科技英语

KEJI YINGYU

（汽车、机械等工科专业用）

主　编　赵　辉
副主编　李俊玲　何玉芳
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内 容 提 要

本书为汽车、机械、电子等专业的科技英语教材，非常适合学完大学基础英语的学生使用。本书共十个单元，对长句、难句均有注释、分析及翻译，因此也非常适合于自学者使用。

前　言

本书以科技内容为主，题材广泛，涉及电子、汽车、机械等内容，非常适合大学高年级学生使用，也可供广大科技人员、英语工作者和英语爱好者自学使用。

全书共分十个单元，每个单元除课文外还安排了一篇相应的阅读材料，以巩固所学课文内容。为了方便自学，课文、阅读材料均附有词汇表，并对特殊的科技词汇作了注解；对一些长句、难句均作了注释、分析及翻译。

本书旨在培养和提高英语的实际阅读能力与翻译能力，课文内容丰富、实用，使用者可以接触到各种文体和科技英语的常用与特殊表达方法。

编　者

1997 年 6 月

CONTENTS

UNIT 1

TEXT

SOLID-STATE DEVICES

By definition, a conductor is a low-resistance material that allows electricity to flow readily, and an insulator is a high-resistance material that blocks current altogether. Conductors do offer some resistance, depending on their exact composition and their physical dimensions, but this is generally an incidental characteristic. The actual difference in resistance between common conductors and insulators is enormous. For example, silver has a resistance of only one-millionth of an ohm between any two faces of a cube measuring a centimeter on a side, while a similar block of mica has a resistance of about a million million ohms, a value so high that it represents in effect an open circuit.

There is a sort of twilight zone between conductors and insulators, and the materials that fall in it, mostly natural or man-made crystals, are known as semiconductors. For example, a centimeter cube of pure germanium measures only about 50 or 60 ohms; a cube of pure silicon, 50000 to 60000 ohms. These resistances fall to much lower values if certain chemical "impurities" are added to the crystals. What is significant about semiconductors treated in this manner is that some of their internal electrons apparently float around loosely, and can be made to move under the influence of very low applied voltages. While conventional vacuum tubes for receiving purposes require plate voltages from about 75 to 300 volts, typical semiconductors in similar applications need only between 1.5 and 12 volts. Since the controllable electron stream in a tube flows through a vacuum, while in semiconductors it goes through a solid, the basic term solid-state has been adopted to distinguish semiconductors from tubes.

The major part of the electric energy supplied to most tubes is consumed by the heater element that boils electrons out of a cathode. (See Chapter 3, dealing with vacuum tubes.) Solid-state devices do not need thermal priming; their loose electrons are on tap at all times and go to work the instant an external voltage is applied. Semiconductors are therefore smaller than tubes, require less space, wiring, and operating power, and work in simpler circuits.

Although solid-state technology is generally considered a development of the 1950's, it actually dates back to the turn of the century. As early as 1903, an American experimenter named Greenleaf Whittier Pickard investigated the possibilities of certain crystals as detectors (that is, rectifiers) of radio signals. In 1906 he obtained excellent results from silicon, which today is a favored material for many solid-state devices. Numerous other crystals, including even ordinary coal, were used successfully. The most sensitive was found to be galena (chemically, lead sulphide), a cheap and abundant by-product of silver-mining operations in the western part of the United States.

The Transistor

Until 1948 all solid-state devices were essentially one-way conductors, and could be used only as signal detectors and as rectifiers in AC power circuits. Unlike tubes, they could not amplify weak signals or act as oscillators to produce high-frequency alternating current for transmission and other purposes. However, in 1948 the electronic art was literally set on its ear by the introduction of an entirely new semiconductor device called the transistor, which could do everything the tube could do, and more, within certain power limitations. A product of intense, highly organized team engineering in the vast Bell Telephone Laboratories, the transistor was an overnight sensation. Requiring no heater or filament current and no glass bulb or vacuum, and taking the form of strong metal beads the size of match heads or peas, the transistor obviously was ideally suited for a wide variety of electronic equipment ranging from tiny hearing aids to portable receivers and transmitters and computers and space instruments.

Semiconductor Theory

There is no single, universally accepted answer to the question "How do semiconductors, and particularly transistors, work?" Several theories have been advanced, and they differ not only in basic approach but also in mere terminology. This is not surprising in view of the fact that the very nature of electricity is still a matter of widespread speculation among scientists. Although the operation of the vacuum tube clearly supports the concept that electricity is a movement of negative electrons toward the positive side of a circuit, some transistor texts confuse the student by indicating both "electron flow" and "conventional current flow" —— in the other direction —— in the same hookup!

