Brief information about the project

Name of the project	AP15473758 "Study of the sintering mechanism of bulk nanostructured thermoelectric materials during their formation"
Relevance	The idea of the project is to obtain new data on the temperature field and mechanical stress in the sample volume, which will make it possible to compare the sintering temperature regime with the properties of the resulting materials and give recommendations for obtaining functional thermoelectric materials with specified/improved properties. This is achievable by using the spark plasma sintering (SPS) method, which consists of compacting nanopowders under Joule heating. The current problem of the project is the complexity and nonlinearity of thermophysical, electrical and mechanical processes during SPS. These processes cannot be directly monitored during the experiment. In this case, there is a need to use numerical modeling based on a phenomenological approach.
Purpose	The goal of the project is to study the mechanism of thermoelectric formation, which influences the increase in the efficiency of the resulting thermoelectric materials using the example of the most promising compounds of nanostructures. The development of a technology for numerical analysis of thermoelectric processing processes will make it possible to create recommendations to produce effective environmentally friendly nanothermoelectrics.
Objectives	To achieve the goals of this project, it is necessary to implement the following main tasks: 1. Development of a numerical model of the geometric shapes of spark plasma sintering (SPS) matrix punches for the maximum and complete representation of thermal, electrical, and mechanical processes occurring in thermoelectric nanomaterials and elements of the SPS installation. 2. Study of the process of formation of bulk thermoelectric materials by the SPS method using the example of several generators nanothermoelectrics, such as thermoelectrics based on solid solutions of bismuth and antimony, zinc and antimony, silicides, skutterudites, Heusler alloys. 3. Refinement and justification of numerical models that make it possible to describe the process of shrinkage and compaction of the sample during the SPS process. Study of mechanical stress fields in the installation elements and the sample during the SPS process. 4. Optimization of conditions for the formation of temperature fields and electric potential during the sintering process of nanomaterials. 5. Study of the structure of the new materials obtained using the recommendations developed within the framework of this project.

Expected and achieved results	Based on the results of the scientific project, the following minimum results will be obtained over the entire period of the project: 1) Will be published for the entire period of the project (2022-2024): - at least 2 (two) articles in journals from the first three quartiles by impact factor in the Web of Science database or having a CiteScore percentile in the Scopus database of at least 50. publication of monographs, books and (or) chapters in books of foreign and (or) Kazakh publishing houses: not planned obtaining patents: not planned development of scientific, technical, design documentation: not planned dissemination of work results among potential users, the scientific community, and the general public: participation in oral presentations at major international conferences. The results of the study will be published in articles in rating journals. other measurable results in accordance with the requirements of the competition documentation and the specifics of the project. Additionally, the section indicates: The result of the project is a numerical analysis of the synthesis process of thermoelectrics using the finite element method, which will provide new data on the creation of nanostructured materials and expand knowledge in the field of alternative energy, materials science and the nanosystems industry of the Republic of Kazakhstan.
Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles	1. Yerezhep Darkhan, Candidate of Technical Sciences, PhD, Hirsch Index – 7, ResearcherID: D-6983-2017, https://orcid.org/0000-0002-2232-2911, Scopus author ID: 57194012596.
List of publications with links to them	In international peer-reviewed journals: 1) **Yerezhep, D.*,** Akylbayeva, A., Golikov, O., Sokolov, D. Y., Shinbayeva, A., & Aldiyarov, A. U. Analysis of Vibrational Spectra of Tetrafluoroethane Glasses Deposited by Physical Vapor Deposition. // ACS Omega. 2023 8, 22, 19567–19574 (IF=4.197, percentile 72) 2) **Yerezhep, D**.; Omarova, Z.; Aldiyarov, A.; Shinbayeva, A.; Tokmoldin, N. IR Spectroscopic Degradation Study of Thin Organometal Halide Perovskite Films. // Molecules, 2023, 28, 1288. (IF=5.11, percentile 78)

	3) Kenbay A.A., Golikov O.Yu., Aldiyarov A.U., **Yerezhep D.*** Low-temperature cell for IR Fourier spectrometric investigation of hydrocarbon substances. // Scientific and Technical Journal of Information Technologies, Mechanics and Optics, 2023, vol. 23, no. 4, pp. 696–702. (percentile 9) 4) Golikov, O., **Yerezhep D.*,** Akylbayeva, A., .. Korshikov, E., Aldiyarov, A. Cryovacuum facilities for studying astrophysical ices // Low Temperature Physics, 2024, 50(1), pp. 66–72 (IF=0.8, percentile 33) in domestic journals recommended by KOKSNVO: 5. Golikov, O., **Yerezhep D.*,** Akylbayeva, A., .. Korshikov, E., Aldiyarov, A. Creep-vacuum installation for the production of astrophysical ice // Fizika Nizkikh Temperatur, 2024, 50(1), pp.70 –76 6. Akylbayeva, A., Sokolov, D., Aldiyarov, A., Golikov, O., Karamysova, L., & **Yerezhep, D*.** (2023). Analysis of retrofitting a universal vacuum cryogenic spectrophotometer. Herald. Series Physical (VKF), 84(1), 82-90.
Patents	-