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Analysis of the Electrophysical Dimensions of Semiconductor Detector with the Help of a Computerno-Mathematical Model

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ABSTRACT: This article presents the experimental (current-voltage) characteristics with mathematical models of silicon semiconductor coordinate-sensitive detectors (SC-SD) nuclear radiation sensitive area with dimensions 50 × 50 × 1.5 mm and 8 stripes electrodes.

KEYWORDS: computer mathematical model, current-voltage characteristic, Li diffusion, Si (Li) p-i-n structures, Li drift, Additional drift, Si (Li) p-i-n detectors.

I.INTRODUCTION

Currently, the most promising method for detecting charged particles is the use of solid-state silicon nuclear radiation detectors. Semiconductor detectors are widely used in nuclear physics experiments, and also find applications in medicine, Geology, environmental protection, etc. At the same time, their creation is associated with a number of physical, structural, technical and technological features [1]. They are associated with the manifestation of effects caused by the perfection of the initial crystal of large diameters and the production of effective nuclear radiation detectors based on them. In particular, this is due to the production of high–quality detector structures with large dimensions of the sensitive surface and the area in the base of p - n or p–i–n structures on silicon single crystals of large diameters (d > 30 mm). Hence, there is a need for a deep understanding of the physical processes caused by the efficiency of the initial large-size silicon. In this regard, it is necessary to conduct computer simulation of each step of the technological process, taking into account at each step the degree of influence of the properties of the initial silicon on the electrophysical and radiometric characteristics of the detector [2-3]. These mathematical models can be used not only for semiconductor detectors, but also for semiconductor devices, in particular diodes, transistors, thyristors, etc.

It is necessary to first study the features of identification and uniformity of distribution of point defects, inclusions, clusters, and other imperfections in the volume of various semiconductor crystals.

One of the main tasks of the computer experiment is to develop and test a mathematical model of the device that describes in quantitative form the relationship between its input and output parameters [4].

At present, the mathematical model is widely used in the creation of semiconductor devices and their practical experience, as well as statistical analysis of the dimensions of the device. It provides an opportunity to see by comparison without having to do many Tests in semiconductor instrumentation and technology. This method of research significantly reduces the time spent on conducting experiments, as well as the cost of development, and it is possible to determine the result of practical experiments using a computerno-mathematical model in comparison with theoretical methods [5].

II.MATERIALS AND METHODS

The mathematical model plays a big role in semiconductor devices and microelectronics. At present, special programs for conducting such comparisons have been developed and are being used. We can see Mosol as TCAD-Technology Computer-Aided-Design Software. This application is used in the analysis of electrophysical dimensions of semiconductor devices, structure optimization, selection of semiconductor material and technological processes [1].

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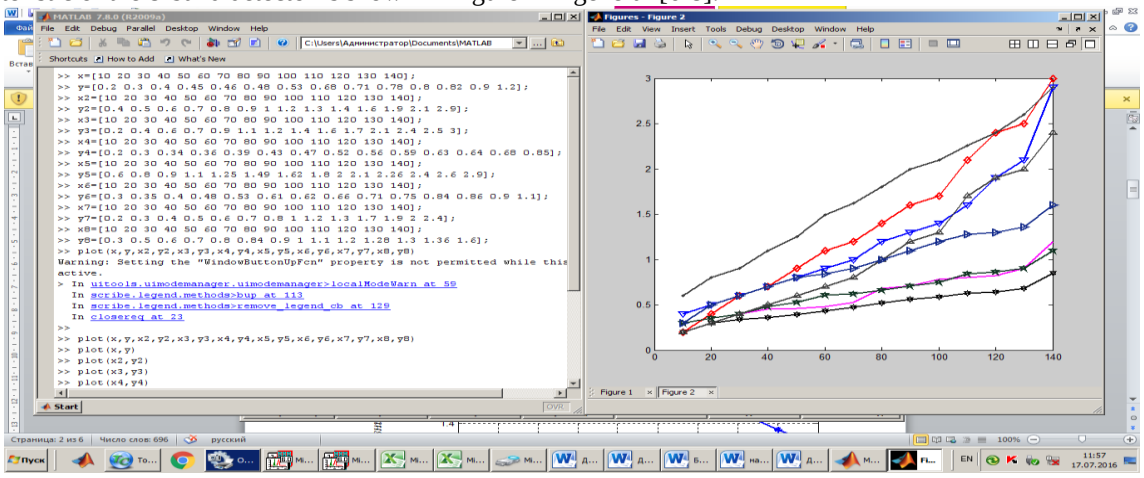
III. DISCUSSIONS AND RESULTS

In this study, the electrophysical magnitude of large-scale nuclear radiation 8-band coordinate-sensing Detektor was compared using a mathematical model. The input parameter of the Bunda is the voltage, the output parameter is the current. It was based on experiments conducted on seeing the mathematical model of the process. The results of the conducted experiment are presented in Table 1.

