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ELECTRON MICROSCOPES

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Abstract

This article provides general information about electron microscopy analysis. The general structure, types, optical scheme and working principle of electron microscopes are introduced. Information about "Levenhook" microscopes is provided. Sample preparation technology, replicates and thin samples were analyzed. The proCesses of determining the structure of disloCations with the help of replicas of the electron microscope are explained. Characteristics of raster electron microscope, emission electron microscopes were analyzed.

Basic word

Electron gun insulator, vrasmthermal cathode, electrode, anode, condenser lens, diaphragm, two-level deflection system, lens, diaphragm optics, reception, detector of secondary electrons, crystal leaf spectrometer, proportional counter, preamplifier, gain block, electric ray tubes.

Enter

It is known that a lot of effective work has been carried out in the field of mechanical engineering and metallurgy in recent years. Including, the works in the direction of material science are also developing. Scientific research, theoretical and practical, testing and a number of experimental works are carried out in large machine-building plants.

This may be the objective of the microscope or the method of illumination adopted, the structure used for the optical circuit, etc. But, as a rule, the main types of microscopes are classified according to the size of the microstructures that can be seen using this system. (Figure 5.3).

According to this division, microscopes are: a) optical (light), b)electron, c) X-ray examination, d) scanning probe.

The most commonly used microscopes are the light type. A rich selection of them can be found in optical stores. With the help of such devices, the main tasks of studying the object are solved. Specialized, more complex microscopes often use other additional systems and devices (Figure 5.2).

Figure 5.2. Types of electron microscopes

Modern approaches include: 1. TEM or transmission electron microscopy. In this setup, an image of a very thin object with a thickness of up to 0.1 μm is formed during the interaction of the electron beam with the test material and subsequent multiplication of the magnetic lens loCated in the objective.

2. SEM or scanning electron microscope. Such a device allows you to take an image of the surface of an object with a high resolution of a few nanometers. When using additional methods, such a microscope provides information that helps determine the chemical composition of surface layers.

3. Scanning tunneling electron microscope or STM. Using this device, the topography of superconducting surfaces with high spatial resolution is measured.

In 2002, a new optical instrument company appeared in America. The range of products includes microscopes, telescopes and binoCulars. All these devices have a high quality image.The company's head office and development department are loCated in Freemond, California, USA. But as for the production facilities, they are loCated in China. Thanks to all this, the company provides the market with advanced and high-quality products at low prices.

Figure 5.3. Leeuwenhoek microscope

The Leeuwenhoek microscope has a wide range of functional features. For example, an entry-level training device can be connected to a computer and is able to record video of ongoing research (Figure 5.3).

Research part

Currently, the most common are transmission type electromagnetic microscopes, in which electrons passing through the object of observation create an image. The electron beam passing through the object enters the foCal (projection) system consisting of an objective and one or more projection lenses (Fig. 5-4).

