EVOLUTION OF SCANNING AND OF THE PROBE MICROSCOPE CHECKING METHODS OF THE ELECTRONIC PRODUCTS

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ABSTRACT: It is organized comparative analysis of possibilities, merits and demerits of the laser scanning and electronic microscopic methods of checking the electronic products. There are considered the principles of operation of the tunnel scanning and atom force microscopes, which spatial resolutions reaches the pica- meters

Keywords : the laser, electronic, tunnel, atom force scanning microscopes.

On early stages of development of microelectronics for finding the fault elements in electronic products (the integral circuits, semiconductor devices, and memory cell) were used the mechanical contact probes with diameter of contact 10 μm. However, for sub-microns elements with high density of layout to find the damaged area there was difficult, and besides, the mechanical systems contribute to the damages in the tested object.

At the production of electronic products a greater attention is spared for checking of electric (static and dynamic) parameters. Usually such checking is realized at the final stages of fabrication by means of functional tests - functional checking.

Parallel with functional checking have been designed the methods of checking based on using of the laser and electronic rays [1-5].

These methods exclude the direct mechanical contact with the object of checking and are based on transformation of the laser or electronic rays' energy under their interaction with object into energy of electric signals, forming image.

Using the methods of scan with laser and electronic bunches allows to perform the analysis of parameters of operation in process of production and get information for the technological process controlling. The structures of electronic products are basically periodic in space and this factor defines the periodicity of scenes. The defects bring to disturb of such periodicity.

The scanning laser microscopes allow measuring the sizes and form of distribution the areas of spatial charge both along surface, and on depth. Using infrared laser scanning microscope it is possible to appreciate the topology of structures, defect distributions, drain of currents and others

[1- 3]. The modulation of intensity of the laser ray allows controlling the condition of elements of the integral scheme, but using the stroboscopes mode allows to research their dynamic features.

When use as a source a helium - neon laser, working at wavelength of λ=0,63 μm the spatial permit forms 2 μm. The laser ray is formed in a spot and moves on the checking object and scans it. Then follows the detecting photo-response signals, the accumulation of information in a digital memory and its processing by microprocessor in real scale of time using certain programs [4, 5].

The merits of the laser scanning method is that checking is non-contact and nondestructive and is performed on air that does not require any premises of checking object in vacuum.

The scanning electronic microscopes serve for reception of information on geometric parameters of solid state surfaces, as well as, for revealing the physical non-homogeneity of the under surface layer. The object surface is irradiated with finely-focused electronic ray, which scans the sample.

As a result of interactions of the focused electronic bunch with sample occurs several physical effects: one part of bunch of electrons is reflected, other part penetrates inside, it is generated the secondary electrons, it is radiated the x-rays, the photons.

Using different detectors is possible to get information on topology of object surfaces, chemical composition, the potential distribution and others. The merit of the scanning electronic microscopes is a big depth of sharpness that allows observing the three-dimensional objects, high resolution: 10-1 nm.

The demerits are necessity to place checking object in vacuum, as well as possibility of its damage in process of checking. The probes microscopes enable to study atomic and molecular structure of the surface, act upon it at a rate of separate atoms and molecules. Among of probe microscopes the most interest for checking of the electronic products present the tunnel scanning and the atom force microscopes. [6.]

The main difference of the probe microscopes consists in type of applicable probe. In the tunnel scanning microscope (TSM) the metallic probe and the conducting surface under investigation sample form the tunnel junction and measure the value of electric current of the tunnel junction. The stable image of many surfaces is possible to get at value of tunnel current of 1 nA. In this case, the probe turns out to be near surfaces at the distance in parts of nanometers. For reception of scene of surface a probe moves on surface of sample, supporting the constant value of tunnel current.

As probe in TSM are used sharpening needles, made from metallic wire, in simplest event by means of usual scissors under angle of 30-60°. By means of TSM is possible to measure and

check the parameters of material and designs, realizing the setting, removing and moving of the separate atoms.

However TSM is possible to use only for conducting surfaces. The atom force microscope (AFM) presents itself the supersensitive meter of the surface profile.

In AFM are used a micro-miniature springy plate (the console) on free end of which by methods of lithography are formed the igloo (the probe) from hard material (nitrous silicon, silicon). When moving the probe along surface of object is registering the deflections of console, on which in principle is possible to appreciate the power of interaction of the probe with the object. The power of interaction of probe with sample is possible to get if summing all elementary interactions for each atom of probe. Therefore, realize the interaction of atom with atom is necessary that edge of probe was as atomic sizes.

The probe scanning microscopes appear near 20 years ago, when the computer technology intensively developed. So, for writing of three-sizes images have been used digital methods of the informational processing, which allow visualization of the surface topology, electrical, magneto and other proprieties.

At present the laser scanning methods and electronic microscopy is wide used due to variety of modes and ensemble of information parameters. However at production a VLSI, magnetic and compact disks, where is required the high spatial permit as checking - measuring equipment it is wide used the scanning tunnel and atom force microscopes.

Thereby, the microscopic methods of checking developed toward of improvement of spatial resolution, which for the last two decades changed from 1nm (the scanning electronic microscope) to10^{-2} nm (the atom force microscope) and approach to a pico-scope area.

It is possible, on the following stage of development of the checking- measuring equipment will become possible the visualization of internal structure of separate atoms.

REFERENCES:

1. Н.Н. Арменча и др., 1978, «Электронная техника», серия 7, вып.1, с. 50-57
2. Н.Н. Арменча, И.А.Васильев, И.П.Молодян, О.А.Попа, 1978, «Микроэлектроника », т. 7, вып.1, с. 66-69
3. Л.А.Ангелова, В.Д.Вернер, Г.М.Сагиян, 1985, Электронная промышленность, вып.3, с. 71
4. Я.Таруи , 1985, «Основы технологии сверхбольших интегральных схем», перев. с япон., М.,
5. В.А.Власенко, О.И.Шкодин, 1990, «Микроэлектронные системы неразрушающего контроля качества изделий электронной техники», Киев,
6. http://www.nanoscopy.org/ebook/cont_ru.html