COMPUTERIZED STAND FOR MEASURING THE STATISTICAL CHARACTERISTICS OF PLANAR RADIATION DETECTORS

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The stand for studying the static (electrophysical) characteristics of planar radiation detectors consists of a microprobe station with manual movement of probes and high-precision measuring equipment connected to a computer for carrying out automated measurements.

The main purpose of the stand is to study the characteristics of planar radiation detectors before placing them in protective housings.

Using the stand allows you to measure the current-voltage and capacitance-voltage characteristics of the detectors, as well as promptly identify detectors with unstable characteristics. The obtained measurement results are used to determine the operating modes and reject semiconductor radiation detectors.

INTRODUCTION

The department of radiation physics and multichannel track detectors has many years of experience in the development and manufacture of silicon uncooled planar detectors and detection systems [1-4]. These detectors were created for research in the field of nuclear physics, nuclear power and nuclear medicine.

In Fig. 1 shows part of the surface of a planar detector.

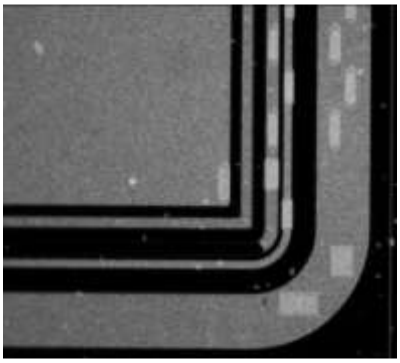

Fig. 1. The surface of the detector enlarged by a microscope. Light rectangles - Al pads

Contact pads are used to connect external circuits in the manufacture of detector modules, as well as to connect a detector using needles fixed in micropositioners. In order to study planar radiation detectors, a computerized stand for measuring the statistical characteristics of planar detectors was created.

1. STRUCTURE AND OPERATION OF THE COMPUTERIZED STAND

In Fig. 2 shows the equipment and devices used in the operation of the computerized stand.

Fig. 2. A computerized stand for measuring the statistical characteristics of planar detectors: 1 - manual test station; 2 – computer; 3 - switching unit; 4 - picoammeter KEITHLEY model 6487; 5 - RLC meter - BK Precision 8953

The measuring equipment is connected to a computer for automated measurements. To measure the static characteristics of the detectors, the following are used: high-precision measuring devices; switch for electrical circuits and measuring circuits; control programs for measuring devices.

In Fig. 3 shows the equipment of the microprobe station.

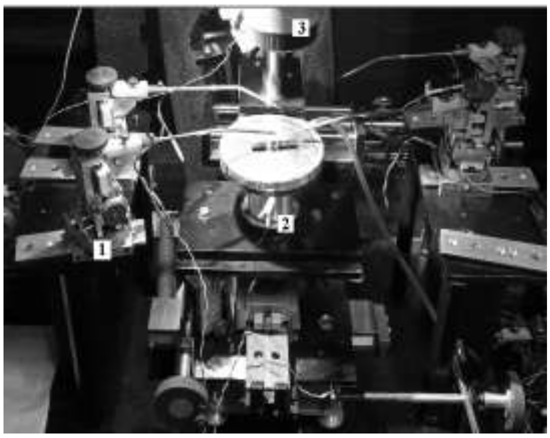

Fig. 3. Microprobe station with manual movement of probes: 1 – micropositioner; 2 - object stage; 3 - microscope

The microscope, stage and micropositioners are manually moved along three coordinates.

Planar detectors on the stage were fixed using a vacuum. Using a microscope, the surface of the detectors is visually examined. The microscope and micropositioners allow connecting to the contact pads of detectors with transverse dimensions up to 20 microns. These contacts are used to create measuring circuits.

Cables coming from the microprobe station and measuring instruments were connected to the switching unit. The measuring circuits are assembled inside the switching unit.

During the operation of the stand, the current-voltage and capacitance-voltage characteristics of the detectors were measured. Using a switch, a corresponding measurement scheme was connected for each measurement mode. Through the switching circuit, the detector was supplied with voltage from a power supply built into the picoammeter.

The picoammeter with a power supply and an RLC meter were connected to the computer through the CEC-488 interface board. The operation of the CEC-488 interface board was supported by the corresponding drivers and subroutine libraries.

The work of the stand was supported by programs that control the course of measurements. The general view of the control program window is shown in Fig. 4.

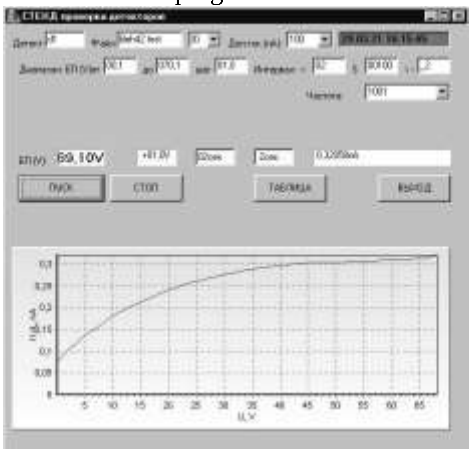

Fig. 4. The general view of the control program window.