Using the electron theory, it is possible to offer a reasonable explanation of semiconductor action. Readers with a college background in modern physics are referred to the advanced books listed in the Appendix.

The atom may be pictured as a central core or nucleus having a positive electric charge, surrounded by a cloud of orbiting electrons having a negative charge. The electrons nearest the core are held more firmly by the latter's positive charge than those farther out at the edges, but under normal circumstances the positive and negative charges balance and no electrons escape. The outer electrons, more easily torn loose, are called valence electrons.

The atoms of pure semiconductors are arranged in a crystalline structure, an orderly framework called a lattice. In the lattice, atoms line up so that their valence electrons are shared. Valence electrons of adjacent atoms are bound together to form electron-pair bonds. These bonds are quite tight, and there are no free electrons on tap to be influenced by outside electric charges. Thus, in effect, the lattice has high resistance.

It is possible to split the electron-pair bonds and to free some electrons by applying heat or high voltage, but these measures are awkward and troublesome. The big breakthrough in semiconductor technology came with the discovery that the same effect could be accomplished much more simply by adding "impurities" —— extremely small amounts of other elements having different atomic structure —— to the pure lattices. This process is called doping, and is the most critical part of semiconductor manufacturing because the ratio of impurities to pure materials is something like one part in ten million!

Doping works in two directions. If the added impurity element has more valence electrons than the pure semiconductor material, the extra electrons tend to float loosely within the lattice because there are no unpaired electrons available in the lattice with which they can form new electron-bond pairs. See Fig. 1-1. Loose electrons are easily affected by an outside charge, so electrons can readily be made to flow; in effect, the loose electrons give the doped semiconductor material a resistance lower than that of the previous pure form. A material having this excess-negative characteristic is called n-type. Common n additives are arsenic and antimony.

Impurity atoms such as aluminum, gallium, and indium have fewer valence electrons than semiconductor atoms. There are not enough of them to form complete electron-bond pairs with all of the latter's valence electrons, so they leave what amounts to holes (that is, areas without paired electrons) in the lattice structure. See Fig. 1-2. Some electrons of adjacent pair bonds tend to shift from their positions under the influence of outside charges and to move into the holes. This movement of electrons constitutes a flow of electricity. The initial vacancy

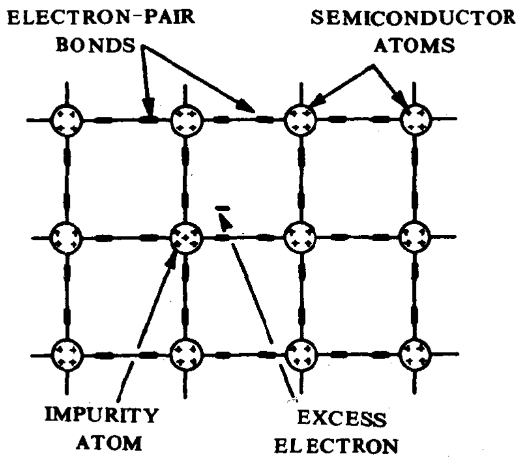

Fig. 1-1 Lattice structure of n-type "doped" semiconductor

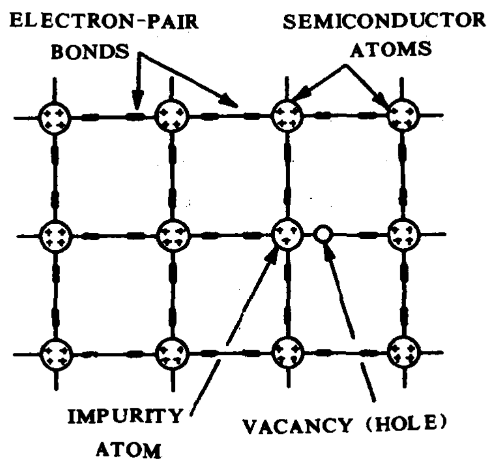

Fig. 1-2 Lattice structure of a p-type "doped" semiconductor

in the lattice is said to have a positive charge because of the absence there of negative electrons, so semiconductors doped in this manner are called p-type.

p-n Junctions

The basic solid-state device consists of a combination of p-type and n-type materials in simple contact, as in Fig. 1-3; this is called a p-n junction. At the junction itself, some of the

