s) \sqrt{\frac{\tau_i}{D_i}} \exp\left(+ V_{os}/kT\right)$$

(18)

Card 2/5

On the theory of the photoadsorption... S/195/62/003/001/004/010
E039/E136

where I_0 is the intensity of the light.   It is shown that the sign of γ is determined by the sign of φ where

$$\varphi = \varepsilon + V_{os} - v \qquad (19)$$

Hence we have:

(a) For acceptor particles:
Positive effect (photoadsorption) if $\varphi < 0$,
Negative effect (photodesorption) if $\varphi > 0$.

(b) For donor particles: (20)
Positive effect (photoadsorption) if $\varphi > 0$,
Negative effect (photodesorption) if $\varphi < 0$.

The results are discussed in detail and the theory compared with experimental data; in particular for the case of adsorption of oxygen on zinc oxide. The sign of the effect depends on the pressure, temperature and also the presence of excess zinc in the ZnO samples.   There are 3 figures.

Card 3/5

On the theory of the photoadsorption... S/195/62/003/001/004/010
E039/E136

ASSOCIATION: Institut fizicheskoy khimii AN SSSR
(Institute of Physical Chemistry, AS USSR)

Moskovskiy gosudarstvennyy universitet im.
M.V. Lomonosova
(Moscow State University imeni M.V. Lomonosov)

SUBMITTED: September 28, 1961

Card 4/5

5.4200

42169
S/195/62/003/005/003/007
E039/E135

AUTHORS: Vol'kenshteyn, F.F., Kuznetsov, V.S., and
              Sandomirskiy, V.B.

TITLE: The chemisorption and catalytic properties of
              semiconducting films on metals ·

PERIODICAL: Kinetika i kataliz, v.3, no.5, 1962, 712-723

TEXT: The case of a metal covered with a plane parallel film
of uniform semiconductor (e.g. its oxide) containing donor and
acceptor centres uniformly distributed throughout its volume is
treated theoretically. Energy diagrams are given for coatings
with a thickness L greater than the screening length ℓ and for
the case when $L \leqslant \ell$ with a net positive or negative surface
charge. Owing to mathematical difficulties only the sign of the
following derivatives is determined for the various conditions:

$$\left. \begin{array}{l} (d\epsilon/dL)_{P, T, \chi} \\ (d\epsilon/d\chi)_{P, T, L} \end{array} \right\} ; \qquad\qquad (7)$$

Card 1/3

The chemisorption and catalytic ... $S/195/62/003/005/003/007$
$E039/E135$

$$(d\theta/dL)_{p, T, \chi} = (d\theta/d\varepsilon)_{p, T} \cdot (d\varepsilon/dL)_{p, T, \chi} \Big\}$$
$$(d\theta/d\chi)_{p, T, L} = (d\theta/d\varepsilon)_{p, T} \cdot (d\varepsilon/d\chi)_{p, T, L} \Big\} \quad ; \quad (8)$$

$$(dg/dL)_{p, T, \chi} = (dg/d\varepsilon)_{p, T} \cdot (d\varepsilon/dL)_{p, T, \chi} \Big\}$$
$$(dg/d\chi)_{p, T, L} = (dg/d\varepsilon)_{p, T} \cdot (d\varepsilon/d\chi)_{p, T, L} \Big\} \quad . \quad (9)$$

Here: ε is the work function of the film, characterised by the position of the Fermi level at the external surface of the film; χ is the work function of the metal; θ is the adsorptive capacity of the film; g is the rate of reaction. It is shown that the adsorptive capacity and catalytic activity and selectivity depend on the thickness of the film. Experimental verification of this work is required. It should be noted that for L to be less than ℓ requires coating thicknesses of less than 10^{-4}-10^{-5} cm and for the coating to be considered as an independent phase L must be greater than 10^{-6} cm.
There are 3 figures.
Card 2/3

The chemisorption and catalytic ...   S/195/62/003/005/003/007
                                        E039/E135

ASSOCIATION: Institut fizicheskoy khimii AN SSSR
              (Institute of Physical Chemistry, AS USSR)

              Institut kataliza SO AN SSSR
              (Institute of Catalysis, SO AS USSR)

              Institut radiotekhniki i elektroniki AN SSSR
              (Institute of Radioengineering and Electronics,
              AS USSR)

SUBMITTED: February 16, 1962

Card 3/3

S/195/63/004/001/001/009
E075/E436

AUTHORS: Vol'kenshteyn, F.F., Gorban', A.N., Sokolov, V.A.