1-table. The experimental voltamper size of the semiconductor detector is listed

Voltage **(U, B)**	Detector ribbon numbers							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Power**(I, μA)**							
10	0,2	0,4	0,2	0,2	0,6	0,3	0,2	0,3
20	0,3	0,5	0,4	0,3	0,8	0,35	0,3	0,5
30	0,4	0,6	0,6	0,34	0,9	0,4	0,4	0,6
40	0,45	0,7	0,7	0,36	1,1	0,48	0,5	0,7
50	0,46	0,8	0,9	0,39	1,25	0,53	0,6	0,8
60	0,48	0,9	1,1	0,43	1,49	0,61	0,7	0,84
70	0,53	1	1,2	0,47	1,62	0,62	0,8	0,9
80	0,68	1,2	1,4	0,52	1,8	0,66	1	1
90	0,71	1,3	1,6	0,56	2	0,71	1,2	1,1
100	0,78	1,4	1,7	0,59	2,1	0,75	1,3	1,2
110	0,8	1,6	2,1	0,63	2,26	0,84	1,7	1,28
120	0,82	1,9	2,4	0,64	2,4	0,86	1,9	1,3
130	0,9	2,1	2,5	0,68	2,6	0,9	2	1,36
140	1,2	2,9	3	0,85	2,9	1,1	2,4	1,6

In order to preserve the static characteristic of the object, a graph of the dependence of the input parameter on the output parameter is drawn. In this case, the temperature values are placed on the obsissa axis, while the temperature values on the ordinate axis are placed on the junction. According to the data presented in Table 1, the static characteristic of the 8-band detector is shown in Figure 1 in general [6-8].



1-picture. 8. static characteristic of ribbon detector

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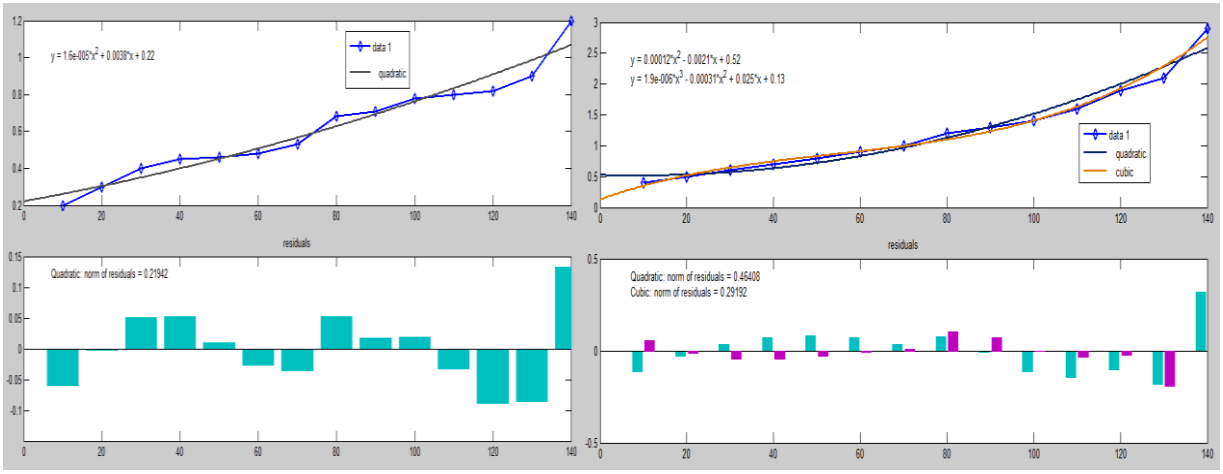
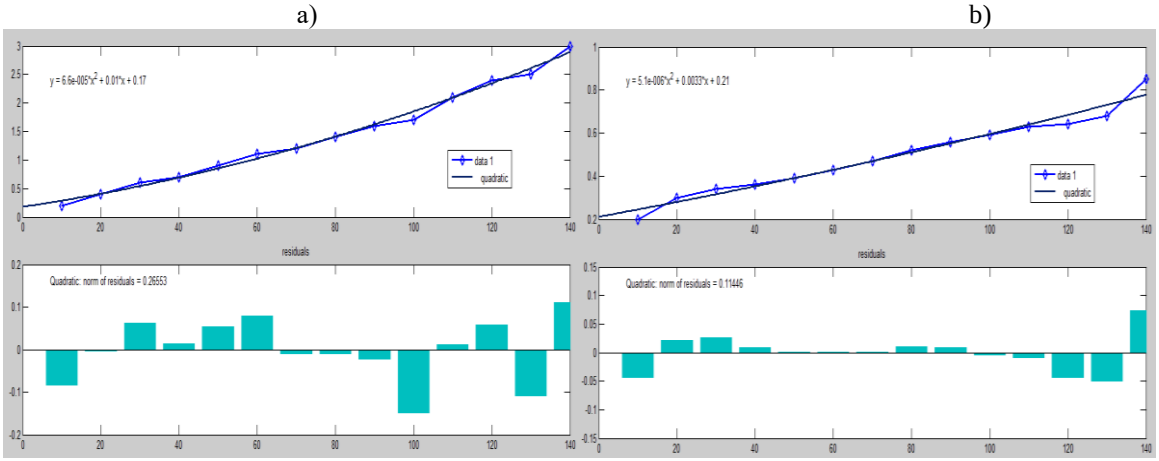
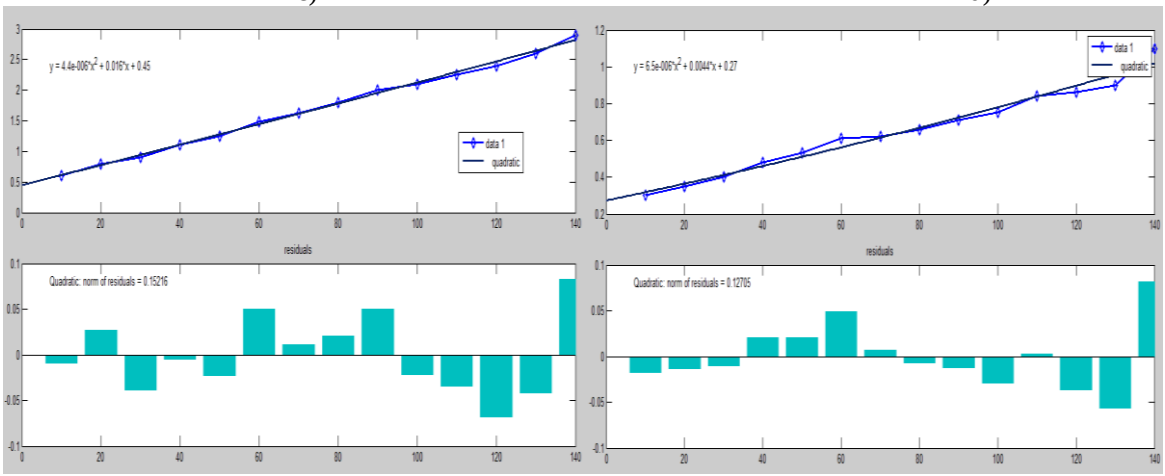