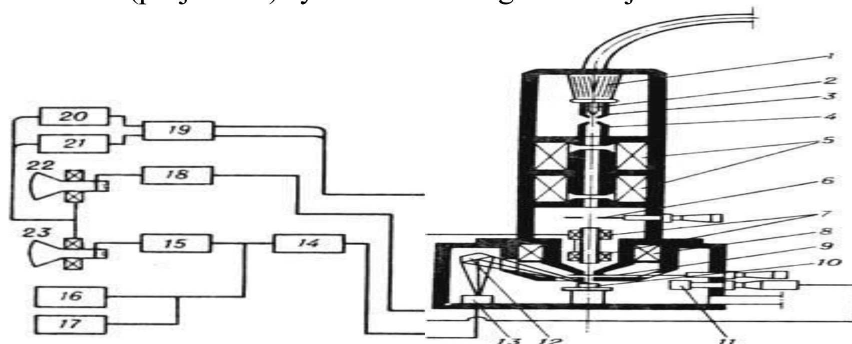

Figure 5.4. Scheme of the scanning electron microscope (SEM): 1 - insulator of the electron gun; 2 - Vrasmthermal cathode; drawing attention to 3 electrodes; 4 - anode; 5 - condenser lens; 6 Diaphragm 7 - two-level deflation system; 8 lenses; 9 - aperture optics; 10 - reception; 11 detector of secondary electrons; 12 crystal leaf spectrometers; 13 - proportional counter; 14 - preamplifier; 15- income unit; 16, 17 X-ray equipment for registration; 18 - income bloCk; 19 - magnification adjustment unit; 20, 21 - burning bloCks horizontal and vertical view; 22, 23 electric light tubes.

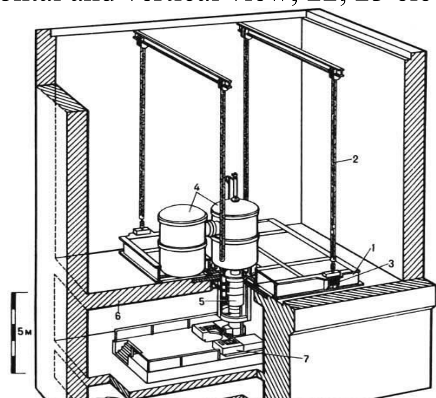

Figure 5.5. Ultra High Voltage Electron Microscope (SVEM): 1-vibration isolation platform; 2nd chain, hanging platform; 3 - shoCk absorption springs; Generator where you are loCated 4-tank electron high voltage and electronic accelerator noise gun; 5th electron-optical column; 6- high electronic circuit ceiling lower halls and working protection personnel lower hall, from X-ray radiation; 7 - remote control microscope control.

Glasses

These parts of the microscope are optical systems designed to create the desired microscopic images on the surface of the observer's eye. Glasses have two groups of lenses. The object closest to the researcher's eye is called the eye, and the farthest is called the field (with its help, the lens creates an image of the object being studied).

Lighting system

A microscope provides a complex structure of diaphragm, mirrors and lenses. With its help, uniform illumination of the studied object is provided. Early microscopes performed this function, and with the improvement of optical instruments, they began to use first flat and then concave mirrors. Later, this information comes to the observer in the form he needs. Small types of light microscopes

Modern classification:

1. Complexity of research, work and school microscope. 2. On surgical, biological and technical fields of application. 3. Phase relationship, fluorescence and polarization by types of microscopy in illuminated and transmitted light devices.

4.The direction of the light flow should be reversed and straight

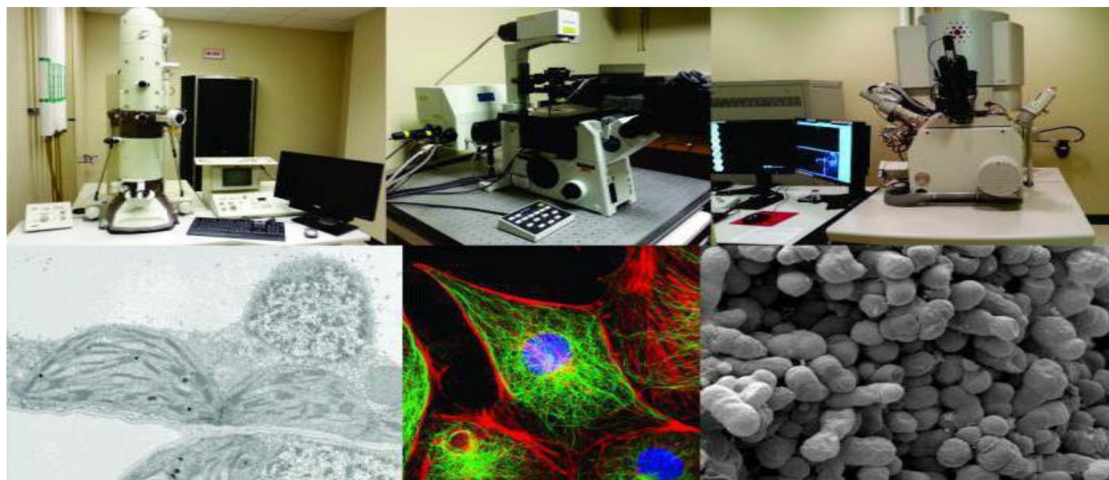

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Figure 5.6. The working principle of an electron microscope