TITLE: The processes of recombination of free radicals on
the surfaces of semiconductors and their role in
luminescence

PERIODICAL: Kinetika i kataliz, v.4, no.1, 1963, 24-34

TEXT: The authors examined the theory of luminescence based on
the recombination of radicals at the semiconductor surfaces and
investigated the influence of external transverse electrical field
on the intensity of candoluminescence.   The luminescence was
stated to be caused by the combination of ionized atoms with
electrons from the solid lattice, the formation of ions being due
to chemisorption.   Electron exchange resulted between the local
levels of chemisorbed atoms and the lattice energy zones.   The
exchange with the valency zones was thermal in character, whilst
the exchange with the conductivity zones resulted from the
recombination of radicals. ‘ The luminescence was produced only
when the recombination occurred between chemisorbed atoms and
atoms from the gaseous phase.   The intensity of luminescence was
determined by the Fermi level on crystal surfaces and given by
Card 1/3

The processes of recombination ...

$$I = A\left[1 + B \exp\left(\frac{\varepsilon - v}{kT}\right)\right]^{-1} \qquad (23)$$

$$\begin{cases} A = \alpha N^{\times} P \\ B = 1 + \dfrac{b}{P} \end{cases} \qquad (24)$$

where $N^{\times}$ - maximum number of atoms that can be adsorbed per unit surface, P - partial gas pressure, b - adsorption coefficient depending on temperature T, ε - energy level above the Fermi level, to which a surface electron is raised after a recombination act, v - total energy of the lattice electron. At $P = \infty$, $\varepsilon_M = v$. The condition favorable for the radical-recombination luminescence is $\varepsilon < \varepsilon_M$ (26) where

$$\varepsilon_M = v - kT \log\left(1 + \frac{b}{P}\right), \qquad I_M = \frac{1}{2}\,\alpha N^{\times} P \qquad (25)$$

When the Fermi level is depressed, the intensity of luminescence increases and vice versa. This confirms the conditions given

Card 2/3

The processes of recombination ...   S/195/63/004/001/001/009
E075/E436

by Eq.(26).   The experimental results agree qualitatively with
the developed theory.   There are 7 figures.

ASSOCIATION: Tomskiy politekhnicheskiy institut
              Institut fizicheskoy khimii AN SSSR
              (Tomsk Polytechnic Institute
              Institute of Physical Chemistry AS USSR)

SUBMITTED: September 18, 1961

Card 3/3

L 1115-66   EWT(1)/EWT(m)/EPF(c)/EWP(j)/T/EWA(h)   IJP(c)/RPL   AT/RM/GS

ACCESSION NR: AT5020492   UR/0000/64/000/000/0457/0462

AUTHORS: Vol'kenshteyn, F. F.; Gorban', A. N.; Sokolov, V. A.

TITLE: On the problem of semiconductor luminescence resulting from the recombination of free atoms and radicals on the surface

SOURCE: Mezhvuzovskaya nauchno-tekhnicheskaya konferentsiya po fizike poluprovodnikov (poverkhnostnyye i kontaktnyye yavleniya). Tomsk, 1962. Poverkhnostnyye i kontaktnyye yavleniya v poluprovodnikakh (Surface and contact phenomena in semiconductors). Tomsk, Izd-vo Tomskogo univ., 1964, 457-462

TOPIC TAGS: semiconducting material, luminescence, free radical, electric field, zinc sulfide, cadmium sulfide, Fermi level

ABSTRACT: A mechanism of radical-recombination luminescence is proposed, and an experiment conducted to confirm aspects of the theory of semiconductor luminescence is described. The work was performed to supplement the authors' earlier research in this area. Tests were run to determine the effect of a field on luminescence. Radicals of hydrogen and air were formed by electric discharge (±5 kV) under a pressure of ~1mm Hg in a tube about 2 m long and 3 cm in diameter, containing ZnS and CdS-Cu phosphor. The experimental results confirmed qualitatively

Card 1/2

L 1115-66

ACCESSION NR: AT5020492

that the intensity of luminescence is dependent upon the location of the Fermi
level and confirmed also the theoretically expected effect of an electric field
on the adsorptivity of a semiconductor surface. Orig. art. has: 2 diagrams,
2 graphs, 1 table, and 9 formulas.

ASSOCIATION: none

SUBMITTED: 06Oct64   ENCL: 00   SUB CODE: SS

NO REF SOV: 007   OTHER: 002

Card 2/2

L 19639-65   EWG(j)/EWT(l)/EWG(k)/EWT(m)/EPF(c)/EWP(j)/T/EWA(h)/EWA(l)
Pz-6/Pc-4/Pr-4/Peb   BSD/ASD(a)-5/AFWL/SSD/DIAAP/IJP(c)   AT/RM

S/0062/64/000/011/1935/1943

ACCESSION NR: AP5000481

AUTHOR: Baru, V. G.; Vol'kenshteyn, F. F.