a) b)



c) d)



e) f)

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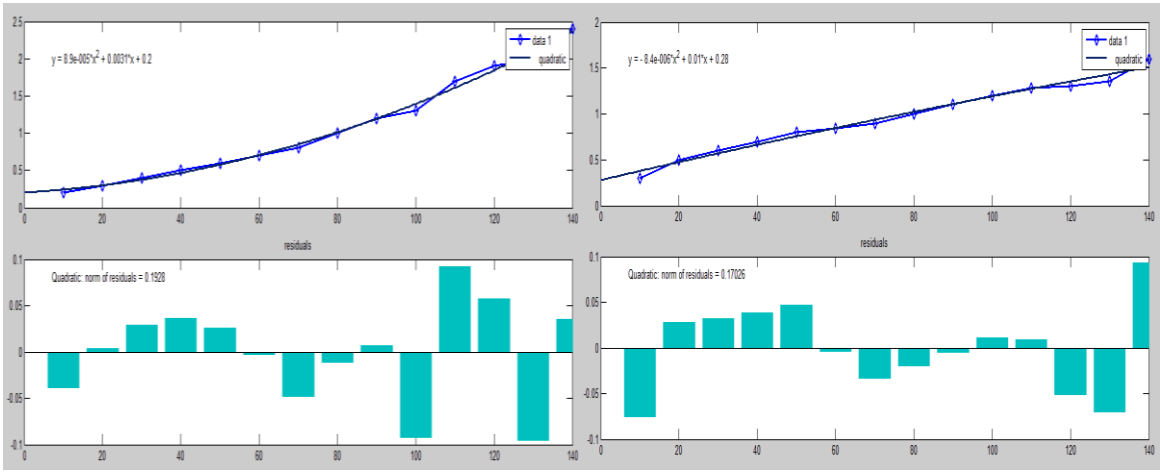

g) h)

2-picture. The entire tape of the semiconductor 8-band detector was compared as a result of a mathematical model. a) - h) compared as a result of the mathematical model on the straps.

The voltamper sizes of all the bands of the semiconductor 8-band Detektor were compared (Figure 2) and MATHLAB 7.8.0(R2015a) was used in carrying out these checks. It was reported that the overall statistical result was different to 0.22. This means that all the technological processes of semiconductor large-scale nuclear radiation coordinate-sensitive detectors and the latter dimensions of the device give a good result, there is little error in performing the specified function.

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