PB 161576

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Technical Note 75

SOVIET RESEARCH IN FIELD ELECTRON AND ION EMISSION, 1955-1959; AN ANNOTATED BIBLIOGRAPHY

U. S. DEPARTMENT OF COMMERCE
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OCTOBER 1960

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Tibor W. Marton and Ralph Klein

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CONTENTS

SOVIET RESEARCH IN FIELD ELECTRON AND ION EMISSION, 1955 - 1959; AN ANNOTATED BIBLIOGRAPHY

TIBOR W. MARTON and RALPH KLEIN*

Soviet field emission research, as reflected in the technical literature from 1955 through 1959, is the subject matter of this annotated bibliography. Topics include experimental and theoretical work on field electron emission from metals and semiconductors, work functions, phase transformations, adsorption, diffusion, evaporation, surface ionization, and field ion emission. Over one hundred complete references to original publications in Russian and Ukrainian and to a few in Polish, Hungarian, and Czech were selected after an extensive search of the literature. Full references are given to English translations of the entries whenever available. A list of relevant scientific meetings, references, and a brief subject index are appended to the compilation.

1. INTRODUCTION

1.1 Purpose and scope. A perusal of the Western literature on field emission reveals that little cognizance has been taken of the Russian effort in this area. This may be ascribed to language difficulties, lack of general availability of the Russian literature, and the proliferation of papers, particularly in the United States and Germany, in the two and a half decades since the initial impetus of the Müller field emission microscope. The purpose of this survey is to bring to the attention of the scientific community the work that has been reported in the Soviet literature on field emission. Brief annotations are included to indicate the scope of the articles, and no critical evaluation is either attempted or intended. The choice of the survey date starting with 1955 is based on the consideration that the monograph "Field Emission" by Elinson and Vasil'ev includes fairly complete Russian references up to mid-1956. Further, most of the more original Russian contributions have appeared since 1955.

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a) Soviet research topics. As the number of Russian papers on field emission has increased, the range of topics has been extended both from the theoretical and experimental viewpoint. Adsorption properties, alloys, semiconductors, dielectrics, space charge effects, emitter shape, and surface phenomena have been investigated. Some consideration has been given to the vacuum arc, the Malter effect, surface ionization under high field conditions, and technical applications of field emitters.

Field emission from semiconductors and dielectrics is represented by investigations on carbon in quartz, lanthanum hexaboride, germanium, silicon, aluminum oxide, tungsten carbide, cadmium sulfide and selenide, and cesium chloride. Metals include tungsten, molybdenum, tantalum, iron, nickel, rhenium, and zirconium. The latter is characterized by a phase transformation which has been studied with field emission microscopy.

Field ion emission, although receiving considerably less attention, has not been completely neglected.

The theoretical aspects of field emission are treated by several authors. These aspects include: 1) High field with field penetration into the metal, 2) Effect of space charge on emission current, 3) Schottky region, and 4) Field emission from semiconductors and dielectrics.

In general, the range of topics considered is similar to that appearing elsewhere. Although there may be some overlap and duplication, the Russian contributions are not to be ignored, and it is hoped that this survey may bring to the attention of those interested in field emission the progress and developments being made in the U.S.S.R.

1.2 Literature search. An extensive search was made of the original Soviet and East European technical literature published from 1955 through 1959 for the purpose of selecting papers relevant to field emission research. A few articles issued in 1954 and 1960 were also included if their importance and availability seemed to warrant it. More than six hundred original periodical articles and books were examined and analyzed; out of these, over one hundred were selected for inclusion. About eighty percent of the entries in this compilation are papers originally written in Russian; the remaining twenty percent comprise references to Ukrainian, Polish, Czech, and Hungarian papers.

1.3 Entries and arrangement. With few exceptions, entries in this bibliography consist of author(s), original and translated title, abbreviated name of the periodical, collation, and citation of available English translation.

The entries are arranged alphabetically by the name of the first author, and then by coauthor(s) if any. Two or more papers by the same author(s) are listed chronologically, beginning with the earliest paper.

a) Titles of papers. To ensure accurate reference identification, the titles are listed in the language of publication. The Library of Congress transliteration system for Cyrillic alphabets has been used throughout. English translation, in parentheses, usually follows the foreign language titles.

b) Abbreviations of citations. Names of periodicals have been abbreviated in accordance with the List of Periodicals Abstracted by Chemical Abstracts, the Style Manual of the American Institute of Physics, and the Publications and Reports Manual of the National Bureau of Standards.

c) Collation. The abbreviated name of periodicals is followed by the volume and issue numbers, inclusive pages, year, and indication of illustrations and references, if any; for instance, 24, no. 3, 165-180 (1959). Illus., 6 refs. The slight deviation from citation practice followed by the American Institute of Physics, National Bureau of Standards, and Chemical Abstracts publications was necessitated by the inconsistencies prevalent in citations of Russian periodicals and their cover-to-cover translations. The language of the original publications is noted [in brackets] at the end of the citation for periodical articles only if the article was published in a language other than Russian.

d) Unpublished papers. An asterisk after the entry number indicates papers read at seminars and symposia for which no separate publication was found, but which were reviewed or summarized in technical journals and meeting transactions or announcements.

e) Translations. To aid readers lacking a reading knowledge of the languages represented in this bibliography, an attempt has been made to give full references to available English translations and to summaries. These citations -- very often references to cover-to-cover translation journals -- are indicated in the entry by " English translation."

f) Annotations. Summaries generally have been made as brief as possible, touching only on the salient points. References to related papers, subjects, or relevant meetings are denoted by "see also" or "cf.", respectively.

1.4 Sources of translations. The majority of Soviet field emission papers are published in a relatively small number of journals, most of which are available in cover-to-cover English translation journals. Such translated journals -- which can usually be found in the larger technical libraries -- are listed as follows: 1) Bulletin of the

Academy of Sciences, USSR, Physical Series (Columbia Technical Translations); 2) Electronics Express (International Physical Index, Inc.); 3) Radio Engineering and Electronics (Pergamon Press, Inc.); and 4) Soviet Physics--Technical Physics (American Institute of Physics).

For English translations of entries not available or not located by the time this bibliography was completed, the reader may wish to check with the following translation centers: U.S. Department of Commerce, Office of Technical Services, Washington 25, D.C. (OTS - PB and LC numbers), The Special Libraries Association's Translation Center at the John Crerar Library, Chicago 1, Illinois, and the Department of Scientific and Industrial Research, Lending Library Unit, 20 Chester Terrace, London N.W.

1.5 Conclusion. Although an attempt was made to record as many Soviet and East European papers as possible, the compilation does not claim to be all-inclusive. A number of original sources, especially dissertations and patents, and some periodicals could not be located by the time set for the bibliography's completion -- just prior to the Seventh Field Emission Symposium at Linfield College, McMinnville, Oregon from August 31 - September 2, 1960. It is hoped that these gaps may be filled in a future supplement which will also cover further developments in Soviet field emission research. The compilers will welcome suggestions for improvement and information on any significant paper which may have been overlooked in this bibliography.

For the convenience of readers, scientific conferences relevant to field emission research are listed on page 35 in simplified form, giving the name, location, and date of the meeting in English only. Addenda, references to bibliographic aids in this subject area, and a subject index are appended to the compilation.

2. ANNOTATED BIBLIOGRAPHY

1. ADIROVICH, E.I. Vliianie avtoelektronnoi emissii na raspredelenie sil'nykh polei v tverdykh telakh. (Effect of field emission on the distribution of strong fields in solids). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 24, no.1, 49-57 (1960). Illus., 2 refs. English translation: Bull. Acad. Sci., U.S.S.R., Phys. Ser., 24 (in process).

   The effect of field emission on the kinetics of the redistribution of the electric field in semiconductors is investigated theoretically.

2. AIZENBERG, N.B. O roli ob'emnogo zariada v sfericheskikh elektronnykh proektorakh. (Role of the space charge in field emission microscopes). Zhur.Tekh.Fiz.,24,no.11,2079-2082 (1954). Illus., 6 refs.

   The effect of a space charge on the correlation between the anodic voltage and the field at the cathode tip of a field emission microscope is discussed. Experimental data published earlier are examined.

3. ALEKSEEVA, A.P., BASALAEVA, N.IA., ELINSON, M.I.,and others. Vos'moe vsesoiuznoe soveshchanie po katodnoi elektronike, Leningrad. Okt. 17-24, 1957. (Eighth All-Union Conference on Cathode Electronics,Leningrad, October 17-24, 1957). Radiotekh. i Elektron., 3, no.8, 1092-1103 (1958). English translation: Radio Eng. and Electronics (U.S.S.R.), 3, no.8, 170-194 (1958).

   Ten papers were read at the field-emission microscopy session of the Conference cited above (pp.186-189 in the English translation) in three groups: 1) Study of surface processes by means of field electron microscopes; 2) Field emission from semiconductors; and 3) Stability of field emission. Present and future research tasks oriented towards better cathode design and materials, and the outlook for scientific and technical applications of field emission microscopy were discussed in detail. (For annotations of papers read at the Conference, see entries #20, 26, 43, 45, 50, 55, 80, 91*, 101, and 107*).

4. AVAK'IANTS, G.M. K teorii emissii elektronov iz metalla v elektricheskom pole. (Theory of electron emission from metals in electric fields). Trudy Fiz.-Tekh. Inst., Akad. Nauk Uzbek S.S.R., 6, 43-53 (1955). Illus., 7 refs.

   In the 10^7 — 10^8v/cm range, there is an observable electric field penetration into the metal.The field penetration results in an apparent decrease in the

work function by 2eEL (where E is the electric field and L the depth of the field penetration). This leads to an apparent decrease of the work function in field emission (in the high-field region) to half of the value obtained for thermal emission.

5. BAGDYKIANTS, G.O. Chetvertyi mezhdunarodnyi kongress po elektronnoi mikroskopii. (Fourth International Congress on Electron Microscopy). Uspekhi Fiz. Nauk, 68, no.1, 185 - 195 (1959). 4 refs. English summary: OTS-PB 140491 T-16.