TITLE: Probable explanation of the effect of radioactive additives on the chemisorption and catalytic properties of semiconductors

SOURCE: AN SSSR. Izvestiya. Seriya khimicheskaya, no. 11, 1964, 1935-1943

TOPIC TAGS: semiconductor crystal, nonmetallic crystal, radiation effect, crystal self irradiation, radioactive additive effect, chemisorption theory, catalysis theory

ABSTRACT: A theoretical study of the changes in adsorptive capacity and catalytic activity of nonmetallic semiconductor crystals self-irradiated by radioactive additives has been presented from the standpoint of the electronic theory of chemisorption and catalysis. The relative changes in the properties were correlated with the changes in the concentration of free electrons or holes on the surface of a radioactive sample. Calculation of the concentration changes was made on the assumption of simultaneously radiation-induced electronic ex-

Card 1/3

L 19639-65

ACCESSION NR: AP5000481

citation and ionization processes. Possible radiation-induced crystal-
lattice defects and chemical transformations were neglected. Mathe-
matical expressions of the excitation and ionization effects were
derived as functions of the specific radioactivity of the sample. It
was shown that the mechanism of the overall radiation effect is de-
termined by the value of specific radioactivity, R. At small values
of R, the main factor is excitation; at large values of R, the ioniza-
tion process prevails. Both mechanisms contribute equally to the over-
all radiation effect at a value R_0 of specific radioactivity, which
depends on the history of the sample. This particular value, R_0,
might be shifted one way or another by an appropriate treatment of the
samples. The shift in R_0 value might cause a change in the magnitude
and sign of the overall radiation effect, which consequently depends
on the history of the adsorbent (catalyst) and on experimental condi-
tions. The change in the sign of R_0 was observed experimentally by
A. A. Balandin, V. I. Spitsyn, et al. [Izv. AN SSSR. Otd. khim. n. 1961,
4] in the catalytic dehydration of isopropylalcohol. Orig. art. has:
2 figures and 49 formulas.

ASSOCIATION: Institut fizicheskoy khimii Akademii nauk SSSR (Institute
of Physical Chemistry, Academy of Sciences, SSSR)

Card 2/3

L 39736-65   EWT(1)/EWT(m)/T/EWA(h)   Pz-6/Peb   IJP(c)   AT
ACCESSION NR: AP5006776   S/0195/65/006/001/0095/0107

AUTHOR: Volkenshteyn, F. F., Peshev, O.

TITLE: The electron factor in the kinetics of chemisorption on semiconductors

SOURCE: Kinetika i kataliz, v. 6, no. 1, 1965, 95-107

TOPIC TAGS: chemisorption, kinetics, semiconductor

ABSTRACT: The kinetics of chemisorption on semiconductors is investigated within the framework of the electron theory. It is assumed that the particles which are held by chemical forces are of the acceptor type. In other words these particles may be electrically neutral (weak surface interaction) or negatively charged (strong surface interaction) and may pass from one state to the other. Let $N^0 = N^0(t)$ and $N^- = N^-(t)$ be the surface concentrations of the neutral and the negatively charged particles respectively, while $N(t) = N^0(t) + N^-(t)$ is the total number of chemisorbed particles of a given type on a unit of the surface at a given time t. If a state of electron equilibrium exists on the surface at the time t, the relative content of the charged and neutral forms of chemisorption on the surface at this moment is given by the Fermi-Dirac statistical formulas:

Card 1/4

ACCESSION NR: AP5006776

$$\eta^-(t)=\frac{N^-(t)}{N(t)}=\left[1+\exp\frac{\epsilon_s^-(t)-\sigma^-}{kT}\right]^{-1}=\left[1+\exp\frac{\sigma^+-\epsilon_s^+(t)}{kT}\right]^{-1}$$
$$\eta^+(t)=\frac{N^+(t)}{N(t)}=\left[1+\exp\frac{\sigma^--\epsilon_s^-(t)}{kT}\right]^{-1}=\left[1+\exp\frac{\epsilon_s^+(t)-\sigma^+}{kT}\right]^{-1}$$

(1)

The notation used here will be clear from an examination of Fig. 1 of the Enclosure which gives the band diagram of a semiconductor with a negatively charged surface: A is the localized level of the chemisorbed particle; FF is the Fermi level. The average lifetime of a particle in the chemisorbed state is designated by τ, while τ⁰ and τ⁻ designate the average lifetimes of neutral and charged chemisorbed particles. The authors show that condition (1) may be considered approximately fulfilled only when t is much greater than τ⁻, i.e. a state of electron equilibrium is reached on the surface during adsorption if τ⁰, τ⁻ ≪ τ while in the opposite limiting case τ ≪ τ⁰, τ⁻ electron and adsorption equilibrium states are reached simultaneously. In the latter case, the energy of adsorption activation depends on the electron state of the system. One or the other of these two limiting cases may occur depending on the nature of the adsorbent and the adsorbate.

