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# ELECTRONIC CONDUCTION PHENOMENA OBSERVED ON THE SURFACE OF SEMICONDUCTORS AND METALS

# ЯВЛЕНИЯ ЭЛЕКТРОННОЙ ПРОВОДИМОСТИ, НАБЛЮДАЕМЫЕ НА ПОВЕРХНОСТИ ПОЛУПРОВОДНИКОВ И МЕТАЛЛОВ

# YARIMO‘TKAZGICHLAR VA METALLAR YUZASIDA KUZATILAYOTGAN ELEKTRON O'TKAZUVCHANLIGI FENOMENLARI

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***Abstract***

*This article analyzes the phenomenon of electronic conductivity observed on the surface of semiconductors and metals. With the development of electronics at the end of the 20th century, the movement of electrons in metals and semiconductors and their distribution in the electrical field were explained in terms of statistical balance. The propagration processes of electrons slow down their acceleration, resulting in electrical resistance. It has also been found that electrical conductivity of thin layers and wires is significantly lower compared to mass samples. At JJ Thomson's suggestion, this great effect may be explained by the additional surface spread.*

***Аннотация***

*В данной статье анализируется явление электронной проводимости, наблюдаемое на поверхности полупроводников и металлов. С развитием электроники в конце 20 века движение электронов в металлах и полупроводниках и их распределение в электрическом поле стали объясняться с точки зрения статистического баланса. Процессы распространения электронов замедляют их ускорение, в результате чего возникает электрическое сопротивление. Также установлено, что электропроводность тонких слоев и проволок значительно ниже по сравнению с массовыми образцами. По предположению Дж.Дж.Томсона, этот большой эффект может быть объяснен дополнительным поверхностным разбросом.*

***Annotatsiya***

*Ushbu maqola yarim o‘tkazgichlar va metallar yuzasida kuzatilayotgan elektron o‘tkazuvchanlik fenomenlarini tahlil qiladi. XX asr oxirida elektronikaning rivojlanishi bilan metallar va yarim o‘tkazgichlarda elektronlarning harakati va ularning elektr maydonidagi tarqalishi statistik muvozanat nuqtai nazaridan tushuntirilgan. Elektronlarning tarqalish jarayonlari ularning tezlanishini sekinlashtiradi va natijada elektr qarshilikka olib keladi. Shuningdek, yupqa qatlamlar va simlarning elektr o‘tkazuvchanligi ommaviy namunalar bilan solishtirganda sezilarli darajada past bo‘lishi aniqlangan. JJ Tomsonning taklifiga ko‘ra, bu katta ta'sir yuzaga kelishi qo‘shimcha sirt tarqalishi bilan izohlanishi mumkin.*

***Key words:*** *electronic conductivity, semiconductors, metals, electronic movement, electrical resistance, surface distribution, thin layers, J Tomson, heat conductivity, hall effect, free electrons, statistical balance, electrical field, material properties.*

***Ключевые слова:*** *электронная проводимость, полупроводники, металлы, электронное движение, электрическое сопротивление, поверхностное распределение, тонкие слои, Джей Джей Томсон, теплопроводность, эффект Холла, свободные электроны, статистический баланс, электрическое поле, свойства материалов.*

***Kalit so‘zlar:*** *elektron o‘tkazuvchanlik ,yarim o‘tkazgichlar ,metallar, elektron harakati, elektr qarshilik, sirt tarqalishi, yupqa qatlamlar, J Tomson, issiqlik o'tkazuvchanligi, hall effekti, erkin elektronlar, statistik muvozanat, elektr maydoni, material xususiyatlari.*

## INTRODUCTION

The conductivity of metals came to be considered an electronic property shortly after the development of electronics at the end of the last century. Due to unclear scattering processes, the movement of electrons in an electric field was explained as the result of a statistical equilibrium in which their acceleration is slowed down, which leads to a resistance current. In addition, it was found that the electrical conductivity of thin films and wires is lower than that of bulk samples. According to JJ Thomson, additional surface scattering may help explain this large effect [1]. This means that the effect can be pronounced when the thickness of the sample is smaller than the mean free paths of a few electrons. Values of electron mass, heat rate and volume Hall effect constant - this indicates the concentration of free electrons. This is used to calculate some calculations of the most recent quantity.