Brief notes and reviews on the above Congress held September 10-17, 1958 in West Berlin. About 370 papers were read, representing all major phases of electron microscopy. Notes on the field emission session include, among many other papers, entry #51. (For annotations of two other Soviet papers on field emission read at this Congress, see entries #18 and 54).

6. BASALAEVA, N.IA. and SAVITSKAIA, IA.S. Mezhduvedomstvennyi seminar po katodnoi elektronike (10-e zasedanie). (Inter-Departmental Seminar on Cathode Electronics; 10th Session. Leningrad, May 5, 1958). Radiotekh. i Elektron., 3, no.9, 1221-1222 (1958). English translation: Radio Eng. and Electronics (U.S.S.R.), 3, no.9, 172-175 (1958).

Brief summaries of papers read at the Seminar cited above; the papers dealt primarily with the thermionic emission of oxide-coated cathodes.

7. BEGIASHVILI, G.A. Kholodnaia emissiia iz uporiadochivaiushchikhsia binarnykh splavov. (Cold emission from ordered binary alloys). Izvest. Vysshikh Ucheb. Zavedenii, Fiz., 1, no.2, 69-72 (1959). 4 refs. English translation: LC or SLA 60-17004-2.

For body-centered cubic lattices, the field emission current is investigated theoretically and the temperature dependence near the transition point is determined. Qualitative conclusions that can be verified experimentally are given.

8*. BOGDANOVSKII, G.A. Issledovanie elektricheskogo kontakta v elektronnom mikroskope. (Investigation of electric contacts using an electron microscope). Reviewed in: entry #21. Radiotekh. i Eletron., 2, no.5, 668 (1957). English translation: Radio Eng. and Electronics (U.S.S.R.), 2, no.5, 208 (1957).

The resistance of an open tungsten contact with a vacuum gap was measured. The surface of the electrodes was estimated with an electron microscope (10,000 x). A change in the electrode surface due to strong fields was observed. It is concluded that the findings are attributable to processes occurring at the field emission cathode surface and to the breakdown of the vacuum gap. (Paper read at the Inter-Departmental Seminar on Cathode Electronics, Leningrad, March 4, 1957; cf. entry #21).

9. CHUENKOV, V.A. Povedenie valentnykh kristallov tipa germaniia v sil'nom elektricheskom pole. (Behavior of germanium-type valence crystals in strong electric fields). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 22, no.4, 363-368 (1958). Illus., 7 refs. English translation:Bull. Acad. Sci. U.S.S.R., Phys. Ser., 22, no. 4, 363-368 (1958).

The distribution function of conduction electrons in a strong electric field was investigated. An expression was obtained relating the electron energy to the field at which an electron avalanche occurs in a homogeneous semiconductor. A comparison was made with the experimental results on the breakdown at abrupt p-n junctions in germanium and silicon.

10. DOBRETSOV, L.N. Elektronnaia i ionnaia emissiia. (Electron and ion emission). Problemy Sovrem. Fiz., 8, no.9, 3-7 (1956).

Translations and reviews in Russian of Western papers published in 1953-4; mostly thermo-, photo-, secondary electron emission topics.

11. DYKMAN, I.M. Soveshchanie po katodnoi elektronike v 1955 g. («All-Union» Conference on Cathode Electronics, 1955). Radiotekh. i Elektron., 1, no. 3, 393-403 (1956). Illus., 12 refs.

Description of papers presented at the above Conference held at the Institute of Physics, Academy of Sciences, Ukrainian S.S.R., Kiev, November 25-29, 1955.(For annotations of field emission papers reviewed in this article, see entries #12, 32, 53, 58, 62, 65, 84, 89, 94, and 105. Also, cf. entries #31 and 70).

12. DYKMAN, I.M. Zmina roboty vykhodu pry adsorbtsii na poverkhni metalu dypol'nykh molekul. (Changes in the work function following the adsorption of dipolar molecules by the metal surface). Ukrain. Fiz. Zhur., 1, no.1, 81-87 (1956). Illus., 9 refs. «In Ukrainian with summary in Russian».

The effect of the physical adsorption of permanent dipolar molecules on the work function is discussed theoretically, and a formula is derived for the change in the work function.Some experimental data are given. (This paper was also read at the All-Union Conference on Cathode Electronics, Kiev, November 25-29, 1955; cf. entries #11, 31, and 70).

13. DYKMAN, I.M. Izmenenie raboty vykhoda pri adsorbtsii na poverkhnosti metalla dipol'nykh molekul. (Changes in the work function following the adsorption of dipolar molecules by the metal surface). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 20, no.9, 1076 (1956). English translation: Bull. Acad. Sci. U.S.S.R., Phys. Ser., 20, no. 9, 1170 (1956).

For annotation see entry #12.

14. ECKERTOVÁ, L. Elektronovaautoemise. (Field emission).Pokroky mat., fys. a astron., 3, no. 1, 53-59 (1958). Illus., 21 refs. [In Czech].

The principles of field emission are briefly outlined. The apparatus, operational principles, parameters and the various possibilities of application of field electron or field ion emission microscopes are described.

15. ECKERTOVÁ, L. and MAŠEK, K. Vremennaia zavisimost' avtoelektronnogo toka s vol'framovogo ostriia. (Time dependence of field emission currents from a tungsten point). Czechoslov. J. Phys., 9, no. 4, 512-516 (1959). Illus., 8 refs. [In Russian with English abstract].

A description is given of the increase in the electron current as a function of time after the voltage in the field emission microscope has been switched on. It is assumed that the increase in current is caused by desorption of the adsorbed layers responsible for the high work function. Hypotheses on the mechanism of desorption are presented.

16. ELINSON, M.I. O vlianii adsorbtsii gazov na poverkhnosti emittera na ego avtoelektronnuiu emissiiu. (Effect of adsorbed gases on the emitter surface upon its its field emission).Radiotekh. i Elektron., 3, no. 3, 438-439 (1958). Illus. English translation: Radio Eng. and Electronics (U.S.S.R.), 3, no. 3, 202-205 (1958).

The current surges which sometimes cause melting and destruction of the field emitter are believed to be caused by positive ions impinging on an adsorbed multilayer film. These ions, it is postulated, are not neutralized immediately.This leads to an increased transmittance through the potential barrier.

17. ELINSON, M.I. Vliianie vnutrennikh elektricheskikh polei v poluprovodnike na ego avtoelektronnuiu emissiiu. (Effect of internal electric fields in a semiconductor on its field emission). Radiotekh. i Elektron., 4, no.1, 140-142 (1959). Illus., 6 refs. English translation: Radio Eng. and Electronics, 4, no.1, 231-235 (1959).

A theoretical derivation of the current voltage relationship is given for semiconductors. Taking field penetration into account,the expression for the emission characteristics of semiconductors is non-linear with respect to the usual ln I vs $\frac{1}{V}$ plot in the high field region. However, in the low field case, the linear relationship is obeyed.

18. ELINSON, M.I. Zur Frage der Stabilität der Feldelektronenemission. (On the stability of field electron emission). [In German]. In: Vierter Internationaler Kongress für Elektronenmikroskopie. Berlin, September 10-17, 1958. Verhandlungen, Band I; Physikalisch-Technischer Teil. Berlin, Springer Verlag, 1960, pp. 25-28. Illus., 4 refs.

Several causes of instability in field emission are outlined in the paper: 1) Mechanical effects of the electric field; 2) Vacuum arc effects; 3) Chemical surface reactions with active gases; 4) Structural weaknesses of certain materials used as cathodes; and 5) Ion bombardment considerations.

19. ELINSON, M.I., GOR'KOV, V.A., and VASIL'EV, G.F. Issledovanie odnogo sposoba umen'sheniia bombardirovki avtoelektronnykh katodov ionami ostatochnykh gazov.(A method of reducing the ion bombardment of field emitter cathodes). Radiotekh. i Elektron., 2, no. 2, 204-218 (1957). Illus., 5 refs. English translation: Radio Eng. and Electronics (U.S.S.R.), 2, no. 2, 107-127 (1957).

A method of reducing the positive ion bombardment on a field emitter tip by producing a special configuration of electric field is investigated. The effectiveness is evaluated and the change of the tip geometry under positive ion bombardment is analyzed. The techniques for the production of suitable electrode systems are described.(This paper was also read at the

Inter-Departmental Seminar on Cathode Electronics, Leningrad, March 4, 1957; cf. entry #21).

20. ELINSON, M.I., GOR'KOV, V.A., and VASIL'EV, G.F. Avtoelektronnaia emissiia reniia. (Field emission of rhenium). Radiotekh.i Elektron., 3, no.3, 307-312 (1958). Illus., 4 refs. English translation:Radio Eng. and Electronics, 3, no.3, 1-10 (1958).

Rhenium possesses a greater stability to ion bombardment than tungsten. Its weak adsorbing capacity,previously observed, is confirmed. Field emission patterns of rhenium emitters correspond to their hexagonal crystal structure. Analogous patterns for rheniated tungsten also show a distinct hexagonal structure for thicknesses of the rhenium layers of approximately 1500 atomic layers. (This paper was also read at the Eighth All-Union Conference on Cathode Electronics,Leningrad, 1957; cf. entry #3).

21. ELINSON, M.I. and IASNOPOL'SKAIA, A.A. Mezhduvedomstvennyi seminar po katodnoi elektronike. [4e zasedanie] (Inter-Departmental Seminar on Cathode Electronics; 4th session). Radiotekh. i Elektron.,2,no.5, 666-668 (1957). English translation: Radio Eng. and Electronics, 2, no.5, 204-208 (1957).

Brief description of field emission papers presented at the above Seminar held in Leningrad at the Institute of Radio Engineering and Electronics of the Academy of Sciences, USSR, March 4, 1957.(For annotations of papers read at the Seminar, see entries #8*, 19, 46*, 79*, 86*, 87*, and 88*).

22. ELINSON, M.I. and VASIL'EV, G.F. Avtoelektronnaia emissiia tantala. (Field emission from tantalum). Zhur. Tekh. Fiz., 26, no.8, 1669-1670 (1956). Illus., 2 refs. English translation: Soviet Phys. - Tech. Phys., 1, no.8, 1623-1625 (1957).