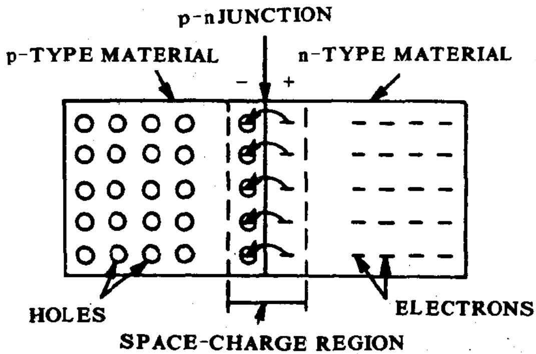

Fig. 1-3 Interaction of electrons and "holes" in the space-charge region of a p-n junction

loose electrons in the n-type tend to diffuse into the adjacent holes. The holes thus acquire a slight negative charge, while the previously all-negative area at the junction becomes slightly positive because it has lost some of its electrons to the holes. This intermediate area is called the space-charge region, transition region, or depletion layer. The very slight electric charge here can be represented as an imaginary battery, as shown in Fig. 1-4. It is known as the energy barrier because it discourages further diffusion across the junction; that is, the initial-negative charge acquired by the holes in the space-charge region prevents additional electrons from the n-type material from crossing into more holes in the p-type.

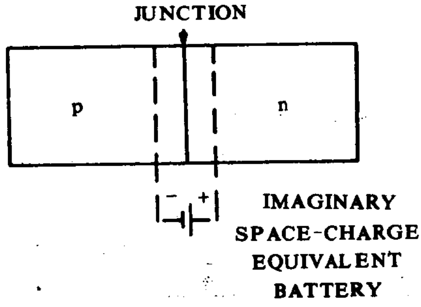

Fig. 1-4 Voltage effect at the center of a p-n junction

The condition just described continues to exist only as long as the p-n junction is isolated. When external voltages are applied, the nature of the space-charge region changes markedly. Consider first the simple circuit of Fig. 1-5, which shows a battery connected to the p and n ends of a junction. The free electrons in the n-type, being negative, are drawn away from the material toward the positive side of the battery. This loss of electrons tends to make the material more positive than before, in effect widening the positive side of the space-charge region. Simultaneously, electrons from the negative pole of the battery go into the positive p-type material, diffuse through the holes, make this section more negative than before, and in effect widen the negative side of the space-charge region. The total effect is to make the latter so wide that it is no longer the imaginary battery shown in Fig. 1-4 but assumes the characteristics of a real battery having a voltage almost equal to that of the external battery. A condition of voltage balance sets in, and, as a result, there is virtually no current flow through the circuit, as indicated by the thin arrow in Fig. 1-5. A p-n junction with the battery polarity as shown in this diagram is said to be reverse-biased.

If the external battery is switched around, as in Fig. 1-6, electrons in the p-type break out of their electron-pair bonds under the pull of the positive side of the battery, creating new holes in the material, and they travel toward the battery. This loss of electrons makes the p-type material more positive than before and causes it to attract more electrons through the space-charge region from the n-type. As these electrons move across, they are replaced by other electrons from the negative side of the battery. In effect the space-charge region virtually disappears, the energy barrier is no longer a barrier, and electrons flow merrily around the circuit, as indicated by the heavy arrow in Fig. 1-6. A junction with this battery polarity is said to be forward-biased.

If we substitute a source of alternating current for the batteries of Figs. 1-5 and 1-6, it is easy to see that a p-n junction is a simple rectifier. While there is some current flow in the reverse-bias condition, this is so small in comparison with the heavy current in the forward-bias mode that it can be disregarded in practical applications.

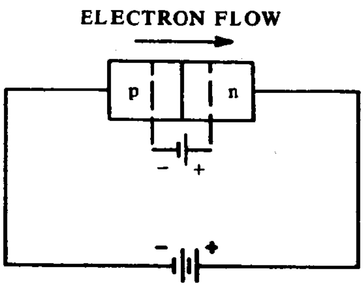

Fig. 1-5 When biased in this manner, a p-n junction has a high resistance and permits only a very small electron flow

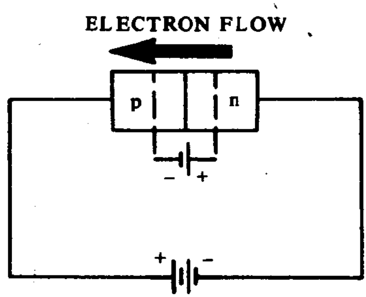

Fig. 1-6 With the bias of this polarity, the p-n junction offers low resistance and passes a heavy current

NEW WORDS

definition	n.	定义
composition	n.	成分
mica	n.	云母
twilight zone		边缘地区 过渡区
crystal	n.	晶体
semiconductor	n.	半导体
germanium	n.	锗
silicon	n.	硅
impurity	n.	杂质
cathode	n.	阴极
voltage	n.	电压
vacuum tube		真空管
plate	n.	板极
plate voltage		板极电压
volt	n.	伏特