A fundamental question in surface physics is, of course, why an electron collides with a surface in the first place, and why this scattering processrather than being viewed as a component of resistance or a proper elastic collision in which energy is stored on a parallel surface occurs. But it was not until the 1960s that this topic received much attention. Furthermore, if the electronic wave function is uniformly reflected from a well-organized surface, the bulk energy field structure can produce size effects independent of dispersion. The experimental challenges of producing thin films and wires with the same metallurgical precision as the larger ones exacerbate these cases. This means that carelessness in the construction of personal objects can lead to errors in their volumetric and dimensional effect.

In addition to being a useful tool in the investigation of metal surfaces, size effects are used to learn more about the mechanism of gas chemisorption on metal surfaces. Chemosorption [2] shows a change in the dimensional effect of electrical conductivity, and chemosorption bonds, which often serve as scattering centers, are the origin of these phenomena. Size effect can also be studied in semiconductors and semimetals [3]. Nevertheless, semiconductors have a related phenomenon called the field effect, which allows a very low concentration of free electrons to enter the crystal at a depth of about 1 cm from an external static electric field [4]. Because the field effect can be used to significantly change the volume charge field, it is actually a much more powerful tool for studying surfaces than the volume effect [5]. Surface phenomena are, of course, another example of material boundary splitting. The field effect at the semiconductor-dielectric separation boundary (silicon - $SiO_2$) is a fundamental phenomenon, as well as a very sensitive random analysis method, which is very important for modern electronic integrated circuit technology.

## RESULTS AND DISCUSSION

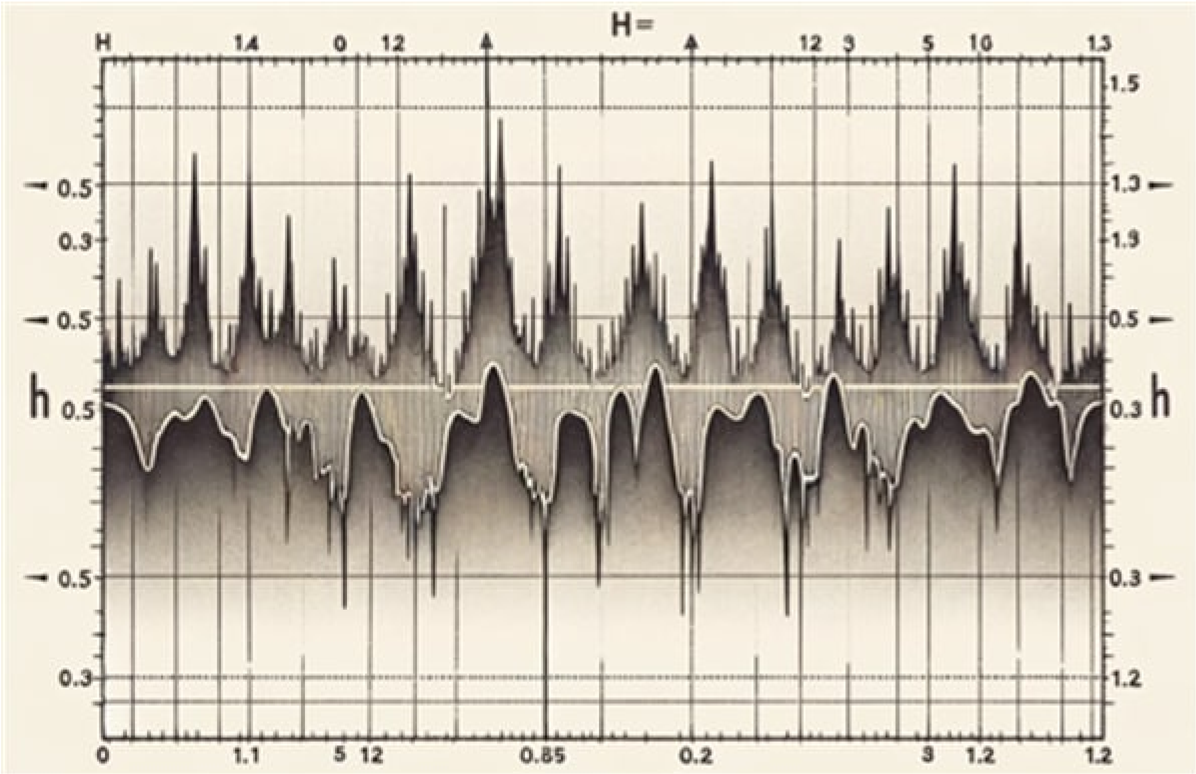
A chemisorbed field effect can occur on the surface of the donors or acceptors exposed to semiconductor gases, and also when there is a difference in the binding work function of the metal in the semiconductor.