Experimental investigation of field emission from tantalum up to 2000° K and its comparison with tungsten are presented. Several microphotographs and field emission patterns are shown.

23. ELINSON, M.I. and VASIL'EV, G.F. Avtorskoe svidetel'stvo, reshenie no. 08-0218, Okt. 13, 1956. (Patent certificate no. 08-0218, dated October 13, 1956).

Description or exact title of patent was not available at the time of the compilation of this bibliography.

24. ELINSON, M.I. and VASIL'EV, G.F. Eksperimental'noe issledovanie avtoelektronnoi emissii geksaborida lantana. (Experimental investigation of field emission from lanthanum hexaboride). Radiotekh. i Elektron., 2, no.3, 348-350 (1957). Illus., 1 ref. English translation: Radio Eng. and Electronics, 2, no.3, 126-129 (1957).

The emitter was made of a pressed powder sample of LaB_6 by electrolytic etching in sulfuric acid. The point was degassed by electron bombardment. At 850° C a pattern characteristic of a cubic structure was obtained. The plot of $\ln I$ vs $\frac{1}{V}$ was linear. Heating of the point did not lead to smoothing as in the case of metals. It was concluded that the emission pattern was associated with lanthanum boride, although under heating a higher boride may have been formed on the surface. The lanthanum boride emitters are characterized by their high stability with respect to ion bombardment.

25. ELINSON, M.I. and VASIL'EV, G.F. Avtoelektronnaia emissiia. (Field emission). Moscow, Gos. izd-vo, fiz.-mat. lit., 1958. 272 p., 120 illus., 243 refs.

The six chapter headings of the book are: 1) Theory of field emission of metals; 2) Experimental investigation of field emission from pure metals; 3) Factors determining the stability of field emission from metals; 4) Theoretical and experimental investigation of field emission from semiconductors; 5) Electronic emission from metals in semiconductors and dielectrics in the presence of strong fields; 6) Applications of field emission.

Considerable emphasis is placed on the theoretical aspects of field emission. Of particular interest are chapters 4 and 5 in which the theory of field emission from semiconductors and dielectrics, the former developed by Morgulis and more completely by Stratton, is presented. It is noted that the experimental data are meager, but mention is made of the investigation of antimony, cesium on platinum, cadmium sulfide, cadmium selenide, and tungsten carbide as representative of the Russian work in this area. The Malter effect is discussed at some length.

Chapters 1, 2, 3, and 6 are similar to treatments found elsewhere, but the rounding out of the discussion with the extensive inclusion of Russian references is of interest. Field ion emission is discussed only briefly, and at the time of the publication of the book, had not

been under active investigation in the Soviet Union.

26. ELINSON, M.I. and VASIL'EV, G.F. Issledovanie avtoelektronnoi emissii geksaborida lantana. (Investigation of field emission of lanthanum hexaboride). Radiotekh. i Elektron., 3, no.7, 945-953 (1958). Illus., 4 refs. English translation: Radio Eng. and Electronics, 3, no. 7, 123-134 (1958).

The field emission pattern obtained with lanthanum hexaboride appears to be characteristic of the boride and not due to the formation of a surface layer on the tip. Smoothing of the surface cannot be obtained at high temperatures, in distinction to the behavior of metal tips. The current-voltage relationship for the field emission region is the same as that for metals. It is shown that a field-emission cathode of lanthanum hexaboride permits a substantial steady-state (~10 ma) and pulse (~1 amp) field-emission currents, corresponding to current densities of 10^7 amp/cm^2. The adsorption properties of the boride and its stability under ion bombardment have been investigated. (This paper was also read at the Eighth All-Union Conference on Cathode Electronics, Leningrad, 1957; cf. entries #3 and 24).

27. ELINSON, M.I. and VASIL'EV, G.F. Nekotorye osobennosti avtoelektronnoi emissii germaniia. (Certain special features of field emission from germanium). Radiotekh. i Elektron., 4, no. 4, 728-729 (1959). Illus., 4 refs. English translation: Radio Eng. and Electronics, 4, no. 4, 246-248 (1959).

The current-voltage characteristic for field emission from n-germanium is given. In spite of vacuum heat treatment, a symmetrical emission pattern could not be obtained. The surface could be cleaned by application of breakdown voltages, but an irregular surface results. The current-voltage curves show non-linearity both at high and low currents. The latter may be explained by the effect of surface states. The former is ascribed to the effects of strong internal fields in the semiconductor.

28. ELINSON, M.I., VASIL'EV, G.F., and ZHDAN, A.G. Avtoelektronnaia emissiia dielektrikov, soderzhashchikh primesi. (Field emission of dielectrics containing impurities). Radiotekh. i Elektron., 4,no.10, 1718-1731 (1959). Illus., 13 refs. English translation: Radio Eng. and Electronics, 4 (in process).

Field emission of new semiconductor emitters (dielectric materials, Al_2O_3 and SiO_2 with C impurities), the effect of temperature on field emission, and the temperature dependence of the conductivity of the emitter were investigated. A correlation between the electric conductivity and field electron emission was found. A marked difference was noted between conditions suitable for field electron and thermoelectron emission.

29. ELINSON, M.I. and ZERNOV, D.V. K voprosu o mekhanizme elektronnoi emissii tonkikh dielektricheskikh sloev pod deistviem sil'nogo elektricheskogo polia (effekta Moltera). (The mechanism of electron emission from thin dielectric layers under the action of a strong electric field (Malter effect). Radiotekh. i Elektron., 2, no.1, 75-84 (1957). Illus., 26 refs. English translation: Radio Eng. and Electronics, 2, no.1, 112-126 (1957).

The basic experimental evidence for the existence of the Malter effect is given. Present theories do not explain all the experimental facts. A new point of view based on an assumption of an essentially non-uniform distribution of potential inside the dielectric film is presented. Tunnel ionization of impurities, impact ionization by fast tunnelling electrons, and thermal-field effects are discussed. (This paper was also read at the Inter-Departmental Seminar on Cathode Electronics, Leningrad, March 4, 1957; cf. entry #21).

30. ELINSON, M.I. and ZHDAN, A.G. Novye svoistva elektronnoi emissii sistem soderzhashchikh tonkie dielektricheskie sloi. (New properties of electron emission from systems containing thin dielectric layers). Radiotekh. i Elektron., 4, no.1, 135-137 (1959). Illus., 2 refs. English translation: Radio Eng. and Electronics, 4, no.1, 221-225 (1959).

Field emission from the system W-SiO_2-C is described. The emitter is prepared by depositing a layer of quartz from the gas phase onto a tungsten point. Carbon is introduced by deposition and thermal diffusion. (See also entry #28).

31. GAVRILIUK, V.M. Soveshchanie po katodnoi elektronike. («All-Union» Conference on Cathode Electronics). Uspekhi Fiz. Nauk, 59, no. 2, 363-374 (1956).

Some advances have been noted in the following areas: 1) Production of large emission densities and field emission microscope design of instruments based on field emission phenomena; 2) Development of field elec-

tron and ion emission microscopes and the study of the nature of field emission patterns; 3) Application of field microscopes to the study of surface phenomena; 4) Field emission phenomena in gaseous discharges. This outline is followed by brief descriptions of papers presented at the above Conference held at the Institute of Physics Academy of Science of the Ukrainian S.S.R., Kiev, Nov. 25-29, 1955. (For annotations of field emission reports reviewed in this article, see entries #12, 32, 53, 58, 62, 65, 84, 89, 94, and 105. Also, cf. entries #11 and 70).

32. GAVRILIUK, V.M. Vplyv adsorbovanoi plivky atomiv bariiu i molekul oksydu bariiu na robotu vykhodu elektrona z metalu. (Effect of adsorbed barium atom films and barium oxide molecules on the work function of metals). Ukrain. Fiz. Zhur., 1, no.1, 73-80 (1956). Illus., 10 refs. [In Ukrainian with summary in Russian].

A linear decrease (to a minimum value of 2 ev) in the work function of tungsten with BaO coverage was observed. After heating, another minimum of 1.0 ev was obtained. Similar observations were made for the systems: barium on gold, barium on tungsten, cesium chloride on tungsten, and barium oxide on gold. (This paper was also read at the All-Union Conference on Cathode Electronics, Kiev, November 25-29, 1955. Cf. entries #11, 31, and 70).

33. GAVRILIUK, V.M. Vliianie adsorbirovannykh plenok atomov bariia i poliarnykh molekul okisi bariia na rabotu vykhoda elektrona iz vol'frama, zolota i germaniia. (Effect of adsorbed barium films and barium oxide polar molecules on the work function of tungsten, gold, and germanium). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 20, no.9, 1071-1075 (1956). Illus., 8 refs. English translation: Bull. Acad. Sci. U.S.S.R., Phys. Ser., 20, no. 9, 967-971 (1956).

For annotation see entry #32.

34. GAVRILIUK, V.M. and IAZEVA, V.G. Sposterezheniia adsorbtsii atomiv Ba i molekul BaO v avtoelektronnomu proektori. (Field emission observations on adsorption of Ba atoms and BaO molecules). Ukrain. Fiz. Zhur., 3, no. 3, 421-424 (1958). Illus., 3 refs.

By means of a field emission microscope, adsorption and surface diffusion coefficients (D) of Ba on the various faces of W single crystals were investigated. At 660°K on the 112 plane, $D=93.10^{-14}cm^2/sec$. It was shown that the adsorption on the 111 plane is stronger than on the 011 plane. This is supported by the fact that the 111 plane with the adsorbed layer shows a lower work function than the 011 plane. When O was adsorbed on the surface of W, Ba diffusion did not occur. Adsorption and diffusion of BaO molecules on various planes of W was also studied. BaO molecules, unlike Ba atoms, are strongly adsorbed on the 112 planes.

35. GOFMAN, I.I., SMIRNOV, B.G., SPIRIN, G.S., and SHUPPE, G.N. K voprosu ob elektrostaticheskoi elektronnoi emissii poluprovodnikov.(Field emission from semiconductors). Zhur. Tekh. Fiz., 27, no.11,2662-2663 (1957). Illus., 2 refs. English translation: Soviet Phys.--Tech. Phys., 2, no.11, 2471-2473 (1957).