Card 2/4

L 39736-65
ACCESSION NR: AP5006776

Desorption kinetics is also studied (pressure maintained at zero). In the first limiting case, electron equilibrium is maintained during desorption (desorption is complete in this case). However in the second limiting case electron equilibrium breaks down during desorption. Desorption in this case is only partially completed (the case of partially irreversible adsorption). The relative content of reversible and irreversible forms of chemisorption on the surface depends on the nature of the adsorbent. Adsorption and desorption kinetics are examined in detail for these two cases. Orig. art. has: 3 figures, 40 equations.

ASSOCIATION: Institut fizicheskoy khimii AN SSSR (Institute of Physical Chemistry, Academy of Sciences SSSR); Fizicheskiy fakul'tet Moskovskogo gosudarstvennogo universiteta im. M. V. Lomonosova (Department of Physics, Moscow State University)

SUBMITTED: 20Feb64   ENCL: 01   SUB CODE: GC, EC

NO REF SOV: 003   OTHER: 010

Card 3/4

VOL'KENSHTEYN, : .' .

Electronic factor in catalysis and the problem of selecting
catalysts. Zhur. fiz. khim. 39 no.8:1809-1816 Ag '65.

1. Institut fizicheskoy khimii AN SSSR.

(MIRA 18:9)

L 18570-66   EWT(m)/T

ACC NR: AP6002430   SOURCE CODE: UR/0020/65/165/005/1101/1104

AUTHORS: Vol'kenshteyn, F. F.; Karpenko, I. V.

ORG: Institute of Physical Chemistry, Academy of Science SSSR (Institut   41
fizicheskoy khimii Akademii nauk SSSR)   B

TITLE: Displacement of the adsorption equilibrium on the surface of a semi-
conductor due to illumination

SOURCE: AN SSSR. Doklady, v. 165, no. 5, 1965, 1101-1104

TOPIC TAGS: semiconductor theory, semiconductor research, semiconductor conduc-
tivity, photoeffect, gas adsorption, semiconductor

ABSTRACT: The authors attempt a theoretical treatment of the photoadsorption
effect and present a discussion which is an extension of their previous work on
the same topic (Kinetika i kataliz, 3, 72, 1962). The discussion is based on the
following, explained by a model shown in Fig. 1, where A is the localized surface
level of the chemisorbed particle, FF - Fermi level in the nonilluminated spec-
imen, and all other quantities are defined as in F. F. Vol'kenshteyn (Kinetika i
kataliz, 2, 481, 1961). On the basis of the proposed model, it is concluded
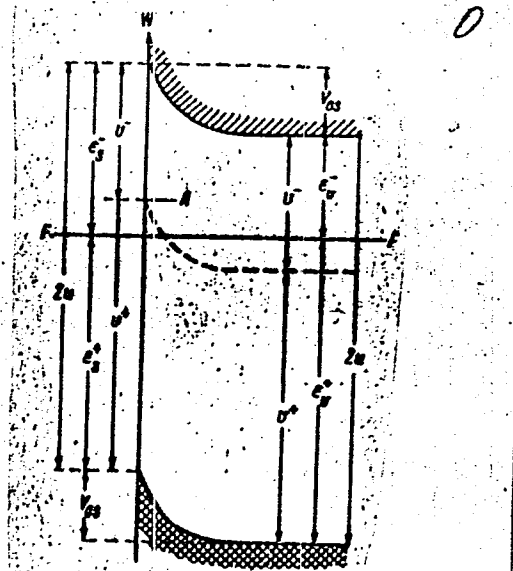
Card 1/3   UDC: 541.183.03

L 18570-66

ACC NR: AP6002430

Fig. 1. Schematic of the energy level
         distribution for the proposed
         model of the photoadsorption
         effect.