Figures 1 a-1 b show the field effect in three cases for these bending regions. Direct plating is used to obtain a macroscopic volume charge potential for semiconductor domain structure. The following shows that similar superpositions are not always easy to understand. Finally, we see that the field effect has been found in metals, despite the obvious experimental difficulties.

Figure 1. Microwave absorption spectrum of gallium in weak magnetic field

T=4.2K; f=332.44 Hz.

T=4.2K; f=332.44 Hz.



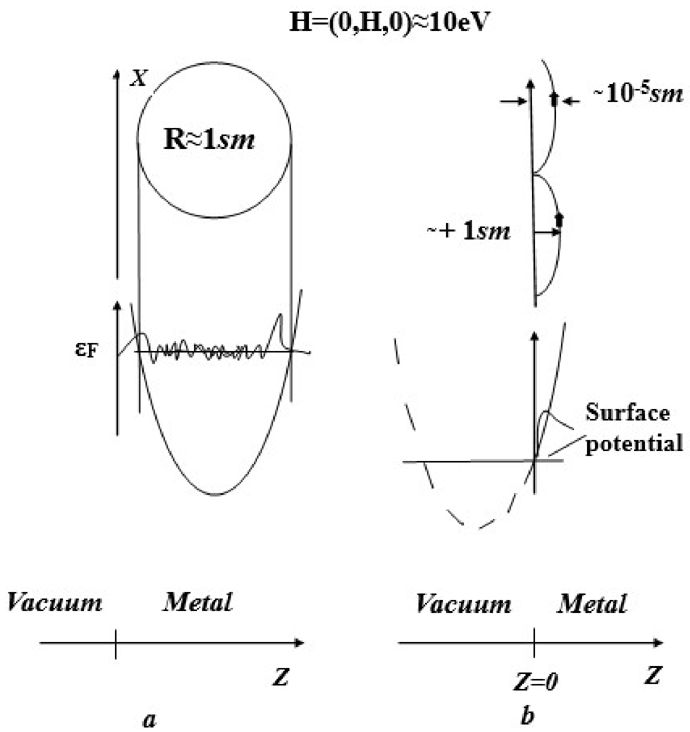




**Figure 2. Magnetic surface states.**

The field along the x-axis is directed toward H and is ~10 eV.
α-cyclotron orbit, Landau level;
b - Prizhkov orbit, quantum surface state.

In addition to the above-mentioned methods for studying static transmission, skin-there are high-frequency methods based on the idea that the effect can also limit the conductive field. Thus, these electron waves are scattered both coherently and incoherently.

