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Production of chip crystals

Modern microchips are striking in their complexity. Probably, these are the highest technological achievements of human civilization today. They are present in absolutely every electronic device, and without them they will not work. But all microcircuits also consist of something, and their main component is a substrate made of a semiconductor crystal.

The most commonly used crystal is monocrystalline silicon (Si), because it has many advantages: the microcircuits on it have small reverse currents, operate at elevated temperatures, allow higher specific loads, can work in the field of electrical breakdown of the p-n junction.

Chip crystals must be produced in controlled and very clean air conditions. Since the functional elements (transistors, conductors) on microchips are very small, any foreign particle (dust, smoke or skin flakes) that gets on the plate with future microcircuits at the intermediate stages of its production can disable the whole crystal. Such rooms are called "clean rooms".

The most common process of producing crystals for microcircuits is called photolithography. It consists in the fact that the necessary material is deposited immediately on the entire surface of the substrate, and then it is carefully removed from those places where it is not needed. First of all, a thin and solid layer of the desired material is created on the substrate in one way or another. Then photolithography is carried out on it. To do this, first a thin layer of photosensitive material called a photoresist is applied to the surface of the plate, then the plate with it is placed in a precision installation, where the desired areas of the surface are irradiated with ultraviolet light through transparent holes in the photomask. The mask contains a corresponding pattern that is developed for each layer during the chip design process. Under the action of ultraviolet radiation, the irradiated areas of the photoresist change their properties so that it becomes possible to selectively remove them in certain chemical reagents. One photoresist "grows stronger" during irradiation, so its non-irradiated areas are removed, and the other, on the contrary, loses its chemical resistance, so its irradiated areas are removed. After removing the photoresist, only those areas of the plate surface remain open over which the necessary operation is required — for example, to remove a layer of dielectric or metal. They are successfully removed, after which the remains of the photoresist can be finally removed from the surface of the plate, exposing the pattern formed in the layer of the desired material for further action. The photolithography is completed.

In the production of modern microprocessors, it is necessary to perform photolithography operations up to 20-25 times — each time over a new layer. In total, it takes several weeks! In some cases, these are layers of insulating materials that serve as the gate dielectric of transistors or insulating layers between transistors and conductors. In others, it is the formation of conductive polysilicon gates of transistors and metal conductors connecting transistors.

Sometimes such an interesting method as explosive photolithography is also used. First, a pattern is formed, then a solid layer of a new material (for example, metal) is applied to the surface of the plate, and finally, the plate is placed in a reagent that removes the remnants of the photoresist or a temporary dielectric. As a result, the layer being removed seems to "explode" from the inside, taking with it the pieces of metal deposited by the latter lying on it, and in the previously "open" sections the metal remained and formed the functional one we need.

After the technological procedures are completed, each of the crystals on the plate is tested, and then the plate is cut into individual crystals (rectangular chips) using a diamond saw. This allows them to be placed in more compact enclosures. Next, each chip is packaged in its own case, which allows it to be connected to other devices. Finally, all packaged chips are tested again, sorted by characteristics and compliance with certain specifications and shipped to the customer.