that there should exist a correlation between the photoadsorptive effect and the

Card 2/3

L 18570-66

ACC NR: AP6002430

$\mathcal{O}$

work function of the semiconductor surface. The equation for the inversion point of the photoadsorptive effect is derived as

$$\Phi = \Phi_M = \dot{y} / b = I \exp (v^{\mp} \mp V_{os}),$$

where ϕ is defined by

$$\Phi = \frac{N - N_0}{N_0} = \frac{\Delta N}{N_0},$$

in which N and N_0 are the surface concentrations of the chemisorbed particles in the presence and absence of illumination respectively. V_{os} is the work function, I is the light intensity, and $v^{\mp}$ is defined in Fig. 1. It is stated that more experimental work is necessary before a conclusive test of the proposed theory for the photoadsorption effect can be made. This paper was presented by Academician M. M. Dubininym on 28 July 1965. Orig. art. has: 2 graphs and 11 equations.

SUB CODE: 20/ SUBM DATE: 26Jul65/ ORIG REF: 005/ OTH REF: 001

Card 3/3 $\mathcal{SRU}$

FIGUROVSKAYA, Ye.N.; KISELEV,V.F.; VOL'KENSHTEYN, F.F.

Effect of chemisorption of oxygen on the work function and conductance of titanium dioxide. Dokl. AN SSSR 161 no.5:1142-1145 Ap '65.

(MIRA 18:5)

1. Moskovskiy gosudarstvennyy universitet i Institut fizicheskoy khimii AN SSSR. Submitted October 28, 1964.

L 36184-66   EWT(m)

ACC NR: AP6010745

SOURCE CODE: UR/0076/66/040/003/0574/0579

AUTHOR: Peshev, O.; Vol'kenshteyn, F. F.

ORG: Moscow State University im. M. V. Lomonosov (Moskovskiy gosudarstvennyy universitet); Institute of Physical Chemistry, Academy of Sciences, SSSR (Institut fizicheskoy khimii Akademii nauk SSSR)

TITLE: Certain irreversible processes in chemisorption on semiconductors

SOURCE: Zhurnal fizicheskoy khimii, v. 40, no. 3, 1966, 574-579

TOPIC TAGS: chemisorption, desorption, semiconductor carrier, adsorption

ABSTRACT: The possible nature of the reversible and irreversible forms of chemisorption is considered from the standpoint of the electronic theory (F. F. Vol'kenshteyn, Electronic Theory of Catalysis on Semiconductors, Fizmatgiz, 1960). The discussion is limited to the case of a homogeneous surface and to the adsorption of an acceptor gas whose particles are in two charge states, negative and neutral. The irreversible form of chemisorption may have a dual nature: (1) it may be due to the hindered desorption of particles in the charged state (mechanism of "apparent" irreversibility) and (2) it may result from the presence of a secondary chemical process on the surface of the semiconductor, such as the reaction of the chemisorbate with the impurity coming to the surface from the volume of the semiconductor (mechanism of "true" irreversibility).

UDC: 541.183

Card   1/2

L 36184-66

ACC NR: AP6010745

Criteria are given for distinguishing these two mechanisms experimentally. Orig. art. has: 5 figures.

SUB CODE: 07/ SUBM DATE: 26Dec64/ ORIG REF: 004/ OTH REF: 002

Card   2/2 //// P

L 26481-66   EWT(1)   IJP(c)

ACC NR: AP6013069

SOURCE CODE: UR/0048/66/030/004/0633/0636

AUTHOR: Sokolov, V.A.; Vol'kenshteyn, F.F.; Brik, O.G.; Kondratenko, M.B.   30

ORG: None

TITLE: Concerning the role of radical-recombination processes in candoluminescence /Report, Fourteenth Conference on Luminescence held in Riga 16-23 September 1965/

SOURCE: AN SSSR. Izvestiya. Seriya fizicheskaya, v. 30, no. 4, 1966, 633-636

TOPIC TAGS: recombination luminescence, chemiluminescence, candoluminescence

ABSTRACT: Although candoluminescence - luminescence under the influence of a flame - has been questioned for many years, the authors assert that the existence of this phenomenon has definitely been proved. The mechanism of candoluminescence was hypothetically developed by one of the authors (F.F.Vol'kenshtein, Elektronnaya teoriya kataliza na poluprovodnikakh, Fizmatgiz, Moscow 1960) on the basis of the electronic theory of catalysis and chemisorption on semiconductors and has been discussed and described in other publications by F.F.Vol'kenshtein et al. According to this mechanism excitation occurs at the expense of the energy released incident to recombination of free atoms and radicals in the flame on the surface of the phosphor. In the present paper there are adduced the inferences based on the radical-recombination theory as regards the influence of extraneous gaseous impurities on the intensity of cando-

