International Journal of Advance Scientific Research
(ISSN – 2750-1396)
VOLUME 04 ISSUE 06 Pages: 40-44
SJIF IMPACT FACTOR (2022: 5.636) (2023: 6.741) (2024: 7.874)
OCLC – 1368736135
Crossref doi Google Scholar WorldCat MENDELEY
ISSN-2750-1396


Journal Website: http://sciencebring.com/index.php/ijasr



Research Article

# STUDY BY MODELING THE ELECTRICAL PROPERTIES OF SEMICONDUCTOR MATERIALS

**Submission Date:** June 16, 2024, **Accepted Date:** June 21, 2024,
**Published Date:** June 26, 2024
**Crossref doi:** https://doi.org/10.37547/ijasr-04-06-07

**Turgunova Nadirakhon Bakhadirovna**
**Andijan machine-building institute, Uzbekistan**

## ABSTRACT

This article discusses the process of developing a device for producing semiconductor elements operating on the basis of the thermoelectric phenomenon. The focus is on methods and technologies that improve the efficiency of thermoelectric converters. The article describes the main stages of device design, as well as an analysis of its functional characteristics. The results of experimental studies are presented, confirming the high efficiency and reliability of the developed device.

## KEYWORDS

Thermoelectric phenomenon, semiconductor elements, thermoelectric converters, device development, thermoelectric generator, thermoelectric cooler, efficiency, heat transfer, energy efficiency.

## INTRODUCTION

Thermoelectric materials and devices based on the thermoelectric phenomenon play an important role in modern energy conversion technologies. These materials are capable of converting thermal energy into electrical energy and vice versa, which makes them extremely promising for use in various fields, including electronics, the automotive industry and energy. The operation of thermoelectric devices is based on fundamental physical effects, such as the

Seebeck effect and the Peltier effect, which were studied and described by academician A.F. Ioffe and his staff.

Thermoelectric phenomena are associated with mutual transformations between electrical and thermal processes in metals and semiconductors [1, 2, 3]. From a technological point of view, thermoelectric materials are used not only in automotive technology, but also in semiconductor technology, radio electronics and household devices. Thermoelectric systems (TES) are used to stabilize and regulate temperatures in the range from -60°C to +120°C [4, 7, 8]. This thesis outlines the operating principle of a thermoelectric module (TEM), defines its main technological parameters, and also presents a system for modeling the automatic control of a thermoelectric object for creating high-quality automotive electronic devices.

## METHODS

This paper discusses the solution of mathematical problems in the field of semiconductor physics such as heat transfer and electrodynamics using the modeling method. The main task of current production is to create efficient and reliable thermoelectric converters that can be used to generate electrical energy from heat, as well as for cooling various systems.

The ANSYS software package solves stationary and nonstationary, linear and nonlinear problems using the finite element method from such areas of physics as solid mechanics, fluid and gas mechanics, heat transfer, and electrodynamics. Calculations can be carried out in batch or interactive modes. For batch mode, a program must first be written using the built-in APDL (ANSYS Parametric Design Language) and ANSYS commands [5, 9, 10]. The interactive operating mode is implemented either using the classic ANSYS graphical interface or on the Workbench platform. These shells consist of command menus and windows. Interactive mode is the main modeling mode, even batch files are usually created using interactive mode tools. The FEM solution of the posed boundary value problem is carried out by the ANSYS program in three stages: preprocessing, solution and postprocessing. The block diagram of the implementation of this algorithm is presented in Figure 1. At the preprocessing stage, the basis of a finite element model of the object under study is created. This stage includes the following procedures: 1 – The physical type of the task is established. 2 – The type of finite element is selected depending on the dimension of the object and its other properties. 3 – The materials of the object are selected and all its necessary properties are indicated. 4 – A geometric solid 3D model of the object is constructed. 5 – The geometric model is divided into finite elements. When laying out, various grid parameters can be specified. 6 – In the case of a contact problem, contact parameters are established, the contact model and its characteristics are determined [11, 12].

The second stage - imposing the necessary boundary conditions on the model and solving the problem - consists of three main steps:

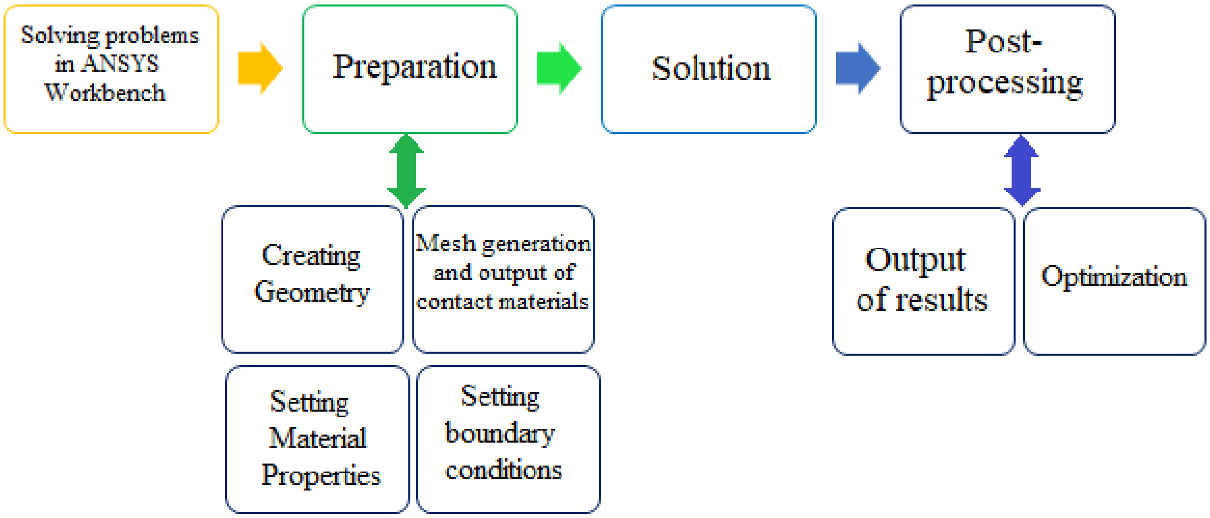


**Figure 1. Flow diagram of the process of solving a problem using the finite element analysis method using the ANSYS calculation platform.**

