UDC 004.942

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ARCHITECTURE AND DESCRIPTION OF THE APPLIED PROGRAMS PACKAGE FOR ELECTRICAL PROPERTIES SIMULATION OF HETEROGENEOUS MATERIALS

Abstract. The specialized program package for simulation electrical properties of materials was elaborated. This package based on the well-known models describes the dielectric properties and electrical conductivity of heterogeneous dielectrics and dielectrics with semiconductor inclusions. Applying this program package, students and scientists can make the different simulations in order to study or research dielectrics properties.

Keywords: simulation of the electrical properties, dielectrics, heterogeneous materials, program package for simulation

Introduction. Computer simulation has become an essential part of science and engineering. Simulation is the most effective method for researching the electrical properties of heterogeneous materials in the electronics, chemistry and other areas of the modern technics and technologies. However, the simulation results are massive and can be calculated only using numeral methods and computer technologies. In order to overcome these difficulties, the special software has been elaborated. Researchers use everything from basic programming languages to various high-level packages implementing advanced methods. The applied programs package usually includes the most famous and important models from experimental practice. Besides the applied program package must have the access service tools to these models.

In this work we represent the architecture and UI of the applied program package that was elaborated. This package based on the well-known models describes the dielectric properties and electrical conductivity of heterogeneous dielectrics [1,2] and dielectrics with semiconductor inclusions [3,4].

Main part. The major idea of this work is the control of the applied program modules library. In order to train specialists in the area of information technologies, can be used simulation of the processes,

situations etc. Therefore, laboratory work is carried out using specially developed packages for simulation like [5] and the developed program package. The elaborated program package is designed for the simulation of electrical properties of dielectrics and heterogeneous systems based on semiconductors. It can be used as a base for creating the effective methods to control physical parameters of materials and to forecast electrical characteristics of electronic equipment elements. Each application is a specific practical work for students. Used module is an Engineering Math Software *Mathcad* document. Computer user must setup the Engineering Math Software *Mathcad*. Without it the application cannot be applied.

The architecture of the elaborated program package is shown below (Fig. 1). The library consists of four thematical blocks. The block has ten applications (applied programs for simulation) which can solve a specific researching tasks in the area of electronic properties of heterogeneous systems.

The first block of elaborated program package represents overall methods of dielectric spectrum analysis. A spectrum type of complex dielectric permittivity can supply information about dielectric polarization mechanism etc.

The second block models are designed for using the frequency dependencies of the relative permittivity, dielectric loss factor, and electrical conductivity of two-component dielectrics in order to obtain information about the physical properties of its components.

The current-voltage characteristics model of a single intercrystallite potential barrier is described in the third block. It based on the most established ideas about the mechanisms of electrical conductivity for working operation modes of products made of metal oxide varistor ceramics.

The fourth block comprises the simulation results of volt-farad characteristics of varistor structures in a wide range of constant bias voltages.

The developed programs package was made for the Windows OS. The navigation between different applications and program parts can be realized by means of the main, intermediate and work menus [6]. The main package menu links all parts. The *Mathcad*-documents location in

the appropriate parts of the program package ensure convenient navigation for users.