Card 1/2   2

L 26481-66

ACC NR: AP6013069

luminescence and there are described the results of attempts at experimental verifica-
tion of the predictions. The inert gas employed in the main experiments was nitrogen
and the phosphor was ZnS·CdS:Cu. A figure gives curves characterizing the variation
of the luminescence intensity of the phosphor with the nitrogen concentration at dif-
ferent temperatures. Another figures shows analogous curves characterizing the in-
fluence of CO and O_2. Comparative experiments to evaluate the recombination coeffi-
cient were carried out with non-luminescing CuO. On the basis of general analysis
of the data it is concluded that radical-recombination processes play a significant
role in excitation of low-temperature luminescence (which, it is asserted, is true
luminescence according to the Vavilov-Wiedemann criterion) but also in excitation of
high-temperature candoluminescence, which is a special form of equilibrium emission
that is not true luminescence. Orig. art. has: 2 formulas and 3 figures.

SUB CODE: 20/   SUBM DATE: 00/   ORIG REF: 007/   OTH REF: 001

Card 2/2

CA VOL'KENSHTEYN, M. V.

3

Raman spectrum of tetraethylammonium iodide. Ya. K. Svirkin and M. V. Volkenstein. *Acta Physicochim. U. R. S. S.* 2, 203–7 (1935) (in German).—A comparison of the data of S. and W. on Et₄NI with previous data on Et₄I and Et₄N indicates that in Et₄NI the characteristic intense frequencies of EtI, as 497 cm.⁻¹ assigned to the C–I bond, are absent, and that the I is bound to neither C nor N but is held ionically outside the coördination sphere. New frequencies, especially 607 and 1231 cm.⁻¹ lead to interpreting the Et₄N ion as a regular tetrahedron with the N atom in the center.　　　F. H. Rathmann

Raman effect of fluosilicic acid. Ya. K. Svirkin and M. V. Volkenstein. *Acta Physicochim. U. R. S. S.* 2, 208–12 (1935) (in German).—Fluosilicic acid (27%) from paraffin bottle was freed of colloidal paraffin (indicated by Tyndall effect), by ultrafiltration through a collodion membrane on a compressed Jena-glass filter. Only one Raman line, ν = 649 ± 5 cm.⁻¹, was observed. The SiF₆ ion is interpreted as being octahedral with the Si atom in the center and the Si–F distance 1.93 Å. The calcd. value for the Raman line is then 680 cm.⁻¹.　　　F. H. R₁

A S.B. S.L.A   METALLURGICAL LITERATURE

Spectroscopic investigation of molecular association. M. V. Vol*kenshtein (Acta Physico-chim. U.R.S.S., 1944, 4, 357—364).—The influence of mol. association on mol. symmetry as deduced from infra-red and Raman spectra is discussed. If the association forces are weak, corresponding with energies > 10 kg. cal. per mol., the mols. can be regarded as unassociated but having their symmetry distorted. If association energy approaches that of homo- or hetero-polar linking, the product is intermediate between a chemical compound and a van der Waals complex. The existence of a frequency band at 622 cm.⁻¹ in the Raman spectrum of AcOH and its weakening with dilution is attributed to the association of two AcOH mols.

O. R. H.

Raman effect in solutions in (liquid) ammonia.
I. M. V. VOLKENSHTEIN (Acta Physicochim. U.R.S.S.,
1936, 5, 627—644; cf. A., 1936, 137, 1440).—
Raman spectra of solutions of NH_4NO_3, NH_4CNS,
$NH_4NO_3 + 2NH_4CNS$, and $AgCl$ in liquid NH_3
have been measured. Frequencies due to liquid
NH_3 differ from those observed with the gas. Lines
characteristic of NO_3' and CNS', but not NH_4', were
observed. The absence of NH_4' frequencies is
explained as due to the formation of $[H(NH_3)_2]'$.
                                           F. L. U

Vibrations of polyatomic molecules and their investigation with the help of group theory. M. V. Vol'kenshtein, Uspekhi Fiz. Nauk 16, 320 (Russian). Theoretical review. Normal vibrations and vibration spectra are classified on the basis of group-theory conceptions. Laws of symmetry and selection are obtained and applied to some specific cases. Exptl. data on the absorption spectra of PCl_3, PBr_3, cis- and trans-$C_2H_2Cl_2$ and of assocd. acetic acid are given. — F. H. Rathmann

ASB-ILA   METALLURGICAL LITERATURE CLASSIFICATION

Raman effect in binary mixtures with liquid sulfur dioxide. M. V. Vol'kenshtein. *Acta Physicochim. U. R. S. S.* 7, 313-14(1937); cf. *C. A.* 31, 6969¹.—A mixt. of 3 mols. SO_2 to 2 mols. $(CH_3)_2O$ was photographed at room temp. in a sealed tube. The SO_2 frequencies were found unchanged; the $(CH_3)_2O$ frequencies were displaced: pure $(CH_3)_2O$: 2988, 2947, 2908, 2868, 2813, 1448, 1095, 920, 408; mixt.: 2998, 2952, 2919, 2868, 2821, 1453, 1088, 808, 411. Pure SO_2: 1336, 1144, 524.5; mixture: 1335, 1145, 523.