    The emission tip was carbided tungsten. It is claimed that the results support the work of Stratton, who developed the analogue of the Fowler-Nordheim equation for semiconductors.

36. GORBATYI, N.A. K voprosu o vliianii sil'nogo elektricheskogo polia ($\sim 10^6$v/cm) na isparenie i soprotivlenie metallov (Mo,Ta,W). (Effect of strong electric fields ($\sim 10^6$v/cm) on the evaporation and resistance of metals (Mo,Ta,W). Dissertation [for the equivalent of Ph.D. in physics]. Sredneaziatechkii Universitet, Tashkend. [Central Asia State University, Tashkend, 1958]).

    The original dissertation was not available at the time of the compilation of this bibliography. For annotation see entry #43.

37. GORBATYI, N.A., RESHETNIKOVA, L.V., SYTAIA, E.P., and SHUPPE, G.N. Elektrostaticheskaia emissiia s monokristalla tantala.(Electrostatic emission from a tantalum single crystal). Zhur. Tekh. Fiz., 27, 296-298 (1957). Illus., 10 refs. English translation:Soviet Phys.--Tech. Phys., 2, no.2, 262-265 (1957).

    Emission patterns from a tantalum field emitter were observed. The pattern of clean tantalum resembled that of clean tungsten except for the absence of the 112 planes. The 334 planes were observed in the pattern of contaminated tantalum points.

38. GORBATYI, N.A., RESHETNIKOVA, L.V., SYTAIA, E.P., and SHUPPE, G.N. Elektrostaticheskaia emissiia s monokristalla tantala.(Electrostatic emission from tantalum single crystals). Trudy Sredneaziats. Gosudarst. Univ., 91, Fiz.-Mat. Nauki, no. 15, 39-42 (1957). Illus., 12 refs.

For annotation see entry #37.

39. GORBATYI, N.A. and SHUPPE, G.N. K voprosu o zavisimosti adsorbtsionnykh sviazei na metallicheskom monokristalle ot kristallograficheskikh napravlenii. (Dependence of adsorption on metal crystals upon the crystallographic orientation). Zhur. Tekh. Fiz., 25, no. 8, 1364-1375 (1955). Illus., 11 refs.

The adsorption of Na, K and Mg on a W tip at various temperatures was observed in a field emission microscope. The migration of adsorbed molecules toward the crystal boundaries, the desorption by heating, and the effect of electronegative contaminants are discussed. Migration depends on the strength and the direction of the electric field. Several emission photographs are presented and analyzed.

40. GORBATYI, N.A. and SHUPPE, G.N. Isparenie molibdena i vol'frama v sil'nom elektricheskom pole. (Evaporation of molybdenum and tungsten in strong electric fields). Doklady Akad. Nauk Uzbek. S.S.S.R., no. 12, 13-16 (1957).

Mo and W wires were heated in high electrostatic fields. The rate of evaporation was determined by loss in weight of the Mo wire and by use of W^{185} in the W wire. No definite effect of field strength on the rate of evaporation was established. The heat of evaporation of W was determined as 8.1 ev/atom.

41. GORBATYI, N.A. and SHUPPE, G.N. Ob isparenii tantala v sil'nom elektricheskom pole. (Evaporation of tantalum in strong electric fields). Izvest. Akad. Nauk Uzbek. S.S.R., Ser. Fiz.-Mat. Nauk, no. 3, 39-46 (1957). Illus., 8 refs.

For annotation see entry #43.

42. GORBATYI, N.A. and SHUPPE, G.N. K voprosu o vliianii sil'nogo elektricheskogo polia na soprotivlenie metallicheskikh provolok. (Effect of strong electric fields on the resistance of metal wires). Izvest. Akad. Nauk Uzbek. S.S.R., Ser. Fiz.-Mat. Nauk, no. 1, 65-73 (1958). Illus., 12 refs.

For annotation see entry #40.

43. GORBATYI, N.A. and SHUPPE, G.N. K voprosu o vliianii sil'nogo elektricheskogo polia ($\sim 10^6$v/cm) na isparenie i soprotivlenie metallov (Mo, Ta, W). (Effect of strong electric fields ($\sim 10^6$v/cm) on the evaporation and resistance of metals (Mo, Ta, W). Zhur. Tekh. Fiz., 28, no. 3, 623-635 (1958). Illus., 11 refs. English translation: Soviet Phys.--Tech. Phys., 3, no. 3, 587-596 (1958).

Measurements of evaporation by weight loss and by tracer techniques (Ta^{182}) indicated that electric fields of 10^6v/cm had no effect on the rate of evaporation of Mo, Ta, and W wires. By using tracer techniques the heat of evaporation of Ta and W was determined and the rate of evaporation for various temperatures was measured. data were in agreement with that published elsewhere. (This paper was also read at the Eighth All-Union Conference on Cathode Electronics, Leningrad, 1957. Cf. entries #3 and 40).

44. IONOV, N.I. Poverkhnostnaia ionizatsiia molekul khloristogo kaliia i khloristogo tseziia v elektricheskom pole. (Surface ionization of potassium chloride and cesium chloride molecules in an electric field). Zhur. Tekh. Fiz., 26, no. 10, 2200-2203 (1956). Illus., 4 refs. English translation: Soviet Phys.--Tech. Phys., 1, no.10, 2134-2137 (1957).

The effect of an electric field upon the temperature threshold of the appearance of positive ions during the surface ionization of KCl and CsCl molecules is discussed. This phenomenon is related to the degree of surface coverage, and this in turn varies with the heat of evaporation of the adatoms.The heat of evaporation is affected by the electric field when the adatoms are in the ionic state. The temperature threshold of surface ionization depends on the field intensity at the surface. (See also entry #105).

45. KLIMIN, A.I. Avtoelektronnaia emissiia s sul'fida i selenida kadmiia. (Field emission from cadmium sulfide and selenide). Zhur.Tekh.Fiz., 27, no.4, 719-721 (1957). Illus., 8 refs. English translation:Soviet Phys.--Tech.Phys., 2, no.4, 649-651 (1957).

Field emission from cadmium sulfide (and cadmium selenide) was studied by fastening crystals of these substances to a molybdenum holder with aquadag. The points were made by electron bombardment. Field emission was obtained at anode voltages ranging from 2 to 10 kv. Illumination of the emitter gave an increased emission current. The form of the spectral distribution curve of the photo-induced field emission agrees with that of the spectral distribution curves of photoconductivity in CdS. (This paper was also read at the Eighth All-Union Conference on Cathode Electronics, Leningrad, 1957; cf. entry #3).

46*. KLIMIN, A.I. Avtoelektronnaia emissiia iz germanii i sul'fida kadmii. (Field emission from germanium and cadmium sulfide). Reviewed in: entry #21. Radiotekh. i Elektron., 2, no.5, 668 (1957). English translation: Radio Eng. and Electronics (U.S.S.R.), 2, no.5, 207-208 (1957).

Cadmium sulfide and cadmium selenide single crystals and chips of germanium crystals served as cathodes. Over a wide range of current values (five orders of magnitude) a straight line dependence of log current vs reciprocal voltage was observed. From the temperature dependence of the field emission it was possible to establish the transition from extrinsic to intrinsic conductivity and to determine the width of the forbidden band in germanium. (Paper read at the Inter-Departmental Seminar on Cathode Electronics, Leningrad, March 4, 1957). (See also entry #45).

47. KOMAR, A.P., SAVCHENKO, V.P., and SHREDNIK, V.N. Elektronnye avtoemissionnye izobrazheniia kristallov uporiadochivaiushchikhsia splavov. (Field electron emission patterns of crystals of ordered alloys. Doklady Akad. Nauk S.S.S.R., 129, no.3, 540-543 (1959). Illus., 3 refs. English translation: Soviet Phys.--Doklady, 4, no.6, 1286-1288(1960).

Ni_3Mn, Cu_3Au, and Cu_3Pt alloy crystals were studied in the 360-1060° temperature range. Several field emission patterns are shown. Gomer's technique (observation of whiskers) is adapted to the investigation of alloy systems. (This paper was also read at the Sixth Field Emission Symposium held at the National Bureau of Standards, Washington, D.C., June 22-24, 1959).

48. KOMAR, A.P. and SELITSKII, IU.A. Opyty s ionnym proektorom. (Field ion emission experiments). Doklady Akad. Nauk S.S.S.R., 96, no. 5, 957-958 (1954). Illus., 4 refs.

Structural changes on the surface of single crystals of W, Mo, Fe, and other metals were studied by means

of a field emission microscope. The use of field ion microscopes was also discussed.

49. KOMAR, A.P. and SHREDNIK, V.N. Izuchenie allotropicheskogo prevrashcheniia $\alpha \rightleftarrows \beta$ Zr pri pomoshchi elektronnogo proektora.(Field emission microscopic study of the allotropic transformation $\alpha \rightleftarrows \beta$ Zr). Zhur. Eksp. i Teor. Fiz., 32, no. 1, 184 (1957). Illus., 4 refs. English translation: Soviet Phys.--JETP., 5, no. 1, 127-128 (1957).

For annotation see entry #50.

50. KOMAR, A.P. and SHREDNIK, V.N. Prevrashcheniia $\alpha \rightleftarrows \beta$ tsirkoniia po nablodeniiam s pomoshch'iu elektronnogo proektora. (The $\alpha \rightleftarrows \beta$ Zr). transformation in zirconium, from field emission observations). Fiz. Metal. i Metalloved., 5, no. 3, 452-464 (1957). English translation: Phys. Metals and Metallography (U.S.S.R.), 5, no.3, 65-76 (1957).

For the cubic-hexagonal transformation, as a rule, only one of the possible orientations of the new phase relative to the original was produced; this is connected with the substantial part played by surface energy for crystals of small size. Indications of dislocations in the zirconium crystals were found. The origin of these dislocations may be associated with the diffusionless transformation mechanism. (This paper was also read at the Eighth All-Union Conference on Cathode Electronics, Leningrad, 1957; cf. entry #3).

