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DIGITAL 3D X-RAY MICROTOMOGRAPHIC SCANNERS FOR ELECTRONIC EQUIPMENT TESTING

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Modern science allows analyzing the internal microstructure of objects by means of various methods. The method of X-ray microtomography is considered to be one of the best ways of nondestructive imaging. X-ray microtomography allows visualization of the internal structure of nontransparent objects in three dimensions (3D) with high spatial resolution. There is a need to examine the internal structure of nontransparent objects, especially biological ones, in the visible range of the electromagnetic radiation with micron resolution. The development of X-ray microscopy methods has allowed looking inside nontransparent objects with resolution that exceeds the capabilities of optical microscopy. Today, computer microtomography is a primary method of 3D visualization of the internal microstructure of organic and inorganic objects using X-rays. The method is similar to medical imaging, but it has significantly higher spatial resolution. Scanning visualizes the entire internal 3D structure of the object and completely preserves the sample for other studies [1,2,3].

Methods of digital X-ray imaging allow carrying out studies of both organic and inorganic objects and materials, identifying statistical features of composition and structure of the samples.

The work process is as follows: the X-Ray unit irradiates the object that is placed on the controlled operating area. Penetrating the object, X-rays are received by the detector element unit, which provides element-by-element recognition the full frame image of the internal structure of the object.

Let us consider a kinematic scheme of the intelligent 3D X-ray microtomographic scanner (XRMTS). Figure 1 shows the kinematic diagram of the device. During the survey, the sample rotates by 180 or 360 degrees with a fixed pitch. A shadow (transmission) image of the sample is fixed for each micro-rotation. The system saves all these projections as 16-bit tiff files. After scanning, the data array represents a set of normal transmission X-ray images. The number of files in the array depends on the step size and the value of the selected total rotation angle. For example, for a 180° rotation angle with 0.9° step, the data array will contain 200 images and a small number used to transform images to compensate for the correctness of the X-ray beam.

Completion of the sample shooting is followed by reconstruction of its image. The obtained 16-bit shadow tiff images are used to reconstruct virtual sections of the object. Further, using the reconstruction algorithm, a preliminary array of sections is generated. These data are not yet images; it is a matrix containing the absorption values in the section under reconstruction.

The size of the matrix is similar to the number of pixels inside the section or the line of the CCD matrix (n is a number of pixels in the line of the shadow image or the CCD matrix). Now we can save the reconstructed section as a floating-point matrix containing attenuation values after reconstruction [2].

Completion of formation of the preliminary array of sections is followed by creation of a 3D image of the sample.

The developed intelligent X-Ray microtomographic scanner for testing of materials of different origin has the following distinctive advantages:

1) high precision positioning system that is able to position objects under study with the accuracy of ± 1 micron;
2) complete automation of the X-ray micro tomography process and reconstruction of a 3D-model of the object;
3) built-in algorithms and classification analysis of the internal structure and defects of objects;
4) built-in algorithms for pre-processing of initial lossless compression data in order to save computing resources of the system;
5) high operating speed of both hardware and software components because of the use of restructurable control algorithms providing significant accuracy of the X-ray micro tomographic scanner [2].

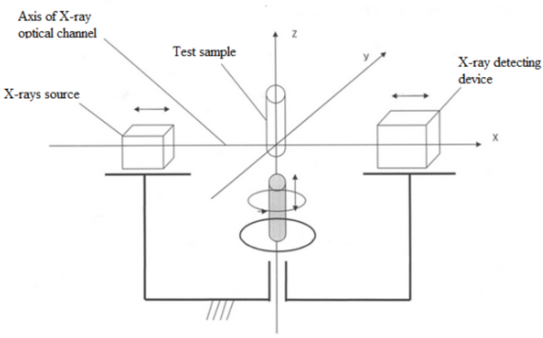

Fig. 1. Kinematic diagram of the device

Competitive advantages of the developed device include portability, compactness, ability to test different materials (organic, nonorganic, and constructive) and elements of electronic equipment, compatibility with other types of equipment, and competitive price [1].

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