The working principle of the electron microscope is based on the properties of electric and magnetic fields. Their rotational symmetry is able to have a foCal effect on electron beams

Sample preparation technology, replicas and thin samples.

Preparation of samples and studying the structure of metals and alloys in an electron microscope, as well as studying the surface of the desired surface with the help of sufficiently intense bright light for non-metallic materials. Therefore, the sample surface should be specially prepared.

Determining the disloCation structure using electron microscope replicas.

The working principle (use) of electron microscopes is set up in electron microscopes because they have the ability to obtain more detailed information about the structure of alloys. Electron microscope allows to determine the change of the spatial composition of alloys during deformation, as well as the formation of dispersed particles during aging of alloys

The method of micro-X-ray spectroscopic analysis

X-ray microspectral analysis is used to evaluate the distribution of alloying elements and inclusions in cast or deformed metals, and to estimate the amount of chemical bonds. Also, the analysis of this method is used to estimate the number of parameters of diffusion proCesses, for example, based on the determination of concentration divisions as a result of chemical thermal analysis of the depth of the diffusion layer.

Analytical responses using MAR-2 can be continuously registered on an object area of 200x200 µm2 (maximum sample size 9x15x8 mm). Micro X-ray spectral analysis is used to evaluate the distribution of deformed or cast metals, alloying elements and primes (additives), as well as to determine the number of chemical compositions. Also, this method is used to determine the number of parameters of diffusion proCesses, to determine the concentration of the depth of diffusion layers in chemical thermal analysis. The x-ray diffraction method for checking the structure of metals is based on the X-ray diffraction of a number of atoms in the metal crystal lattice, which allows measuring the spacing of atoms about ÍǺ and, therefore, determining the shape of the crystal lattices of metals or alloys and the spacing of atoms (ions) in the lattices. The spatial arrangement of atoms (ions) is reflected in an X-ray image. Each metal forms a unique system of lines with a certain loCation, width and intensity on the radiograph.

Crystal lattices of almost all metals and alloys are determined by X-ray structure analysis. As you know from the course of physics, X-rays are similar in nature to light rays, but X-rays differ from light rays in that their wavelength is much smaller. Since the wavelength of X-rays is small, these rays do not return from the surface of the substance, but penetrate into this substance. According to X-ray analysis, the following special carbide phases are determined: B_4C_3, Me_2C_6, Me_7C_6, Me_7C_7, etc. This method is performed with Fe-iron deposition in step scanner radiation in the DRON-2.0 X-ray machine

The Dron-2.0 diffractometer is an X-ray device designed primarily for comprehensive research and X-ray structural analysis of various materials, including metals and their alloys. The sets included in the x-ray diffractometer set-top box allow for the following analyses:

1. Perform research in accordance with the general recommendation of phase analysis in terms of

quality and quantity;

2. Obtaining integral intensity dispersive full beam from monoCrystals;
3. Determining the purpose of cross sections of monoCrystals;
4. To determine and study texture and others with the help of research.

In addition, when using a special attachment, which is not included in the permanent set of the X-ray machine, it is possible to perform the following:

1. Small-angle goniometric device GMU-1, starting from 12oC, with a small-angle territory, conducting research in a wide-angle l interval;
2. Research in the temperature range from room temperature to plus 2000^{oC} (high-temperature X-ray device) URVT - 2000^{oC};
3. Research in the temperature range from room temperature to minus 180oC (low-temperature X-ray device - URNT-180oC);
4. Conducting a study of X-ray physical research using an X-ray camera, registration (listing) of the diffractometer in the second working place (set-up PRF-1 for the X-ray imaging method).