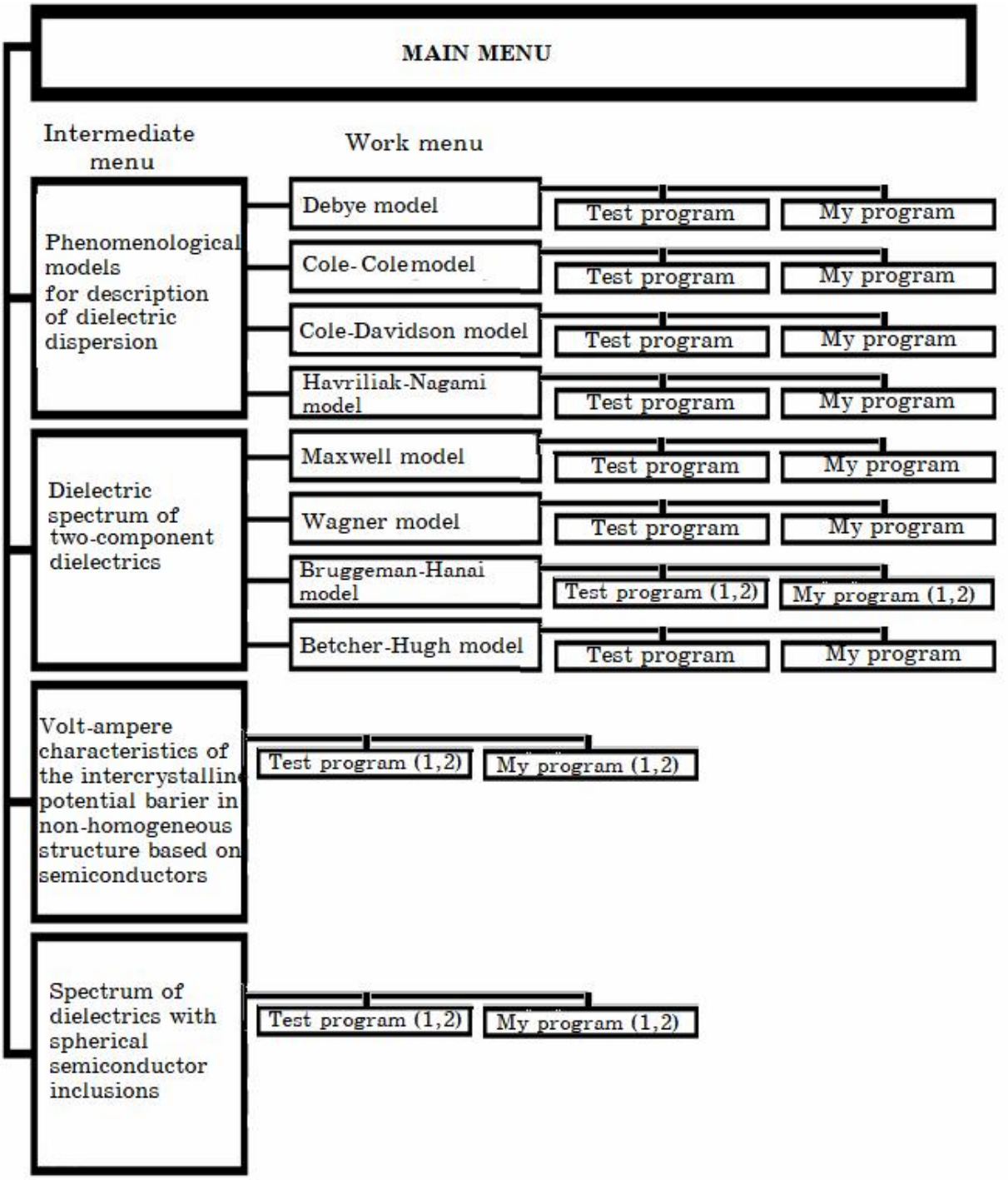


Figure 1 – The applied programs package architecture

The user interface is a series of nested windows (forms) sequences, with access from the first (the main) window (Fig. 2). It allows choosing the desired option from model's library.

For example, when user chooses *Dielectric spectrum of two-component dielectrics* option and presses the button, the window with intermediate menu will be opened (Fig 3 (a)). This menu allows choosing a specific formula for describing two-component dielectrics spectrum (work menu – Fig. 3(b)).

The main and intermediate windows have a toolbar with two drop-down menus, namely *Menu* and *Help*. The drop-down menu named *Menu* has two elements (constituents). First *Open Mathcad* element allows us to start Engineering *Mathcad* Math Software or to choose the *Mathcad* file. Second *Exit* subparagraph closes application.

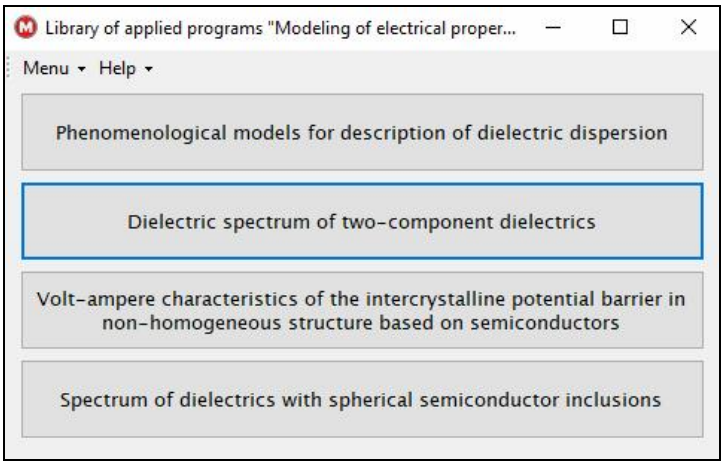
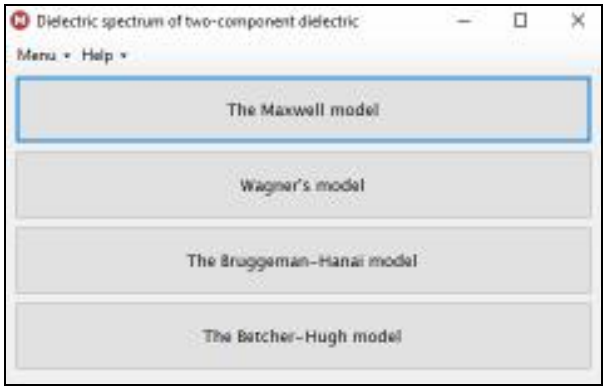
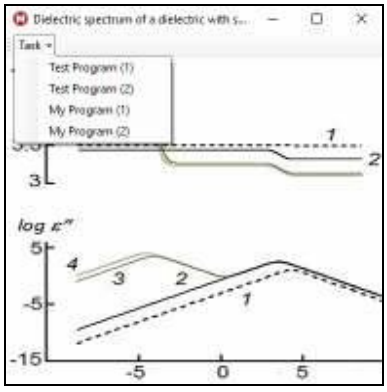


Figure 2 – The main window of the UI programs package

The drop-down *Help* menu also has two elements. First *User's Manual* element allows us to open the user's Manual document. Second *Workshop* element opens references as to the base information about all used models. These documents can be viewed by standard .pdf-file reader.



a)



b)

Figure 3 – UI programs package:
a – intermediate menu; b – work menu

Working menu has the following two options: «*Test Program*» and «*My Program*» (Fig. 1). The test program is an example for familiarization. User cannot make changes to program. *My Program* option allows us to modify the desired model (change the model).

