Brief information about the project

Name of the project	AP19678266 «Development of a selective gas sensor for explosive and harmful substances, which is based on nanostructured semiconductors for industrial safety»
Relevance	The manufacture of highly sensitive gas sensors to harmful and explosive gases in industrial facilitie a high sensitivity, fast response, good selectivity, low detection limit, as well as an autonomous mobile monitoring tool on site and in real time is of paramount importance to ensure the safety of health and environmental safety of the environment. Unlike the existing metal-oxide, optical and chemical sensors, the sensor device we offer is inexpensive, compact and operates at room temperature, and also has the properties of rapid recovery after gas adsorption (unlike graphene-like materials for the sensor).
Purpose	The aim of the project is to develop an autonomous device of a selective gas sensor for harmful, toxic and explosive gas molecules with an accuracy of at least 0.1 ppm using heterostructural and surface modifications of porous silicon nanostructured films.
Objectives	1. Obtaining nanostructured films and studying the minimum response values of electrical characteristics depending on a certain concentration of ammonia, toluene, chloroform, and methane gas molecules. 2. Investigation of the maximum concentration value of the instantaneous appearance of a stream of harmful and explosive gases before the surface of the sensor films is saturated with gas and a possible area of reduction in the efficiency of regulation to gases in high concentrations. 3. Investigation of response time and selectivity to gases, as well as comparison with existing sensors. 4. Surface modification and creation of a heterostructure on the surface of the obtained films of porous nanostructured silicon. 5. Development and design of a digital gas sensor device with wireless sensor networks. 6. Testing and commissioning of a prototype of a distributed self-organizing network of gas sensors interconnected by means of a radio channel.
Expected and achieved results	As a result of the research work, there will be a highly efficient gas sensor for use in industrial facilities, including mines. The developed sensor will be characterized by high sensitivity to low gas concentrations, as well as selectivity to harmful and explosive gases and gas mixtures. The sensor will operate at room temperature without heating the sensor surface and will also continuously notify the monitoring center remotely. The cost of the sensor itself is minimal since expensive materials and optical devices will not be used. 1) publication of articles in foreign peer-reviewed scientific journals;

	- or at least 2 (two) articles and (or) reviews in peer-reviewed scientific publications indexed in the Science Citation Index Expanded of the Web of Science database and (or) having a CiteScore percentile in the Scopus database of at least 35 (thirty-five) and at least 1 (one) patent included in the Derwent Innovations Index database (Web of Science, Clarivate Analytics); - as well as at least 1 (one) article or review in a peer-reviewed foreign or domestic publication recommended by Committee for Quality Assurance in the Field of Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan; - preparation of at least 1 (one) Doctor of Philosophy (PhD) or doctor in the profile. 2) publication of monographs, books and (or) chapters in books of foreign and (or) Kazakh publishing houses. - one monograph on the research topic. 3) obtaining patents in foreign patent offices (European, American, Japanese), in Kazakhstan or Eurasian patent offices; - one patent in the Kazakhstan patent office or one copyright certificate. 4) development of scientific and technical, design documentation; - one scientific and technical documentation. 5) dissemination of the results of the work among potential users, the community of scientists and the general public; - the results of the study will be published in journals and collections in open access for scientists and the general public on Internet resources, as well as in the library of KazNU. 6) other measurable results in accordance with the requirements of the tender documentation and the specifics of the project. 1) the scope and target consumers of each of the expected results; The proposed sensors will be used in mines and industrial facilities. 2) the impact of expected results on the development of the main scientific direction and related fields of science and technology; Own optimal parameters and scientific and technological documentation for the manufacture of highly sensitive selective nanosensors will be developed. The proposed digital modules of wireless sensor technologies will have domestic intellectual content, and it will also be possible to use them additionally in robotics, medicine and the agricultural industry. 3) applicability and (or) the possibility of commercialization of the obtained scientific results;

