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Semiconductor Ics

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Annotation: *The article describes integrated circuits, their features and the manufacturing process. This topic is relevant because in the modern world such boards are used everywhere in electronic devices.*

Keywords: *Semiconductor ICS, epitaxy, photolithography, diffusion, ion implantation, artificial oxidation.*

"In physics, the truth is rarely crystal clear, and the same is always true of human affairs. In a word, everything that is not shrouded in doubt cannot be the truth."

Richard Feynman

Introduction

Integrated circuits are microelectronic devices consisting of a large number of parts, but also in some cases of components that, based on their technical requirements and properties, are considered as one product. Also, all the composing chips in question are interconnected, therefore, that the device has a higher density of electrical components, which are similar in properties to an ordinary circuit. The singularity of semiconductor integrated circuits is the performance of absolutely all elements and inter element connections on a given surface or in the volume of a semiconductor material.

Semiconductor ICS are a difficult structure, for this reason, in addition to considering the steps of production, you need to know about the materials used in the construction of ICS, and some unusual devices.

The integrated circuit is widely used in robotics, radio engineering, digital communication technologies and in the creation of computers. The device in question may have a complete, however difficult, list of capabilities up to an entire microcomputer (single-chip microcomputer).

Let's move on to the essence of procurement processes. The assembly of the chip can include up to 200 operations. As a result of the assembly, a common shell is obtained, on which active, passive and connecting elements are placed, forming a microscopic multifunctional node. Semiconductor ICS can be single-crystal (plates made of a single crystal), multi -crystal (plates made of a large number of crystals) and in the form of a single crystal of silicon on a sapphire substrate. All components of the IC are manufactured in a single scientific and technical cycle, which ensures reliability, low cost and impossible efficiency.

Next, let's look at the stages of production. The assembly process can be divided into three steps: procurement, processing and control. The first step of procurement procedures includes obtaining ingots of semiconductor metals, cutting them into crystal plates, processing plates, creating parts for the case and assembling them.

At the second step, a narrow processing of the components acquired in the first step takes place. This step consists of the following procedures: augmentation of the outer part of the monocrystalline layer (epitaxy), artificial oxidation, phytolithography, diffusion, technochemical treatment, vacuum spraying, ion implantation and control of the treated parts for proper functioning.

Research Methods

Epitaxy is a method of building up a semiconductor layer on the surface of a monocrystalline semiconductor, also having a monocrystalline structure. Methods of liquid epitaxy are used, in which place the layer build-up comes from a melt containing semiconductor atoms; gas-phase epitaxy, where atoms arrive at the surface of the layer being built up from the gas atmosphere; molecular epitaxy, where atoms or molecules come from a beam or beam formed in a very rarefied atmosphere. The final two methods are instrumentally similar to the methods of gas-phase deposition and vacuum deposition, discussed below, but the principal difference of epitaxy is in the monocrystalline structure of the layer being built up.

The type of conductivity and the doping level of the layer being built up may differ from those for the initial substrate, for this reason, epitaxy provides very large for the formation of layered semiconductor structures.

Photolithography is the application of a layer of a special substance called a photoresist to the surface of the plate and the following etching of layers of different materials on this surface of the plate or the plate material itself in the spheres in which the photoresist is absent.

Diffusion is a method of forming near-surface semiconductor layers with a variable doping level due to the preferred movement of impurity atoms in a semiconductor in the direction of decreasing their concentration during chaotic thermal motion.

Ion implantation is a method of introducing dopant atoms into the initial plate when bombarded with beams of high-energy ions of these atoms. Accelerated impurity ions enter the plate to a certain depth, depending on their energy, and therefore form layers hidden under the surface with the desired type of alloying impurity and its concentration.

The third step completes the process of assembling the finished components. The plates are divided into separate crystals, the crystals are installed in the case, the conclusions are boiled, sealed, the assembled structure is checked for working capacity, labeling and packaging.

The properties of the manufactured semiconductor IC are influenced by the materials of which it consists. Silicon or germanium are used in good quality materials for crystal plates. These materials are part of the group of mono crystalline conductors.

Germanium as a single crystal has the highest hardness with the last fragility. In its pure form, this element achieves a resistivity of up to 60-68 ohms * cm. The melting point is 937 C. The Russian industry uses preferably doped germanium with electrical and hole electrical conductivity. Sensors, rectifiers for high currents and temperature indicators of resistance to low temperatures are manufactured on the basis of germanium.

A single crystal of silicon is also brittle, in its pure form it has a specific resistance of 20-40 ohms * cm. The melting point is the same 1423 C, which is significantly higher than that of germanium. Silicon-based elements can withstand higher operating temperatures (up to 180C) than similar germanium components. In its pure form, silicon and germanium do not possess sufficient conductivity needed for semiconductor parts. that's why impurities are added to the material.

To create an n-type semiconductor (electrical conductivity), the valence of the additional element must exceed by one point the valence of the main material of the crystal lattice. When covalent bonds are formed between the atoms of different parts, one extra electron remains, which is weakly bound to the atom. Such an admixture is called a donor. Almost all the atoms of the donor impurity form motionless positive ions, which makes the excess of the number of free electrons over the number of holes. In the crystal lattice, the electron plays the role of the main carrier, and the hole as a minor one.

P-type semiconductors (hole conductivity) are obtained by selecting an element for an impurity with a valence lower by one point in comparison with the main material. Similar impurities are called acceptor. When developing a covalent bond, the impurity atom is forced to create one more bond than the interacting atom of the main material offers. The acceptor atom receives an additional bond by means of a torn electron from the orbit of another atom of the main material interacting with it. In the structure of the crystal lattice, acceptor atoms form fixed negative ions. Empty orbits of the atoms of the main material form holes that absorb free electrons from the place, reducing their concentration. In p-type semiconductors, the hole plays the role of the main carrier, and the electron in a good quality is a minor one.

The required characteristics of semiconductors are set by the configuration route in the crystal lattice of the concentration of a donor or acceptor impurity.

Conclusion

The superiority of these processes is the lower manufacturing cost and the highest strength of the resulting device. However, there are several flaws: the procurement processes of the microcircuit have a natural technological limitation as there are no inductors in the semiconductor, because of the large number of components; there is a discrepancy in the arrangement of elements in the condition of a limited area.

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