51. KOMAR, A.P. and SHREDNIK, V.N. The investigation of phase transformation $\alpha \rightleftarrows \beta$ Zr. [In English]. In: Vierter Internationaler Kongress für Elektronenmikroskopie. Berlin, September 10-17, 1958. Verhandlungen, Band I; Physikalisch-Technischer Teil. Berlin, Springer-Verlag, 1960, pp. 792-796. Illus., 6 refs.

For annotation see entry #50.

52. KOMAR, A.P. and TALANIN, IU.N. Izuchenie kristallizatsii primesei na poverkhnosti kristalla s pomoshch'iu elektronnogo i ionnogo proektorov. (Study of impurity crystallization on crystal surfaces using field electron and ion emission microscopes). In: Soveshchanii po rostu kristallov. 1st, Moscow, 1956. Moscow, Izd-vo Akad. Nauk S.S.S.R., 1957, pp. 110-118. Illus., 16 refs. English translation: Growth of Crystals (Rost kristallov). New York, Consultants Bureau, c1958, pp. 86-93.

This report was presented at the First Conference on Crystal Growth held at the Institute of Crystallography, Moscow, March 5-10, 1956. It describes observations on the emission pattern of tungsten with oxygen and carbon contamination. The crystal form of the emitter under various conditions is discussed.

53. KOMAR, A.P. and TALANIN, IU.N. Opyty s elektronnym i ionnym proektorom. (Experiments with a field electron and ion microscope). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 20, no.10, 1137-1141 (1956). Illus., 15 refs. English translation: Bull. Acad. Sci. U.S.S.R., Phys. Ser., 20, no.10, 1029-1034 (1956).

A tungsten tip emitter was used in a continuously evacuated field emission microscope. Several observations could be made in spite of relatively poor ($\sim 10^{-7}$mm) vacuum conditions. In strongly contaminated W and Mo points the formation of hexagonal W_2C and Mo_2C was observed. (This paper was also read at the All-Union Conference on Cathode Electronics, Kiev, November 25-29, 1955; cf. entries #11, 31, and 70).

54. KOMAR, A.P. and TALANIN, IU.N. The formation of carbides on the surface of Mo and W single crystals. [In English]. In: Vierter Internationaler Kongress für Elektronenmikroskopie. Berlin, September 10-17, 1958. Verhandlungen, Band I; Physikalisch-Technischer Teil. Berlin, Springer-Verlag, 1960, pp. 817-819. Illus., 4 refs.

The formation of W_2C and Mo_2C crystals were studied by means of a field emission microscope. W and Mo crystals were heated to 1300°C (in a 10^{-8}mm vacuum) where the carbide formation occurred. At higher temperatures (2300° - 2500°C) the hexagonal form transformed into the cubic form. Cf. entry #93.

55. KOMAR, A.P. and TALANIN, IU.N. Kartiny avtoelektronnoi emissii kristallov karbidov vol'frama i molibdena. (Field emission patterns of tungsten and molybdenum carbide crystals). Izvest. Akad. Nauk. S.S.S.R., Ser. Fiz., 22, no. 5, 580-593 (1958). Illus., 20 refs. English translation: Bull. Acad. Sci. U.S.S.R., Phys. Ser., 22, no. 5, 579-591 (1958).

(This paper was also read at the Eighth All-Union Conference on Cathode Electronics, Leningrad, 1957; cf. entry #3. For annotation see entry #54).

56. KOMPANEETS, A.S. Vliianie ob'emnogo zariada na avtoelektronnuiu emissiiu. (Effect of space charge on field emission).Doklady Akad. Nauk S.S.S.R., 128, no.6, 1160-1162 (1959).Illus., 6 refs. English translation: Soviet Phys.--Doklady, 4, no. 5, 1077-1079 (1959).

The effect of space charge on field emission at current densities of the order of 10^7 amp/cm^2 is discussed. Spherical geometry is considered. For large current densities, introduction of an image force correction function to the current density equation is recommended.

57. KRYLOV, K.I. and FEDOROV, V.L. Nekotorye voprosy avtoelektronnoi emissii. (Problems in field electron emission). Izvest. Leningrad Elektrotekh. Inst., 36, 68-77 (1958). Illus., 22 refs.

The causes underlying the instability of field emission and various possible methods for eliminating these causes are discussed; a new design for field emission cathodes is suggested.Experiments designed for the study of stability and for the investigation of useful life of field emission emitters are described.

58. LEBEDEV, A.A. Vstupitel'noe slovo (Opening address). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 20, no. 9, 975-976 (1956).English translation: Bull. Acad. Sci. U.S.S.R., Phys. Ser., 20, no. 9, 881-882 (1956).

This is a general introduction and brief survey of the topics presented at the All-Union Conference on Cathode Electronics, Kiev, November 25-29, 1955. (Cf. entries #11, 31, and 70).

59. LIFSHITS, T.M. and IASNOPOL'SKAIA, A.A. Mezhduvedomstvennyi seminar po katodnoi elektronike. 1-3, Leningrad, Dek.3, 1956. (Inter-Departmental Seminar on Cathode Electronics, 1st Session, Leningrad,Dec.3, 1956). Radiotekh. i Elektron., 2, no. 2, 253-255 (1957). English translation: Radio Eng. and Electronics (U.S.S.R.), 2, no. 2,179-183 (1957).

At the first seminar of the above series,which dealt with photo- and secondary electron emission, it was announced that the seminars would meet provisionally on the first Monday of each month at the Institute of Radio Engineering and Electronics of the U.S.S.R. Academy of Sciences, Leningrad. Field emission was scheduled as the topic of the March 4, 1957 Seminar. (Cf. entry #21).

60. MĘCLEWSKI, R. and WOJDA, L. On the influence of the shape of the nickel point on the electron image in the Müller microscope. Acta Phys. Polon., 14, no.6, 501 (1955). Illus., 9 refs. [In English].

This is a brief preliminary paper on the subject presented in entry #61.

61. MĘCLEWSKII, R. and WOJDA, L. The role of the emitter shape in cold emission research. Acta Phys. Polon., 16, nos. 1-2, 25-33 (1957). Illus., 17 refs. [In English].

Observations were made on the build-up of iron and nickel points while being heated in high fields. These points were also examined by means of an electron microscope. The authors note that the build-up process resulted in local changes of the electric field distribution over the point.

62. MORGULIS, N.D. Nekotoryė itogi i zadachi issledovanii v oblasti katodnoi elektroniki. (A survey of research accomplishments and problems in the field of cathode electronics). Izvest.Akad.Nauk S.S.S.R., Ser. Fiz., 20, no.9, 977-992 (1956). 50 refs. English translation: Bull. Acad. Sci. U.S.S.R., Phys. Ser., 20, no.9, 883-897 (1956).

Review of papers dealing with thermo-, field, photo-, and secondary emissions and surface ionization phenomena. Part 2 (pp. 981-983 in the Russian text and pp. 886-888 in the English translation) is a literature survey of Soviet and Western field emission papers published prior to 1955. (This paper was also read at the All-Union Conference on Cathode Electronics, Kiev, November 25-29, 1955; cf. entries #11, 31, and 70).

63. MORGULIS, N.D. Issledovaniia uchenykh Ukrainy v oblasti fizicheskoi elektroniki. (Ukrainian research in physical electronics). Vestnik Akad. Nauk S.S.S.R., 27, no. 5,51-55 (1957). English translation: F-TS-9936/III, Wright-Patterson AFB (in process).

Review of research work in the above subject area completed between 1955 and 1957. References are made to advances in field emission research.

64. MORGULIS, N.D. Problemy katodnoi elektroniki. (Problems in cathode electronics). Vestnik Akad. Nauk S.S.S.R., 28, no. 9, 47-52 (1958).

Survey of the technical aspects of this research and development area. The following field emission topics are discussed: the tunnel effect, strong (10^7-10^8 v/cm)

electric field effects on pure metals, semiconductors and dielectrics, study of surface phenomena, the feasibility of photo-controlled field emission, high-resolution field ion emission for the study of electronic and molecular phenomena, improved emitter design and technical applications.

65. MORGULIS, N.D. and GAVRILIUK, V.M. Vliianie adsorbirovannoi plenki dipol'nykh molekul na rabotu vykhoda elektrona iz metalla. (Effect of adsorbed films of dipole molecules on the electron work function). Zhur. Eksp. i Teor. Fiz., 30, no. 1, 149-159 (1956). Illus.,19 refs. English translation: Soviet Phys.--JETP., 3, no. 2, 159-167 (1956).

The variation of the work function produced by the deposition of cesium chloride on tungsten was investigated. Film thicknesses were measured using the radioactive Cs^{134} in admixture with the CsCl. It was found that CsCl decreases the work function, but less than that of cesium atoms. A theoretical interpretation of results is presented. (This paper was also read at the All-Union Conference on Cathode Electronics, Kiev, November 25-29, 1955; cf. entries #11, 31, and 70).

66. MORGULIS, N.D. and GAVRILIUK, V.M. Vliianie adsorbirovannykh plenok dipol'nykh molekul na raboty vykhoda elektrona iz metalla.(Effect of adsorbed films of dipole molecules on the electron work function).Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 20, no. 9, 1069-1070 (1956). 3 refs. English translation: Bull. Acad. Sci. U.S.S.R.,Phys. Ser., 20, no. 9, 965-966 (1956).

Paper read at the All-Union Conference on Cathode Electronics, Kiev, November 25-29, 1955. For annotation see entry #65; cf. entries #11, 31, and 70).

67. MORGULIS, N.D. and GAVRILIUK, V.M. Sorok let sovetskoi katodnoi elektroniki. (Forty years of Soviet cathode electronics). Radiotekh. i Elektron., 2, no. 11, 1451-1467 (1957). English translation:Radio Eng. and Electronics, 2, no. 11, 193-217 (1957). 174 refs.

Survey of Soviet literature on the above topic. Among many relevant subject areas, field emission papers are briefly discussed on p. 202 and on p. 207 of the English translation. (For annotations of papers included in this survey, see entries #22, 39, 44, 53, 89, and 105).

