

# Theoretical Study of Semiconductor Research and Its Devices



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## ABSTRACT

The physics of semiconductor and its devices is naturally dependent on the physics of semiconductor materials themselves. This chapter presents a summary and review of the basic physics and properties of semiconductors, As it appears from most of the historical reviews of semiconductor research, semiconductor devices –preceded by the adjectives early and primitive usually refer to the crystal rectifiers used for WIRELESS Application in the early 1900's in this sense, early 1900's is regarded as the time when the semiconductor devices of the 19<sup>th</sup> century. person and Brattain outlined the developments in semiconductor research before 1900 in [1].semiconductor research and semiconductor device application is an interest-entirely of the 20<sup>th</sup> century, in a more rigorous sense, of the second half of the century-but the roots of this discipline extend to the 19<sup>th</sup> century, too semiconductor properties- as fascinating as negative dynamic resistance of junctions, were observed. Use to semiconductors in the 19<sup>th</sup> century lacks proper investigation and integration how semiconductor properties came to scientists' notice and debut in the field of application in the pre 1900 era present us with an untold pre-1900 history of semiconductors.

## INTRODUCTION

This article presents a critique of the origin of semiconductors and pre 1900 developments in semiconductor research and device applications. Although the history of semiconductors stretches back to a time as far as 1833, semiconductors made debut in engineering field by dint of Bose's research in the 1890s. Selenium photoelectric cell, Braun's introductory applications of semiconductors for wireless engineering can be considered the milestones of the 19<sup>th</sup> century in this regard. We put forward a suggestion to identify Bose's pioneering research with semiconductor detector of wireless signals and which is otherwise less pronounced, as an IEEE Milestone.

### History of semiconductor Research:

The beginning of semiconductor research is marked by faraday's 1833 report on negative temperature coefficient of resistance of silver sulfide. This is the first observation of any semiconductor property .in his 1833 paper, "Experimental Researches in electricity" he disclosed this observation [2].this observation was distinction from the usual properties of metals and electrolytes in whose case resistance increase with temperature.

The next significant contributor to semiconductor field in chronological order is the French experimental physicist Edmond Becquerel. In 1839, he reported the observation of photo voltage in the silver chloride coated platinum electrodes [3]. In his experiment, an AgCl coated platinum electrodes was immersed in an aqueous nitric acid electrolyte solution. Illumination of the electrode generated photo voltage that altered the EMF produced by the cell, in fact, it produced a reductive (cathodic) photocurrent at the AgCl coated electrode: this was the first reported photovoltaic device photo voltage was generated at the Ag/AgCl metal semiconductor contacts, Ag at the junction was formed by the absorbed clusters in the AgCl electronic states [4].

The next important decade in the semiconductor research is the decade of 1870. During this period selenium was discovered as a semiconductor, rectification at metal semiconductor interface came into scientists' notice.

In 1873, Willoughby Smith arrived at the discovery of photoconductivity of selenium [5]-[7]. how he reached at this observation has interesting story. He was initially working with submarine cables. He set into experiments with selenium for its high resistance, which appeared suitable for his submarine telegraphy. Various experimenters measured the resistance of selenium bars, but the resistance as measured by them under different conditions did not agree at all, then Smith discovered that the resistance actually depended on the intensity of incident light. When the selenium bars were put inside a box with the sliding cover closed, the resistance was the highest. When glasses of various colors were placed in the way of light, the resistance varied according to the light passing through the glass. But when the cover was removed, the conductivity increased. He also found that the effect was due not due to temperature variation.

In 1874 came the most significant discovery in semiconductor field of the 19<sup>th</sup> century- the discovery of rectification at the contact between certain materials, especially naturally occurring sulfide crystals. Barium's discovery [8] was related to natural crystals and Schuster's discovery [9] to contact between tarnished and untarnished copper wire. In Schuster's experiment the copper oxide layer on the untarnished wire presumably acted as the semiconductor giving the contact a rectification property. Braun's experiments were more conclusive and systematic, so well approached that this is generally acknowledged as the first systematically approached study of metal semiconductor contacts.

The first observations of photovoltaic effect in a solid system were made in 1876. The semiconductor substance was again selenium. W. G. Adams, along with his student R. E. Day was investigating the photoelectric properties of selenium at Cambridge. They discovered that illuminating a junction between selenium and platinum had a photovoltaic effect.

In 1833, Charles Edger Fritts, a New York electrician, built a selenium solar cell [11]. It consisted of thin selenium wafers covered with very thin semi-transparent gold wires and a protective sheet of glass. It is to be noted that, this was the first large area metal semiconductor junction device. However, it was very inefficient ( $\mu < 1\%$ ) in converting solar energy into electrical energy.

Although the most significant observation of the 19<sup>th</sup> century came during the period 1870 -1885, the semiconductors had not received any device application for any practical purpose yet .it was not until 1890's that any field recruited these materials for any practical use .wireless communication is this first field to employ these materials for practical application.

After Hertz's demonstration of existence of electromagnetic waves in 1888, a number of scientists got involved with experimenting with this newly discovered waves , and wireless telegraphy became practicable among them , Bose was the first person to introduce semiconductors for the reception of wireless waves ,in course of determining the various optical properties (polarization, refraction) of electromagnetic waves, he discovered that polarizing crystals had selective conductivity [12].according to [13] ,this study led him to discover a galena detector ,which is the first semiconductor diode detector of wireless waves . He also used point contact of metals for detections of millimeter waves, which have I-V characteristics similar to modern semiconductor junctions [14]. Marconi's 1901 transatlantic receiver is considered the first major use of a semiconductor detector devices- that semiconductor device actually originated from Bose's research in the 1890's For another time the focus shifts on Braun .in 1898, he began experiments with wireless telegraphy. He used semiconductors for reception of wireless signals, and in 1901 he realized the advantage of using them for this purpose.

Thus ends the history of semiconductor of the 19<sup>th</sup> century. The saga of semiconductor begins with faraday's silver sulfide in 1833, and at the end of the century it enters the next century of glory with Bose's introductory application of semiconductors for wireless purpose.

## CONCLUSION

Slow pace and narrow field of application characterize the pre-1900 history of semiconductor research and semiconductor devices applications .but this history surely deserves to be preserved and should be well documented ,the roots of photovoltaic engineering , electronics principle and wireless applications of semiconductor devices find ground in the 19<sup>th</sup> century .no matter how in signification the contribution of research efforts of this century is to the development of this field in the 20<sup>th</sup> century , the germ of early 1900 semiconductor device applications was there in the 19<sup>th</sup> century.

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