	The results of the project can be commercialized in industrial enterprises, mining companies, the private sector to ensure the safety of people and the environment. With the successful implementation of all the tasks of the project, further expansion towards the creation of large production companies and / or introduction into production together with organizations in the field of electronic industry and automation is possible. 4) social, economic, environmental, scientific and technical, multiplicative and (or) other effect of the project results with justification. Nanosensors and radio modules of wireless sensor networks will be developed to guide the domestic production of individual physical modules of electronic systems of a wide profile. Young specialists are being trained for promising electronic and communication technologies. Professors, Doctor of Philosophy (PhD), 6 PhD doctoral students take part in the project, thereby applying their research results to contribute to increasing the innovative potential and socio-economic development of the country.
Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles	1. Ibraimov Margulan, PhD, acting professor – Leading Researcher, Supervisor. ResearcherID: AEP-9550-2022; ORCID: 0000-0002-8049-3911; Scopus Author ID: 57189617696. 2. Zhanabaev Zeinulla, Doctor of Physical and Mathematical Sciences, professor – Chief Researcher. ResearcherID: B-2924-2015; ORCID: 0000-0001-5959-2707; Scopus Author ID: 15840905700. 3. Sagidolda Yerulan, PhD, associate professor – Senior Researcher. Researcher ID: DNT-2266-2022; ORCID: 0000-0002-4608-7573; Scopus Author ID: 56465977800. 4. Kaisha Aitkazy, PhD – Senior Researcher. ResearcherID: AGM-0096-2022; ORCID: 0000-0001-7203-9842; Scopus Author ID: 57210920713. 5. Alimbetova Dina, PhD – Senior Researcher. ResearcherID: EKW-5279-2022; ORCID: 0000-0001-5437-8146; Scopus Author ID: 57216589092. 6. Zhekseby Dauren, PhD – Researcher. ResearcherID: EIY-7515-2022; ORCID: 0009-0008-1884-4662; Scopus Author ID: 57204696440. 7. Khaniyev Bakyt, PhD – Researcher. ResearcherID: FGH-7559-2022; ORCID: 0000-0002-0103-9201; Scopus Author ID: 57218681308. 8. Skabylov Alisher – Junior researcher. ResearcherID: DVY-1190-2022; ORCID: 0000-0002-5196-8252; Scopus Author ID: 57218876415. 9. Duisebaev Tolagai – Junior researcher. ResearcherID: HMH-0343-2023; ORCID: 0000-0002-4992-0495; Scopus Author ID: 58071081400. 10. Almen Dinara – Junior researcher.

	11. Tileu Ayan – Junior researcher. ResearcherID: EDL-8875-2022; ORCID: 0000-0001-9965-6728; Scopus Author ID: 57218680509. 12. Sarmanbetov Sanzhar – Junior researcher. ORCID: 0000-0003-1749-2163; Scopus Author ID: 58837577300.
List of publications with links to them	-
Patents	-

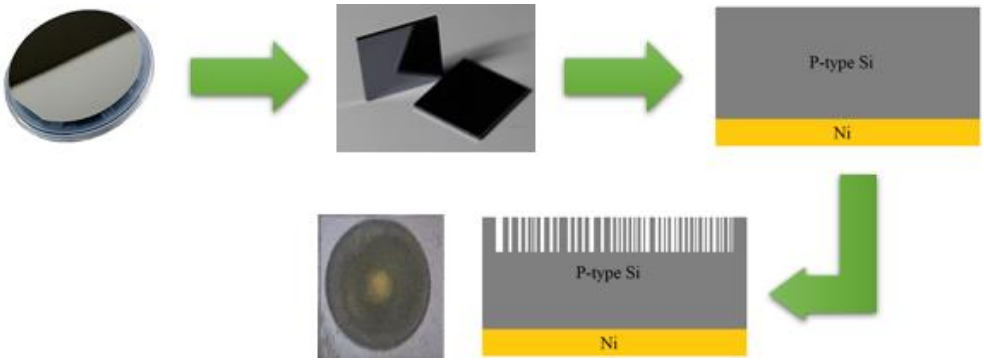
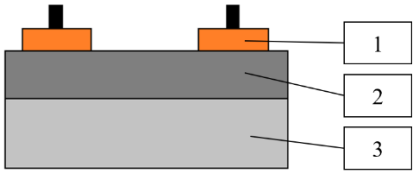


Figure 1. The scheme of obtaining a PC



1 – InGa contact; 2 – PC layer; 3 – silicon.

Figure 2. Metal contact fixed on the PC surface

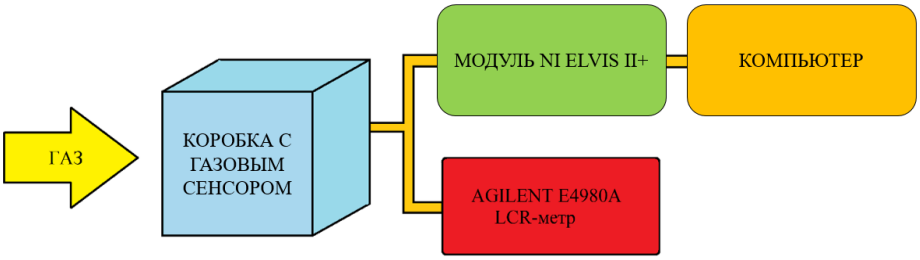


Figure 3. Diagram of the study of the sensitivity of samples to types of gas