In special windows, information on the identification of the tested detector, the name of the file for recording the results, and the measured characteristic were set. In the corresponding windows of the program, the following were set: range and step of voltage change; the current and time of test modes.

The computer program controlled the operation of the instruments (picoammeter, RLC meter) and ensured the sequence of measurements. The measurement procedure involved: testing with an increase in the applied voltage; maintaining the applied voltage for a certain time; decrease in applied voltage. The measured detector current was compared with the set permissible value. When this value was exceeded, the increase in the testing voltage stopped. The program went into the test mode with a decrease in the applied voltage. The information obtained during the measurement was displayed on the monitor screen in a tabular or graphical form.

2. MEASUREMENT RESULTS

The measurements of the characteristics of the detectors were carried out at different stages of the creation of the detecting modules. Information about the measurements carried out was saved in files on the hard disk of the computer. To process the test results, various programs for constructing graphs and tables were used.

In Fig. 5 shows one of the test results of planar radiation detectors.

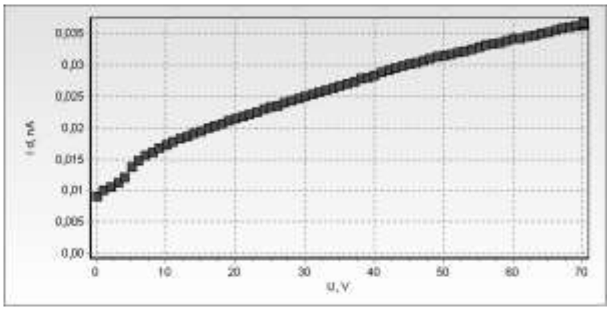

Fig. 5. Results of measurements of the I - V characteristic of a detector with stable parameters

In Fig. 6 and Fig. 7 shows the results of measurements, reflecting the capabilities of the used testing algorithm.

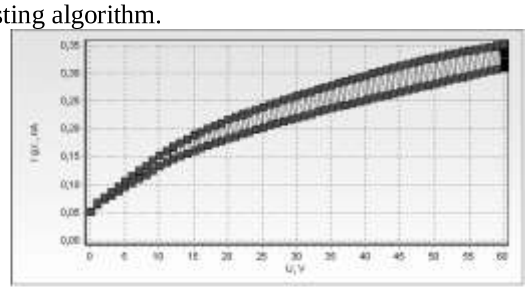

Fig. 6. The current-voltage characteristic of a detector whose current varied by more than 10% during the stability test. The upper curve is the current-voltage characteristic, measured with decreasing voltage

After increasing the voltage to the specified maximum, the stability of the detector characteristics was checked. Test time - standard 100 s, with the possibility of arbitrary correction in the window of the measurement program. During the stability check, the leakage current of the detector (Fig. 6) increased by more than 10%. As a result, the program started the process of measuring the I – V characteristic with a decreasing voltage. Based on the measurements, it was determined that the I - V characteristic of the detector is unstable over the entire range of the applied voltage.

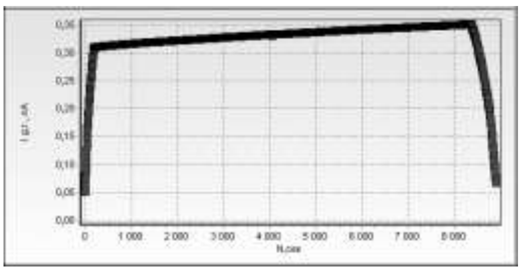

Fig. 7. The results of measuring the leakage current of the detector over time. Results were obtained by stability testing for 2 hours

The measurement results presented in Fig. 7 allow assessing the nature of the detector instability during testing.

For detectors with stable I-V characteristics, it is necessary to measure the capacitance-voltage characteristic (Fig. 8)

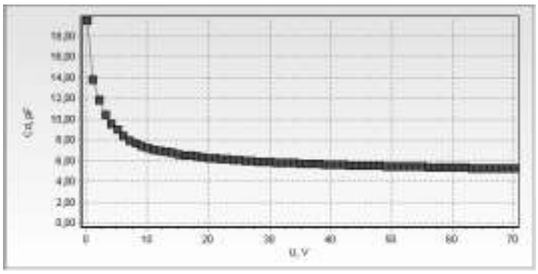

Fig. 8. Capacitance-voltage characteristic of the detector

The results of measuring the capacitance-voltage characteristic were used to determine the operating modes of the detector during spectrometry. Based on these data, the complete depletion voltage and the capacitance of the biased detector were determined.

The graphs and tables obtained during processing were used for analysis and publications. When the detector modules were created, the corresponding data were placed in the documents accompanying the production - assembly routes.

CONCLUSIONS

A stand was created for the study of static characteristics (electrophysical parameters), intended for the study of planar radiation detectors.

The main purpose of the stand is to study the characteristics of planar radiation detectors before placing them in protective housings.

The use of stands makes it possible to measure the current-voltage and capacitance-voltage characteristics of detectors, as well as promptly identify detectors with unstable characteristics. The obtained measurement results are used to determine the operating modes and reject semiconductor radiation detectors.

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