68. NIKLIBORC, J. Emisja polowa elektronow z metali.(Field emission from metals). Postepy Fizyki, 8, no.1, 23-44 (1957). Illus., 70 refs. [In Polish].

This is a review article of the Western and Russian literature from 1928 to 1956 on field emission from metals.

69. NIKLIBORC, J. Polowa mikroskopia jonowa. (Field ion emission microscopy). Postepy Fiz., 9, no. 4, 417-428 (1958). Illus., 18 refs. [In Polish].

Review of the design and principles governing field ion microscopes. The mechanism of image formation and the factors affecting resolution are discussed. The principles of field desorption are also given.

70. PTUSHYNSKYI, IU.N. Narada z katodnoi elektroniki. (Conference on Cathode Electronics). Ukrain. Fiz. Zhur., 1, no. 2, 204-206 (1956). [In Ukrainian].

Report on the Conference held at the Institute of Physics of the Ukrainian Academy of Sciences, Kiev, November 25-29, 1955. The meetings were organized as: 1)Thermoelectric emission -- opening address by B.M. Tsar'ev, and 15 other contributions, 2) Field emission -- opening address by D. V. Zernov, #104, and two other papers: Komar and Talanin,#53, and Sokol'skaia,#89, 3) Secondary electron emission -- opening address by L.M. Dobretsov, and 8 other papers, 4) Photoelectric emission -- opening address by P.V. Timofeev, and 19 other papers.

For annotations of other field emission reports reviewed in this article, see entries #12, 32, 53, 58, 62, 65, 84, 89, 94, and 105; cf. entries #11 and 31.

71. ROGINSKII, S.Z. and SHISHKIN, V.A. Issledovanie adsorbtsii nepredel'nykh ftoruglerodov C_2F_4 and C_3F_6 v elektronnom proektore. (Investigation of the adsorption of unsaturated fluorocarbons C_2F_4 and C_3F_6 in a field emission microscope). Doklady Akad. Nauk S.S.S.R., 130, no. 3, 577-580 (1960). Illus., 6 refs. English translation: Soviet Phys.--Doklady (in process).

The "spot" patterns of C_2F_4 and C_3F_6 on tungsten were investigated. Some interpretations involving the pi-bonds of these compounds are proposed.

72. ROGINSKII, S.Z. and TRET'IAKOV, I.I. O nekotorykh iavleniiakh, nabliudaemykh na poverkhnosti vol'framovogo monokristalla v elektronnom mikroskope-proektore v prisutstvii gazov. (On certain phenomena observed on the surface of tungsten single crystals in a field emission microscope in the presence of gases. Doklady Akad.Nauk S. S.S.R., 105, no. 1, 112-114 (1955). Illus., 4 refs.

Field emission microscope observations of tungsten surfaces in the presence of hydrogen, oxygen, and helium are described qualitatively. These include the formation of a granular pattern on the screen, the lowered emission due to the adsorbed layer, heightened emission spots, and pulling-off of the tips.

73. ROGINSKII, S.Z. and TRET'IAKOV, I.I. Issledovanie adsorbtsii prostykh gazov na metallicheskikh monokristallakh pri pomoshchi emissionnogo mikroskopa-proektora. (Study of the adsorption of simple gases on metal single crystals by means of a field emission microscope). Zhur. Fiz. Khim., 30, no. 11, 2539-2546 (1956). Illus., 17 refs. English translation: ATS-79J14R., 11 p.

Electron emission from a W tip of 0.2 μ diameter was decreased by H, O, or N at 10^{-8} mm. The presence of He caused no observable effect. At 10^{-7} mm and higher pressures, H, O, N, and A caused the formation of strongly-emitting patches which appeared and disappeared as a unit. (See also entry #72).

74. ROMANOV, A.M. and STARODUBTSEV, S.V. O roli neodnorodnosti poverkhnosti pri adsorbtsii i ionizatsii natriia i litiia na vol'frame. (Role of the surface structure in the adsorption and ionization of sodium and lithium on tungsten). Izvest. Akad. Nauk Uzbek. S.S.R., Ser. Fiz.-Mat. Nauk, no.3, 11-26 (1957). Illus., 22 refs.

The surface of a tungsten emitter is a patch structure with various work functions.Data and graphs for adsorption and ionization of Na and Li on various W surfaces are shown. Na and Li are adsorbed first on the parts of the surface with an open structure (112 planes).The opposite effect was observed with respect to ionization of Na and Li.

75. ROMPE, R. Nekotorye issledovaniia "kholodnoi" elektronnoi emissii monokristallov sernistogo kadmiia. (Study of "cold" electron emission from cadmium sulfide single crystals). Radiotekh. i Elektron., 2, no.2, 219-221 (1957). Illus. English translation: Radio Eng. and Electronics (U.S.S.R.), 2, no.2, 128-132 (1957).

Field emission from cadmium sulfide was investigated. The crystal was mounted in Wood's metal and then split to form a sharp tip. Fluorescence of the CdS was observed during emission. In experiments where the tip was illuminated, the spectral variation of the emission process is similar to that of photo-conductivity.

76. ROZENTSVEIG, L.N. O poluchenii puchka poliarizovannykh elektronov. (On obtaining a polarized electron beam). Zhur. Eksp.i Teor. Fiz., 31, no.3, 520-521 (1956). Illus., 6 refs. English translation: Soviet Phys.--JETP., 4, no. 3, 455-456 (1957).

It is proposed that a beam of electrons may be produced that is preferentially polarized by the application of of a magnetic field to a field emitter. A temperature of 20°K, a field of 10^6v/cm, and a magnetic field of the order of 10^5 gauss is required. A formula was developed for the dependence of current density on field strength for plane electrodes. The effect of space charge was also taken into consideration.

77. SCHMIDT, G. Cold emission at high current densities. Magyar Tudományos Akad., Központi Fiz.Kutató Intézetének Közleményei, 4, no.1,76-82 (1956). [In English].

A formula was developed for the relationship between current densities in cold emission and intensity for plane surface electrodes providing for the effects of ambient charges.

78. SCHMIDT, G. Electrical discharges in high vacuum. Acta Phys. Acad. Sci. Hung., 4, no.1-2, 1-12 (1958). Illus., 16 refs. [In English].

The mechanism of the breakdown in high vacuum and of the discharge preceding the breakdown have been investigated. It is concluded that there is no essential difference between the breakdown at low or at high voltages. Measurements indicate that only electrons play an important part in the pre-discharge phase of the breakdown.

79*. SHREDNIK, V.N. Avtoelektronnaia emissiia tsirkoniia na vol'frame. (Field emission of zirconium on tungsten). Reviewed in: entry #21. Radiotekh. i Elektron., 2, no. 5, 666 (1957). English translation: Radio Eng. and Electronics (U.S.S.R.), 2, no. 5, 205 (1957).

The distribution of zirconium over a surface of tungsten depends on the temperature: up to 1100-1200°C the zirconium is adsorbed preferentially in the region of the 001

boundaries; at higher temperatures it persists longer on the 113, 111, and 112 planes. Upon heating in an electric field, the surface covered by the zirconium is built up in a characteristic way. (Paper read at the Inter-Departmental Seminar on Cathode Electronics, Leningrad, March 4, 1957; cf. entry #21).

80. SHREDNIK, V.N. Adsorbtsiia tsirkoniia i bariia na vol'frame i rabota vykhoda elektronov. (Adsorption of zirconium and barium on tungsten and the electron work function). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 22, no. 5, 594-604 (1958). Illus., 20 refs. English translation: Bull. Acad. Sci. U.S.S.R., Phys. Ser., 22, no. 5, 592-603 (1958).

(This paper was also read at the Eighth All-Union Conference on Cathode Electronics, Leningrad,1957. For annotation see entry #81; cf. entry #3).

81. SHREDNIK, V.N. K voprosu o rasshifrovke avtoemissionnykh izobrazhenii metalloplenochnykh katodov. (The problem of the interpretation of field emission patterns of metal-film cathodes).Fiz.Tverdogo Tela, 1, no. 7, 1134-1139 (1959). Illus., 9 refs.English translation: Soviet Phys.--Solid State, 1, no. 7, 1037-1042 (1960).

The distribution of intensities in field emission patterns is caused by variation of both work function and local field over the surface. Experimental techniques for differentiating between these effects are given. These are: 1) Additional deposition, 2) Thermal-field emission, 3) Detection of planes by "collar" formation, and 4) Rearrangement in the electric field. These methods are applied to the systems Zr-W and Ba-W. (This paper was also read at the Sixth Field Emission Symposium held at the National Bureau of Standards, Washington,D.C. June 22-24, 1959).

82. SHREDNIK, V.N. Simpozium po avtoelektronnoi emissii. (Symposium on field emission).Vestnik Akad. Nauk S.S.S.R.,29,no.11,83-85(1959)Illus.

The proceedings of the Sixth Field Emission Symposium held at the National Bureau of Standards,Washington,D.C. June 22-24,1959 are described.(For annotation of Russian papers presented at the Symposium,cf.entries #47 and 81).

83. SHUPPE, G.N. Elektronnaia emissiia metallicheskikh kristallov.(Electron emission of metal crystals). Trudy Sredneaziats. Gosudarst. Univ., 115, Fiz.-Mat. Nauki, no. 17 (1957). 110 p. Illus.,141 refs.

Review of the literature on the dependence of mostly thermo-electron emission on the crystallographic orientation of pure surfaces of metal (Ag, Cu, Bi, Zn)

single crystals. The author's experimental work completed in this field between 1945 and 1956 is outlined. The work function of the various crystallographic planes of W single crystals is discussed in detail.

84. SHUPPE, G.N., SYTAIA, E.P., and KADYROV, R.M. Rabota vykhoda elektronov grani (110) monokristalla vol'frama i polozhitel'naia poverkhnostnaia ionizatsiia natriia na etoi grani. (Work function of the 110 plane of tungsten single crystals and positive surface ionization of sodium on this plane). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 20, no. 10, 1142-1150 (1956). English translation: Bull. Acad.Sci.,Phys. Ser., 20, no. 10, 1035-1043 (1956). Illus., 23 refs.