Dron-2.0 X-ray apparatus (diffractometer) provides operation of BSV-8 (GOST 16994-71) or BSV-10 (GOST 19829-74) in combination with one or two X-ray tubes at the same time.

Raster electron microscopes.

Sample preparation for examination in a raster electron microscope. Scanning electron microscopy is the study of objects irradiating a finely foCused electron beam placed on the surface of a thin, degraded nut. As a result of the interaction of the foCused electron beam with the sample surface, secondary electrons are visible, reflected electrons, characteristic electron beams, X-rays, and photons of various energies. The presence of contamination on the crack surface has a negative effect on the secondary emission, causing distortions in the formation of images. Some foreign particles get charged from the electron beam and repel it

Figure 5.7. Scheme of Raster Auger electron microscope (ROEM): 1 - ion pump; 2- cathode; 3 - three-electrode electrostatic optics; 4-channel detector; 5-aperture optics; 6-stage electronic probe scanning deflection system; 7th lens; 8- cylindrical external electrode window tester; Object 9.

SEM with a field emission gun has high resolution (up to 2-3 nm). A cathode in the form of a tip is used in a field emission gun, and strong electricity is generated at the top of the horn. field emission by drawing an electron from the cathode). The electronic brightness of a gun with a field emission cathode is 10 times 3 -10 times 4 times higher than the brightness of a thermal cathode gun. Accordingly, the current of the electronic probe increases. Therefore, in a SEM with a field emission gun, the diameter of the probe is reduced to increase the resolution along with the slow fast sweep. However, the field emission cathode only works under high vacuum (10 -7 -10 -9 Pa), which makes the design and operation of SEMs difficult

Characteristics of a raster electron microscope

Transparent raster E. m. (PEMP) has the same high precision as PEM. These devices use field emission weapons operating under high vacuum conditions (up to 10 -8 Pa), providing sufficient current in a small size probe (0.2-0.3 nm). The diameter of the probe is reduced by two mags. lenses (Fig. 4.8). Detectors are loCated under the object - central and ring. In PEM, high precision is achieved by slow friction, as the current is small in the probe, which is only 0.2-0.3 nm in diameter. PREMs are equipped with all the analytical equipment used in electron microscopy. object research, in particular energy spectrometer. electron loss, X-ray. spectrometers, complex systems for detecting transmitted, backward and secondary electrons, groups of electrons scattered in decay. breaking angles. energy etc. The devices are equipped with computers for complex proCessing of incoming data

Figure 8. Schematic diagram of a transparent raster electron microscope (PEM): 1-autoemission cathode; 2nd intermediate anode; 3- anode; 4- aperture "illuminator"; 5-magnetic optics; 6 double-electron level deflation system; 7-magnetic optics; 8 - diaphragm objective diaphragm; Object 9; 10 - deflector system; 11 - ring detector of scattered electrons; 12 - the detector of non-scattered electrons (when it is released, the operation of the magnetic spectrometer); 13 - magnetic spectrometer; 14-deflection system for choosing electrons with different energy losses; 15 - cavity spectrometer; 16-detector spectrometer; VE-

secondary electrons; hv X-ray radiation.

An emission electron microscope creates an electronic image of an object that emits the object itself when heated, bombarded with primary electron beams under the influence of an electron magnet. using radiation and strong electricity. field of withdrawal of a body from an electron.

The mirror creates an image on the screen in "reflected rays": microflons loCated near the surface of the object redistribute the electrons of the reflected rays. [2]

Conclusion

In conclusion, general information about electron microscopy analysis is given. Modern electronic microscopes are all connected to a computer, and after preparing a slide of the examined sample, we can observe its internal structure, melting point, boiling point, density, specific gravity, crystal lattice shape, allotropy, isotope, atomic molecular mass. and all the features are covered in detail..

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