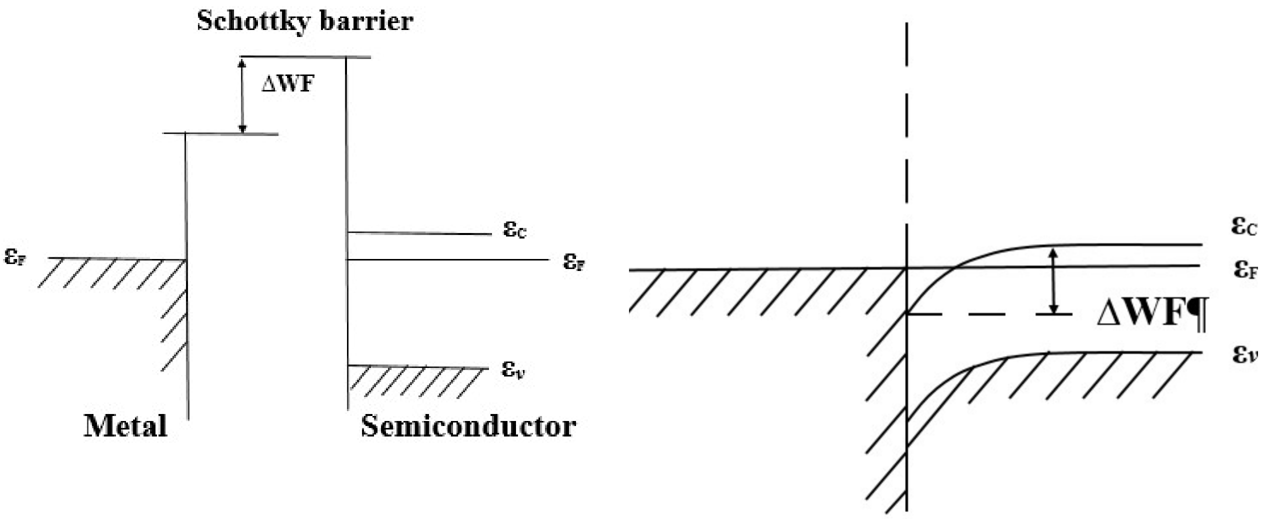



**Figure 1a. Field effect in the Schottky barrier (no surface state)**.

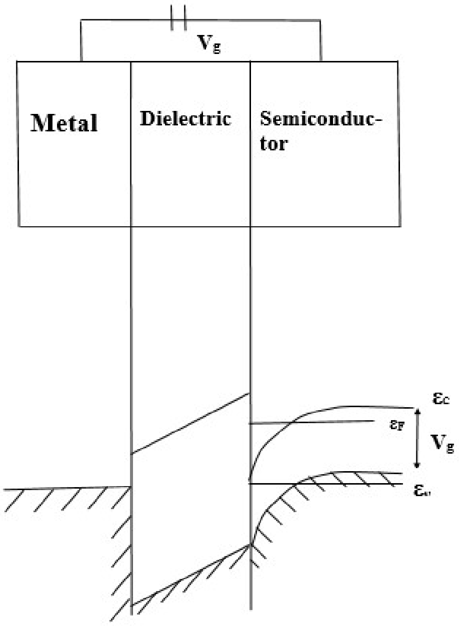



**Figure 3. Metal-dielectric-semiconductor field effect in the structure (no surface state).**

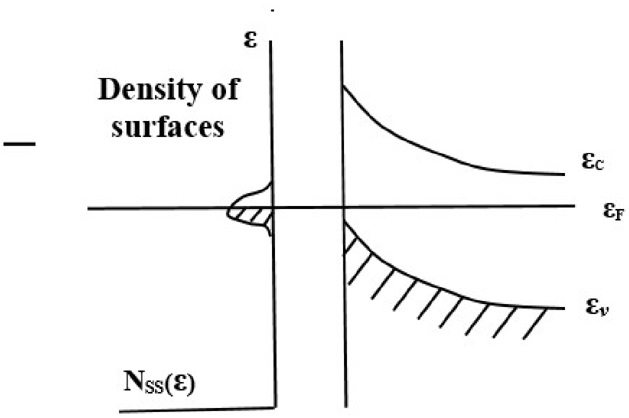


***Fig. 1b Chemosorption in the field effect with acceptor surface states.***

This mainly happens when there are few large collisions per period and the thickness of the spin layer is greater than the distance traveled by the electrons per period, andrefers to the anomalous skin effect.

Depending on the strength of the magnetic field, the surface impedance is anomalous in weak magnetic fields parallel to the metal surfaceexhibits interesting vibrations (9) with a skin-effect. These "Haykin oscillations" are now understood to be relevant for transitions between specific surface layers. This can be seen as allowed quantum-mechanical hopping orbits of surface electrons (Figures 2 and 3) according to Landau's proposal [10]. It can be seen that the degree to which the electron is scattered by the surface determines the width of the line for these cases. It is particularly interesting that the structure and conductance-related involvement of these surface Landau levels are formally analogous to the quantizing state properties found in narrow inversion layers of semiconductors.

## CONCLUSION

Summary of the Article: Phenomena of Electron Conductivity Observed on the Surface of Semiconductors and Metals

The article explores the concept of electron conductivity, a fundamental electronic property of metals and semiconductors. Since the advent of electronics in the late 19th century, the movement of electrons in an electric field has been understood in terms of statistical equilibrium, where scattering processes slow down electron acceleration, resulting in electrical resistance.

Key points include:

1. Electron Movement and Scattering:

Electron movement in metals and semiconductors is hindered by scattering processes, which create resistance.

The electrical conductivity of thin films and wires is notably lower than that of bulk samples due to increased surface scattering.

2. JJ Thomson's Contribution:

JJ Thomson suggested that surface scattering significantly affects electron conductivity, especially in samples thinner than the mean free paths of electrons.

3. Measurement and Calculation:

The article discusses the use of electron mass, heat rate, and volume Hall effect constants to determine the concentration of free electrons.

These values are crucial for calculating various quantities related to electron conductivity.

The findings highlight the significant impact of surface phenomena on electron conductivity, particularly in thin samples, providing a deeper understanding of the electronic properties of materials.

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