Brief information about the project

Name of the project	AP19680205 «Investigation of adsorption processes in amorphous structures of cryocondensates at low temperatures on model surfaces of space objects» (0123PK00553)
Relevance	To date, over 140 different molecules have been identified in the interstellar medium. Dust particles were also found, and some of these molecules were frozen in at temperatures (10–20 K) with the formation of molecular ices. Understanding the adsorption and desorption processes of these formed ices is critical to understanding the processes that lead to the formation of stars and planets. Highly sensitive surface techniques, including temperature-programmed desorption and reflective adsorption infrared spectroscopy, are increasingly being used to study interactions between condensed objects. Experimental data of this kind provide an understanding of the processes occurring in ices of astrophysically significant molecules from several surfaces of model cosmic surfaces. A successful interpretation of this kind of data was made by comparing the obtained results with laboratory studies studying interstellar ice analogues under the conditions of experimentally simulated space simulators. The main goal of the planned research is to obtain experimental data on the processes of adsorption and thermal variation in thin films of cryocondensates of astrophysical significant molecules of substances. The research is aimed at understanding the mechanisms of adsorption and desorption on amorphous porous samples under conditions of the existence of similar outer space. Using the method of vacuum condensation of substances on cryogenic surfaces, experimental results of the structural transformation of films, their optical characteristics will be obtained, as well as methodological recommendations for identification and addition to the verification database of space substances will be developed. The fundamental knowledge gained during the experiments will bring practical significance to the technologies and processes occurring on the low-temperature surfaces of the cryogenic equipment of spacecraft. Thus, this project is devoted to the experimental study of the processes of adsorption and desorption of astrophysical significant molecules of substances formed on low-temperature surfaces of cryogenic vacuum equipment. Investigation of relaxation processes and thermally stimulated structural-phase transformations in samples condensed at low temperatures. The objects of research are cryocondensates of gases such as nitrogen, carbon monoxide, alcohol, water, and other substances, the

	condensation of which forms amorphous structures at low temperatures. Conducting this kind of research is aimed at establishing the relationship between the conditions of condensation (substrate temperature and gas phase pressure) and the properties of the resulting cryofilms, such as growth rate, optical characteristics, and thermal adsorption.
Purpose	Complex study of adsorption and desorption processes in amorphous cryocondensates at low temperatures on model surfaces of space objects. Study of the influence of temperature regimes of surfaces of cryogenic equipment on the interaction of molecules of astrophysical interest.
Objectives	1. Experimentally determine the conditions for the adsorption of gas molecules on amorphous cryocondensates during condensation on cryogenic surfaces. This aspect is a necessary basis for the successful implementation of the project and is confirmed by the fact that the scientific team has many years of experience in the field of low temperature physics, infrared cryo-vacuum deposition, and mass spectroscopy. 2. Obtain the optical characteristics of samples in the dynamics of temperature variations of the cryosurface by IR spectrometric analysis. Using the method of quadrupole mass spectroscopy, to determine the effect of the porosity of amorphous condensates on the adsorption properties of the surfaces of multicomponent gas mixtures in a percentage ratio from 1% to 25%. The effect of condensation pressures on the growth rates of samples will be determined by laser interferometry, and the density and refractive index values will be obtained. 3. To determine the signs characterizing adsorption and the ranges of the quantitative content of molecules in amorphous formations, to determine the thermally stimulated boundaries of the existence of samples. To implement the task, the method of thermal desorption and quadrupole mass spectrometry of residual gases will be used. This will help to determine the parameters, existence conditions, and temperature range of stable phases of the formed amorphous compounds. 4. Determining the conditions for controlled thermal variation of components into a gaseous state is due to the presence of a cryogenic substrate heating system. Determination of the range of cryogenic substrate heating rates for obtaining transformation data in amorphous formations, considering the determination of the temperature limits of desorption of gas molecules. 5. Data analysis and addition of the verification base with experimental results for astrophysically significant substances.
Expected and achieved results	Experimentally determine the conditions for the adsorption of astrophysically significant molecules by amorphous condensates during condensation and thermal variation on cryogenic surfaces. Investigate the main properties of

	cryocondensates in the low-temperature measurement range. Conditions for temperature control and cryocapture of gases by cryocondensate molecules in the process of condensation on cryogenic surfaces will be determined. An experimental study of the main properties of condensates will be carried out. To measure the optical characteristics of samples IR spectroscopy and the dynamics of thermal desorption of films by quadrupole mass spectroscopy obtained by deposition of two or more component mixtures with a content of 1% to 25% of the concentration of molecules. The optical and IR-spectrometric characteristics of cryogenic surfaces in the processes of gas adsorption will be determined. The influence of the growth rate and cryocondensation temperature of samples on their density and refractive index will be determined by laser interferometry. Determine the features that characterize the temperature variations in the desorption of astrophysically significant molecules, determine the thermally stimulated boundaries of the existence of samples. Obtain thermal desorption characteristics of systems in cryocondensates on a cryogenic surface. Thermal desorption characteristics of gas systems in cryocondensates on a cryogenic surface will be obtained. The determination of the conditions for the controlled thermal transition of the components to the gaseous state is due to the presence of a cryogenic substrate heating system. The conditions for the controlled thermal transition of the components to the gaseous state will be determined due to the presence of a cryogenic substrate heating system. The range of cryogenic substrate heating rates will be experimentally calculated to obtain transformation data in formations, taking into account the addition of the verification base. Data analysis and addition of the verification base with experimental results for astrophysically significant substances.
Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles	1. Коршиков Евгений Сергеевич. Доктор PhD 6D072300 «Техническая физика» НАО «Казахский национальный университет имени Аль-Фараби»Индекс Хирша- 5, Author ID в Scopus - 55319247600, Researcher ID Web of Science - N-4876-2014, ORCID ID - 0000-0002-9479-4192 2. Алдияров Абдурахман Уалиевич. К.ф.-м.н. (PhD), Асс. Профессор, ГНС НАО «Казахский национальный университет имени Аль-Фараби»Индекс Хирша - 8; Scopus Author ID: 16201950600, https://orcid.org/0000-0002-5091-7699 3. Нурмукан Асель. Доктор PhD. НАО «Казахский национальный университет имени Аль-Фараби» Индекс Хирша – 2, https://orcid.org/0000-0002-4231-0766
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