Victor Dietz

—**Raman spectra of solutions of mercuric cyanide in ammonia and pyridine.** M. V. Vol'kenshtein. *Acta Physicochim. U. R. S. S.* 7, 315-16(1937).—The Raman spectra of the following solns. are reported: (I) satd. soln. corresponding to $Hg(CN)_2.6NH_3$, (II) dil. soln. corresponding to $Hg(CN)_2.23NH_3$, (III) satd. soln. in pyridine. The spectra are: I, 2161; II, 2163; III, 2041, 2160 cm.⁻¹. The solvent frequencies are unchanged.

VOL-KENSHTEYN, M.V.

RAMAN EFFECT AND INTERMOLECULAR INTER-
ACTIONS. (Raman-effkt I Mezhdumolekuliarnoe
Vzaimodelstvie). M. V. Vol'kenshtein. Translated by
G. Belkov from Uspekhi Fiz. Nauk 18, 163-202(1937).
60p. (TT-499)

Raman spectra of pyrene compounds. M. V. Volkenschtein and J. K. Siorin (J. Phys. Chem. Russ.; 1938; 12, 677—679).—Dimethylpyrone, its hydrochloride and hydrobromide, coumarin and its hydrochloride, coumarone, and xanthone were investigated.
J. J. B.

Raman effect of hydrocarbons and the analysis of liquid fuels. M. V. Vol'kenshtein. *Uspekhi Khim.* 8, 970-97 (1939).—Data are given on the Raman spectra of numerous hydrocarbons and the qual. and approx. quant. analysis of motor fuels by means of their Raman spectra are discussed for various fractions. A complete analysis is possible in solns.   F. H. Rathmann

Karpov Inst. Phys. Chem. - Moscow -

CA: 34 - 2581/2

METALLURGICAL LITERATURE CLASSIFICATION

BC

Karpov Phys. Chem. Inst.

CA: 33-7664/6

A-1

Raman effect of pyrone compounds and electronic resonance. M. V. Volkenstein and J. K. Syrkin (Acta Physicochim. U.R.S.S., 1939, 10, 677-706). —The Raman spectra of 2:6-dimethylpyrone (I), coumarin (II), xanthone, coumarone, and dioxan, and oxonium compounds of (I) with HCl and HBr and of (II) with HCl have been investigated. The addition of a H halide produces no considerable effect on the spectrum of (I), thus indicating that there is no OH in these oxonium compounds. The Raman spectrum of (II) resembles those of $C_{10}H_8$ and coumarone. The effect of electronic resonance on the Raman spectrum is discussed with particular reference to the CO group. The oxonium bond is a result of intermol. interaction stabilised by the presence of a resonance state in the form of the H bond. The dipole moments of (I) and xanthone are calc. from the frequencies of oscillation of the CO group, which are < normal in these compounds. A. J. M.

A10.3LA METALLURGICAL LITERATURE CLASSIFICATION

Raman effect of pyrone compounds and electronic reso-
nance effects.   M. V. Vol'kenshtein and Ya. K. Syrkin
J. Phys. Chem. (U. S. S. R.) 13, 918 G1(1939).- Exptl.
data are given on the Raman spectra of dimethylpyrone,
coumarin, xanthone, coumarone and dioxane alone and
in HCl and HBr solns.   The results are considered from
the standpoint of Pauling's theory of electron resonance.
                                           F. H. Rathmann

U-1615, 3 Jan 52

Karpov Phys. Chem. Inst.
CA: 34-4664/8

Analysis of gasolines by means of their Raman spectra.
II. M. V. Vol'kenshtein and P. P. Shurygin. *J. Phys.*
Chem. (U.S.S.R.) 13, 1812-22(1939); cf. *C. A.* 34,
5881.—V. and S. collect data on the Raman frequencies
of a large no. of possible constituents, satd. and unsatd.,
straight- and branched-chain, cyclic and aromatic, of vari-
ous types of gasolines. On the basis of exptl. data, they
show that the method of Raman spectra applied to various
fractions permits of a rapid and sufficiently accurate detn.
of the qual. and semiquant. compn. of gasoline fractions
boiling up to 100°. The analysis of higher-boiling frac-
tions is more difficult and must in most cases be limited
to group rather than to individual-component analysis.
                                         F. H. Rathmann

U-1615, 3 Jan 52

Phys.Chem.Inst. im. Karpov

CA

CA: 35-1608/9

Karpov Inst. Phys. Chem.