Figure 4 (a) illustrates the page that a person can see when press *My Program* button. The toolbar gives access to functionality such as *Open*, *Save*, *Print*, *Undo*, *Paste*, *Delete* etc. Also, on this page a person can write constant values, data and formulas that link these values. In order to construct graphs, a person should press the *Calculate* button (Fig. 4 (b-d)).

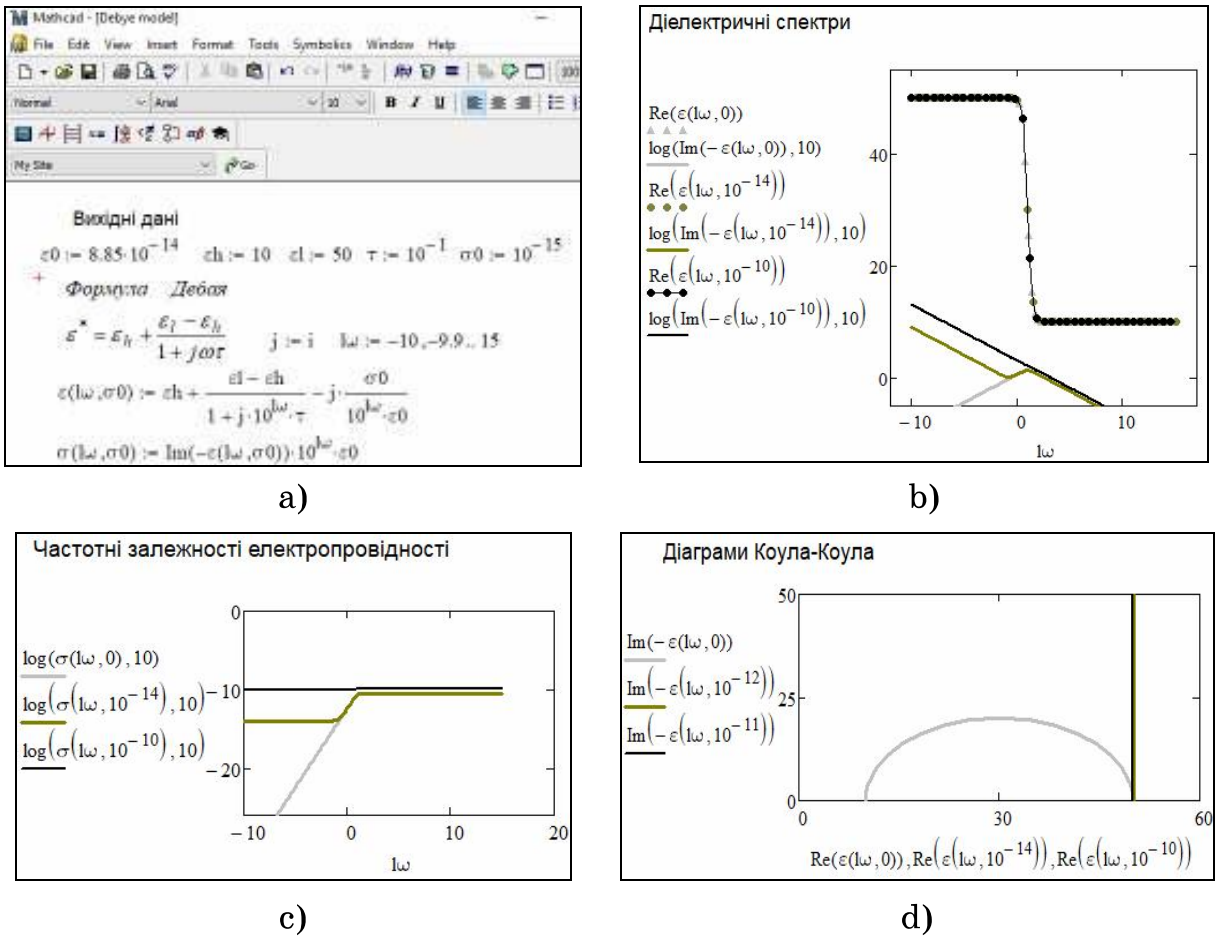


Figure 4 – *My Program* Option using Debye model:
a – to customize model; b-d – to construct graphs

Some models have algorithm saved (located) in two files. The exchange of data between them occurs by means of prn documents that contain the variables values.

 ISSN 1562-9945

Conclusions. The architecture and UI of the applied program package for simulation of the dielectric properties and electrical conductivity of heterogeneous dielectrics and dielectrics with spherical semiconductor inclusions were elaborated. Applying this program package, students and scientists can make the different simulations in order to study or research dielectrics properties.

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