A review and analysis of data on the above topic reported by Western and Russian researchers. (This paper was also read at the All-Union Conference on Cathode Electronics, Kiev, November 25-29, 1955; cf. entries #11, 31, and 70).

85. SHUPPE, G.N., SYTAIA, E.P., and KADYROV, R.M. Polozhitel'naia poverkhnostnaia ionizatsiia natriia i kaliia i rabota vykhoda elektronov u grani (110) monokristalla vol'frama. (Positive surface ionization of sodium and potassium, and the electron work function of tungsten single-crystal faces). Trudy Sredneaziats. Gosudarst. Univ., 91, Fiz.-Mat. Nauki, no. 15, 5-15 (1957). Illus., 24 refs.English translation: Wright-Patterson AFB (in process).

(For annotation see entry #84).

86.* SIMONOV, V.A. Issledovanie proboi v vysokom vakuume pri nalichii podzhigaiushchei iskry. (Investigation of breakdown in high vacuum in the presence of sparks). Reviewed in: entry #21. Radiotekh. i Elektron., 2, no.5, 667 (1957). English translation: Radio Eng. and Electronics (U.S.S.R.), 2, no.5, 206-207 (1957).

The mechanism of discharge in vacuo in the presence of sparks was studied. Discharge phenomena in vacuo can also be observed following the initiation of vacuum arcs by field emission currents, by heating the cathode tip, and by local heating of the cathode by rapidly moving macroscopic particles. (Paper read at the Inter-Departmental Seminar on Cathode Electronics, Leningrad, March 4, 1957).

87*. SLIVKOV, I.N. O mekhanizme proboia v vakuume. (Mechanism of breakdown in vacuum). Reviewed in: entry #21. Radiotekh. i Elektron., 2, no.5, 668 (1957). English translation: Radio Eng. and Electronics (U.S.S.R.), 2, no.5, 207 (1957).

Investigations of breakdown in vacuo for the case of plane and spherical steel electrodes. A formula is derived for breakdown voltage $UE_K.E_A^{2/3}$ constant, where U is the breakdown voltage, E_K is the field strength at the cathode, E_A is the field strength at the anode, and the value of the constant depends on the material, shape and disposition of the electrodes. (Paper read at the Inter-Departmental Seminar on Cathode Electronics, Leningrad, March 4, 1957).

88*. SOBOLEVA, A.A. Avtoelektronnaia emissiia v prisutstvii vodoroda. (Field electron emission in the presence of hydrogen). Reviewed in: entry #21. Radiotekh. i Elektron., 2, no.5, 667 (1957). English translation: Radio Eng. and Electronics, 2, no. 5, 205-206 (1957).

Field electron emission was investigated as a function of the pressure of hydrogen. An increase in the pressure caused a decrease in field emission currents. At a $1x10^6$ v/cm field strength, optical microscopic observations were made of the bright spots at the surface of the emitter point. (Paper read at the Inter-Departmental Seminar on Cathode Electronics, Leningrad, March 4, 1957).

89. SOKOL'SKAIA, I.L. Poverkhnostnaia migratsiia atomov vol'frama v elektricheskom pole. (Surface migration of tungsten atoms in an electric field). Zhur. Tekh. Fiz., 26, no. 6, 1177-1184 (1956). Illus., 9 refs. English translation: Soviet Phys.--Tech. Phys., 1, no.6, 1147-1154 (1956).

The energy of activation for surface migration under high field conditions (10^8 v/cm) was determined by rate measurements for establishing the steady state. This was determined to be 2.4 ± 0.2 ev over the temperature range 1260-1640°K, independent of the sign of the field. The activation energy for the process of reestablishing the zero field pattern was measured as 3.2 ± 0.2 ev. From these data, the energy required to separate the nearest neighbors in the tungsten lattice is derived as 1.57ev. (This paper was also read at the All-Union Conference on Cathode Electronics, Kiev, November 25-29, 1955; cf. entries #11, 31, and 70).

90. SOKOL'SKAIA, I.L. Poverkhnostnaia migratsiia v elektricheskom pole i energiia sviazi atomov vol'frama. (Surface migration in an electric field and the atomic binding energy of tungsten). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 20, no. 10, 1151-1152 (1956). Illus., 4 refs. English translation: Bull. Acad. Sci. U.S.S.R., 20, no.10,

1044-1045 (1956).

For annotation see entry #89.

91*. SOKOL'SKAIA, I.L. Avtoelektronnaia emissiia CdS napylennogo na poverkhnost' monokristalla W. (Field emission of cadmium sulfide deposited on W single crystals). Reviewed in: entry #3. Radiotekh. i Elektron., 3, no.8, 1100 (1958). English translation: Radio Eng. and Electronics, 3, no.8, 187 (1958).

The field emission current from a tungsten tip decreases during deposition of CdS to a final equilibrium value. This is characteristic of CdS alone. Infrared illumination reduced the field emission by an order of magnitude. (Paper read at the Eighth All-Union Conference on Cathode Electronics, Leningrad, 1957).

92. SPIVAK, G.V. and GEL'BERG, A. Issledovanie avtoelektronnoi emissii nikelia. (Study of field emission from nickel). Doklady Akad.Nauk S.S.S.R., 94, no.3, 455-458 (1954).

Using a Ni field emitter, the following phenomena were investigated: 1) Effect of hydrogen on the pattern, 2) Change of the field emission when passing through the Curie point, and 3) Angular distribution of current density.

93. TALANIN, IU.N. Obrazovanie karbidov na monokristallicheskikh vol'frame i molibdene po nabliudeniiam v elektronnom i ionnom proektorakh. (Field electron and ion microscopic observations on the formation of carbides on W and Mo single crystals). Dissertation [for the equivalent of Ph.D. in physics]. Leningrad Fiz.-Tekh. In-T., Leningrad, 1958.

The original dissertation was not available at the time of the compilation of this bibliography. For annotation see entry #54.

94. TIMOFEEV, P.V. Emissiia elektronov iz slozhnykh poverkhnostei.(Electron emission from complex surfaces). Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., 20, no. 9, 993 (1956). English translation: Bull. Acad. Sci. U.S.S.R., Phys. Ser., 20, no. 9, 898 (1956).

This paper is concerned primarily with the photo-,and secondary electron emission from complex surfaces (Ag-Cs-O). In the case of field emission from such surfaces, the emission depends on the positive changes

on the surface and does not follow the Fowler-Nordheim expression. (This paper was also read at the All-Union Conference on Cathode Electronics, Kiev, November 25-29, 1955; cf. entries #11, 31, and 70).

95. TIMOFEEV, P.V. Emissiia elektronov so slozhnykh poverkhnostei.(Emission of electrons from complex surfaces). Radiotekh. i Elektron., 2, no. 1, 85-91 (1957). Illus., 5 refs. English translation:Radio Eng. and Electronics, 2, no. 1, 127-136 (1957).

For annotation see entry #94.

96. TRET'IAKOV, I.I. Primenenie elektronnogo i ionnogo mikroskopov-proektorov dlia izucheniia adsorbtsii gazov na metallakh. (Use of field electron and ion emission microscopes for the study of the adsorption of gases on metals). Khim. Nauka i Prom., 2, no. 2, 181-189 (1957). Illus., 34 refs.

This is a review article in which the principles of construction, operation and application of the field electron and ion microscopes are given. Subjects such as gas adsorption, the visibility of individual molecules, and ionization are discussed.

97. TRET'IAKOV, I.I. and ROGINSKII, S.Z. Ob istinnoi prirode izobrazhenii otdel'nykh molekul kisloroda, opisannykh v rabote Bekera i Brandesa. (On the true nature of images of individual molecules of oxygen, described in the paper by Becker and Brandes). Doklady Akad. Nauk S.S.S.R., 107, no. 6, 857-858 (1956). 8 refs.

Experiments with hydrogen showed 'spot' patterns similar to those obtained by Becker and Brandes with oxygen. The interpretation of their results is questioned and it is suggested that the observed phenomenon is caused by carbon formed from pump oil contamination.

98. TRET'IAKOV, I.I. and SADILENKO, K.M. Electronno-ionnyi proektor. (Field electron and ion emission microscope). Nauka i Zhizn, 23, no. 2, 45 (1956).

Popular article.

99. VASIL'EV, G.F. K voprosu o teorii avtoelektronnoi emissii poluprovodnikov. (Theory of field emission from semiconductors). Radiotekh. i Elektron., 3, no. 7, 962-964 (1958). 3 refs. English translation: Radio Eng. and Electronics, 3, no. 7, 151-154 (1958).

An expression is derived for the field emission of a semiconductor assuming either a degenerate or a non-degenerate electron gas.

100. VEKSLER, A.Z. Teoriia emissii elektronov v ferromagnetitakh, vyzvannoi elektrostaticheskim polem. (Theory of electron emission from ferromagnetic materials due to electrostatic fields). Fiz. Metal i Metalloved., 4, no. 2, 222-227 (1957). 5 refs.English translation: Phys. Metals and Metallography, 4, no. 2, 23-27 (1957).

An investigation of electron emission in nickel under the influence of an external electrostatic field showed that there is a fairly strong dependence of the work function on temperature near the Curie point. This can be explained on the basis of the s-d exchange model, which correlates the "anomalous" characteristics of ferromagnetic materials with the s-electron energy spectrum. Appropriate corrections are introduced in the field electron emission theory. (See also entry #92).

101. ZANDBERG, E.IA. Poverkhnostnaia ionizatsiia atomov kaliia i molekul KCl i CsCl v elektricheskikh poliakh do 2 Mv/cm na vol'frame. (Surface ionization of potassium atoms and KCl and CsCl molecules on tungsten filaments in electric fields up to 2×10^6 v/cm. Zhur. Tekh. Fiz., 27, no. 11, 2583-2594 (1957). Illus., 15 refs. English translation: Soviet Phys.--Tech.Phys., 2, no. 11, 2399-2409 (1957).