Analysis of gasolines by means of Raman spectra. M. V. Val'kenshtein, P. P. Shorygin and N. N. Shumova (Karpov Inst. Phys. Chem.). *Zavodskaya Lab.* 9, 580 (1940). — The chief problems of Raman spectra in the analysis of motor fuels are reviewed and data are tabulated on the detns. for individual compds. in (1) 4 fractions of Syzran gasoline, (2) 10 fractions of Grozny gasoline and (3) gasoline obtained by cracking with $AlCl_3$. Results of the last case lead to the following preliminary conclusions regarding cracking with $AlCl_3$. As a result of the reaction there are formed isoparaffins with 1 side branch and with 1 Me group in the side branch. In all the cases under investigation it was not possible to identify multibranched isoparaffins. The octane no. should drop with increasing b. p. of the fraction. The high octane no. of the lightest fractions is dependent on their large content of isopentane. The content of naphthenes and aromatic compds. is dependent on the selection of the crude oil and the type of process (preliminary purification with H_2SO_4). Nine references. H. Z. Kamlet

CA

PROCESSES AND PROPERTIES INDEX

2

The modern theory of natural optical activity. I. M. V. Vol'kenshtein. *Uspekhi Khim.* 9, 1080-1123(1940).— Review and theoretical, covering the work of Fresnel and Drude, the foundations of the theory of polarization, Born's and Kuhn's theories, and circular dichroism. Exptl. data for various compds. are compared with the values predicted by these theories. II. Quantum mechanics of optical activity, *Ibid.* 1252-79.—Theoretical and math. review of the work of Kuhn, Rosenfeld, Kirkwood, and the one-electron model. The superposition of optical activity of sugars, abs. configuration of optically active mols., intermol. forces and optical activity are considered together with the related biochem. problems.

P. H. Rathmann

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

VOL'KENSHTEIN, M. V.

PRILEZHAYEVA, E. N., SYRKIN, Ya. K. and VOL'KENSHTEIN, M. V.   CA: 34-5756/5
(Karpov Inst. Physical Chemistry, Moscow; State Univ., Minsk)
Acta Physicochim. URSS 12, 176-80 (1940) - in English
The Raman spectra of halogenated ethylenes. Preliminary note.

C A

The Raman effect of oxonium compounds. A. K. Gautmacher, M. V. Vol'kenshtein and Ya. K. Syrkin. *Acta Physicochimica U. R. S. S.* 12, 780 03(1940)(in English.; cf. C. A. 33, 7004; 34, 4061.—From exptl. data on the Raman spectra for the system $(CH_3)_2O + n\ HCl$ with $n = 1, 2, 3$ at temps. from -80 to $+20°$, G., V. and S. find that interaction causes a lowering of the valence frequency of the C-O-C system, an increase of that of CH_3 and of the deformation frequency of C-O-C. For 1:1 mixts. the displacement of the CH_3 and C-O-C frequencies is const. throughout the temp. range studied. With increasing amts. of HCl, a new line $\Delta\nu = 500$ cm.$^{-1}$ and a diffuse band at 2400 cm.$^{-1}$ due to HCl deformed 14% relative to liquid HCl, appear simultaneously. The 2400 band is attributed to the oxonium resonance complex

$$CH_3\!\!\diagdown O^+ \cdots H\ Cl^- \cdots HCl$$
$$CH_3\!\!\diagup$$

and the 500 line to a hindered HCl rotation. The evidence indicates trivalent rather than quadrivalent oxygen; the latter is also unlikely from thermodynamical considerations. F. H. R.

CA: 35- 976/8

Kupov·Phys. Chem· Inst.

METALLURGICAL LITERATURE CLASSIFICATION

VOL'KENSHTEIN, M. V.

SHORYGIN, P. P. and VOL'KENSHTEIN, M. V.   CA: 37-23(5/6
(Karpov Inst. Phys. Chem., Moscow)
Bull. acad. sci. URSS, Ser. phys. 1941, 174-81 - English summary
Analysis of benzines by the Raman spectra.