**Research results**. To solve the thermoelectric problem, there is a special type of analysis in the ANSYS software package - thermoelectric (Figure 2) [6]

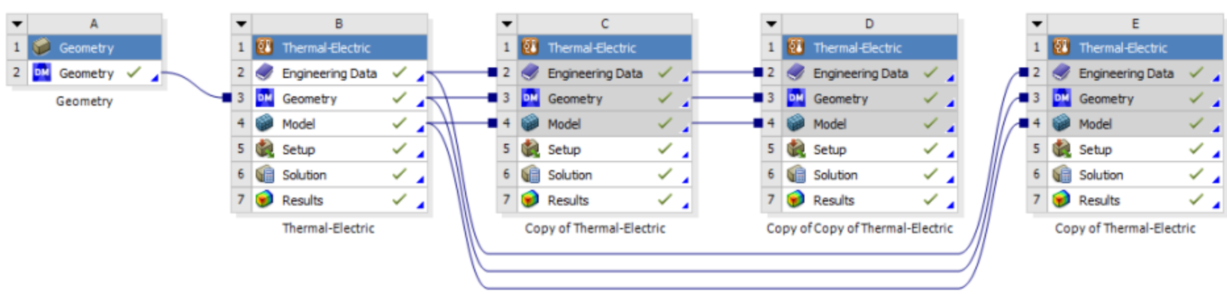


**Figure 2 – Calculation tree when using thermoelectric analysis [6].**

This project tree allows, when specifying one parameter of boundary conditions and material properties, to carry out calculations of multiple models. Moreover, in each subsequent branch you can separately change any of the parameters: boundary conditions, mesh size, model geometry, material parameters. In the tree presented in Figure 3.2, almost all parameters are related to the initial model and the calculation is based on the fact that the geometry of the object is common for all options. The only difference in this project is the boundary conditions. When solving a thermoelectric problem, the following physical quantities can act as boundary conditions:

– temperature;

– heat flow;

– convection;

– liquid cooling.

In this case, the temperature on the plates of thermoelectric modules was implemented as boundary conditions. Setting the physical properties of materials is carried out in the "Engineering Data" section; for this, standard data from ANSYS libraries are used, or your own libraries are created, into which data is entered either from literary sources or measured independently. As part of this work, various material libraries were created.

## Conclusion

This article presents the results of modeling a device for producing semiconductor elements designed to operate based on the thermoelectric phenomenon. The studies have shown that the proposed methods and technologies can significantly improve the efficiency of thermoelectric converters. Experimental data confirmed the high reliability and stability of the developed device. These results open up new possibilities for the widespread use of thermoelectric devices in various fields, including energy, automotive and electronics. Future research will be aimed at further improving technologies and methods for producing semiconductor elements, as well as developing new applications of thermoelectric technology.

## Reference

1. Anatychuk L.I., Semeshok V.A., Tarasov Yu.A. and others. Thermoelectric phenomena and their application. - M.: Nauka, 2018.
2. Bozhenar D.A., Tarasov R.Yu., Golytsman B.M. Technologies for producing thermoelectric materials. - St. Petersburg: Politekhnika, 2019.
3. Kudinov V.A., Smirnov I.A. Semiconductor thermoelectric converters. — Ekaterinburg: Ural Branch of the Russian Academy of Sciences, 2020.
4. Aliev S.A., Zulfigarov E.I. Automation of thermoelectric systems. - Baku: BSU Publishing House, 2021.
5. V. A. Bruyaka, V. G. Fokin, E. A. Soldusova, N. A. Glazunova, I. E. Adeyanov. Engineering Analysis in ANSYS Workbench [Book]. - Samara: Samar. state those. Univ., 2010.
6. A. S. Korotkov, V. V. Loboda, S. V. Dzyubanenko, E. M. Bakulin. Development of a thin-film thermoelectric generator for low-power applications [Journal] // Microelectronics. - 2019. - pp. 1-10.
7. Trasova G.I., Zaitsev G.F., Sergeev S.A. Automatic control systems for thermoelectric objects. — Kazan: KFU Publishing House, 2019.
8. Popov E.P., Bessonov A.A. Microprocessor control systems. - M.: MSTU im. Bauman, 2020.
9. Solodovnikov V.V., Plotnikov V.N. Modeling of thermoelectric systems. — Novosibirsk: NSU Publishing House, 2018.
10. Habuchi Hitoe. Thermal Conductivity and Thermoelectric Materials in Automotive

Applications. — Tokyo: University of Tokyo, 2019.

11. Yoshihide Shibata. Advances in Thermoelectric Materials and Devices. — Kyoto: Kyoto University Press, 2020.
12. Turgunova N.B. Investigation of thermal conductivity efficiency and application of thermoelectric generators as sources of alternative energy// Texas Journal of Engineering and Technology Vol.17 No:2770-4491 02/17/2023, pp 44-47
13. Turgunova N.B. Development of a new tubular thermoelectric generator for waste heat recovery//International scientific and practical conference "Integration of science and production: problems and solutions" Namangan 05/03/2023, pp 114-118