The effect of field intensity on the temperature threshold for surface ionization of potassium atom and KCl and CsCl molecules on tungsten filaments was investigated. The threshold is lowered 170°C by a field of 2×10^6 v/cm. In the pre-threshold temperature region, the temperature decreases proportionally to. E for constant ion currents. (This paper was also read at the Eighth All-Union Conference on Cathode Electronics, Leningrad, 1957; cf. entry #3).

102. ZANDBERG, E.IA. Poverkhnostnaia ionizatsiia molekul NaCl i LiCl na vol'frame v elektricheskikh poliakh do 1.3×10^6v/cm. (Surface ionization of molecules of NaCl and LiCl on tungsten in electric fields up to 1.3×10^6v/cm. Zhur. Tekh. Fiz., 28, no. 11, 2434-2443 (1958). Illus., 14 refs. English translation: Soviet Phys.--Tech.Phys., 3, no. 11, 2233-2241 (1958).

The surface ionization of NaCl and LiCl molecules on tungsten has been studied in the range of electrical fields from 5.5×10^4 to 1.3×10^6v/cm at tungsten temperatures from 1750 to 2650°K.In this temperature range,

the temperature dependence of the current at various fields may be represented by a modified Saha-Langmuir equation. The work function to be used is an appropriate average for the non-uniform surface.

103. ZANDBERG, E.IA. and IONOV, N.I. Poverkhnostnaia ionizatsiia. (Surface ionization). Uspekhi Fiz. Nauk, 67, no. 4, 581-623 (1959). Illus., 113 refs. English translation: Soviet Phys.--Uspekhi, 2, no. 2, 255-281 (1959).

Published data on the phenomenon of surface ionization and the use of this phenomenon to study various physical, physicochemical and technical problems were reviewed critically.

104. ZERNOV, D.V. Avtoelektronnaia emissiia i avtokatody. (Field emission and field emission cathodes). Izvest. Akad. Nauk S.S.S.R.,Ser. Fiz., 20, no. 10, 1135-1136 (1956). English translation: Bull.Acad. Sci. U.S.S.R., Phys. Ser., 20, no. 10, 1027-1028 (1956).

This paper is a one-page summary of entry #105.

105. ZERNOV, D.V. and ELINSON, M.I. Avtoelektronnaia emissiia i avtokatody. (Field emission and field emission cathodes). Radiotekh. i Elektron., 1, no. 1, 5-22 (1956). Illus., 54 refs.

An extensive survey and analysis of the theoretical and experimental (mostly Western) contributions to the topic. Prospects for the technical applications and design of reliable field emission cathodes are discussed. The future development of the theory of field emission from metals and semiconductors is considered.(This paper was also read at the All-Union Conference on Cathode Electronics, Kiev, November 25-29, 1955; cf. entries #11,31, and 70).

106. ZUBENKO, IU.V., KLIMIN, A.I., and SOKOL'SKAIA, I.L. K voprosu o vol'tampernykh kharakteristikakh avtoelektronnogo toka s poluprovodnikov. (Field emission current characteristics of semiconductors). Fiz. Tverdogo Tela, 1, no. 12, 1845-1847 (1959). Illus., 6 refs. English translation: Soviet Phys.--Solid State, 1, no. 12,1691-1692, (1960).

The linearity of the ln I vs 1/v plot for W_2C and Ge over the current range of 10^{-3} to 10^5 amp/cm^2 can be explained by the absence of surface states. If surface states were present, a curvature of this plot

would be obtained, assuming the validity of Stratton's theory. (See also entry #46).

107*. ZUBENKO, IU.V. and SOKOL'SKAIA, I.L. Avtoelektronnaia emissiia torirovannogo karbidirovannogo vol'frama. (Field emission of thoriated-carbided tungsten). Reviewed in: entry #3. Radiotekh. i Elektron., 3, no. 8, 1100 (1958). English translation: Radio Eng. and Electronics, 3, no. 8, 186 (1958).

Using field emission techniques, it was confirmed that carbided tungsten is easily decarbidized by traces of oxygen. It was found that the evaporation of thorium from carbided tungsten occurs at a substantially higher temperature than from pure tungsten. (Paper read at the Eighth All-Union Conference on Cathode Electronics, Leningrad, 1957).

2.1 ADDENDUM

108. BASALAEVA, N.IA., VIKHLIAEVA, R.P., ZHDAN, A.G., and others. 9-e Vsesoiuznoe soveshchanie po katodnoi elektronike. (9th All-Union Conference on Cathode Electronics [Moscow, October 21-28, 1959]. Radiotekh. i Elektron., 5, no. 5, 866-879 (1960).

Fifteen papers were read at the field-emission and surface-phenomena session of the Conference cited above. Elinson, Gofman, Komar, Kompaneets, and Shrednik, among others, presented papers on the following topics: Pulse field emission of high current densities, space charge effects, surface phenomena, field emission from semiconductors, Malter effect, and emitter design. (Many of these papers will probably be published in various Russian technical journals. Direct references could not be located by the time set for completion of the manuscript of this bibliography).

109*. SOKOL'SKAIA, I.L., KLIMIN, A.I., and ERMOLAEVA, T.Z. Field emission from cadmium sulfide. (Brief paper submitted [in English] but not read at the [Fifth] Field Emission Symposium held at the University of Chicago, June 23-25, 1958).

Field emission from cadmium sulfide single crystals and CdS on tungsten was investigated. The time constants for rise and decay of currents were of the order of minutes. Illumination increased the emission, and the spectral response was similar to that known for photoconductivity.

3. LIST OF MEETINGS
RELEVANT TO SOVIET FIELD EMISSION RESEARCH

1) All-Union Conference on Cathode Electronics [7th]. Kiev, November 25-29, 1955. Cf. entries #11, 31, 70.

2) All-Union Conference on Cathode Electronics, 8th. Leningrad, October 17-24, 1957. Cf. entry #3.

3) All-Union Conference on Cathode Electronics, 9th. Moscow, October 21-28, 1959. Cf. Addendum, entry #108.

4) All-Union Conference on Electron Microscopy, 2nd. Moscow, May 9-13, 1958. Cf. entry #81.

5) Field Emission Symposium [5th]. Chicago, June 23-25, 1958. Cf. Addendum, entry #109*.

6) Field Emission Symposium, 6th. Washington, D.C. June 22-24, 1959. Cf. entry #82.

7) Inter-Departmental Seminar on Cathode Electronics, 1st. Leningrad, December 3, 1956. Cf. entry #59.

8) Inter-Departmental Seminar on Cathode Electronics, 4th. Leningrad, March 4, 1957. Cf. entry #21.

9) Inter-Departmental Seminar on Cathode Electronics, 10th. Leningrad, May 5, 1957. Cf. entry #6.

10) International Conference on Electron Microscopy, 4th. Berlin, September 10-17, 1958. Cf. entry #5.

4. REFERENCES

The following bibliographic aids (dates of issues searched are indicated) proved to be very useful in locating relevant papers in the original and translated Soviet technical literature on field emission research:

Annotirovannyi ukazatel' literatury po radioelektronike. (Annotated bibliography of electronics). Moscow, Sovietskoe Radio, 1956--1959. [In Russian].

Chemical abstracts, 1955--to date.

East European accessions index. Washington, U.S.Govt.Print. Off., 1955--to date.

Good, R.H. and Müller, E.W. Field emission. In: Handbuch der Physik, v.21, pt.1, 1956. Berlin, Springer-Verlag,1955--; pp. 176-231.

Monthly index of Russian accessions. Washington, U.S. Govt. Print. Off., 1955-- to date.

Nottingham, W.B. and others. Bibliography on physical electronics. Cambridge, Research Laboratory of Electronics, MIT, c1954. 428 p.

Nuclear science abstracts. 1955-- to date.

Physics abstracts, 1955-- to date.

Physikalische Berichte. 1955-- to date.

Referativnyi zhurnal: Fizika. 1957-- to date. [In Russian].

Referativnyi zhurnal: Khimiia. 1955-- to date. [In Russian].

Technical translations. Washington, U.S.Department of Comm., Off. of Tech. Serv., 1959-- to date.

Translation monthly. Chicago, SLA Translation Center, 1956-1958.

SUBJECT INDEX

USCOMM--DC

U.S. DEPARTMENT OF COMMERCE
Frederick H. Mueller, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colo., is suggested by the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

WASHINGTON, D.C.

ELECTRICITY. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics.

METROLOGY. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Scale. Volumetry and Densimetry.

HEAT. Temperature Physics. Heat Measurements. Cryogenic Physics. Rheology. Molecular Kinetics. Free Radicals Research. Equation of State. Statistical Physics. Molecular Spectroscopy.

RADIATION PHYSICS. X-Rays. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

CHEMISTRY. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Molecular Structure and Properties of Gases. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

MECHANICS. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Combustion Controls.

ORGANIC AND FIBROUS MATERIALS. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

METALLURGY. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics.

MINERAL PRODUCTS. Engineering Ceramics. Glass. Refractories. Enameled Metals. Constitution and Microstructure.

BUILDING RESEARCH. Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials.

APPLIED MATHEMATICS. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics.

DATA PROCESSING SYSTEMS. Components and Techniques. Digital Circuitry. Digital Systems. Analog Systems. Applications Engineering.

ATOMIC PHYSICS. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics.

INSTRUMENTATION. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

Office of Weights and Measures.

BOULDER, COLO.

CRYOGENIC ENGINEERING. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Gas Liquefaction.

IONOSPHERE RESEARCH AND PROPAGATION. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services.

RADIO PROPAGATION ENGINEERING. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation-Terrain Effects. Radio-Meteorology. Lower Atmosphere Physics.

RADIO STANDARDS. High frequency Electrical Standards. Radio Broadcast Service. Radio and Microwave Materials. Atomic Frequency and Time Standards. Electronic Calibration Center. Millimeter-Wave Research. Microwave Circuit Standards.

RADIO SYSTEMS. High Frequency and Very High Frequency Research. Modulation Research. Antenna Research. Navigation Systems. Space Telecommunications.

UPPER ATMOSPHERE AND SPACE PHYSICS. Upper Atmosphere and Plasma Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.


NBS