Brief information about the program BR 24992935

Title	Development of new innovative materials for efficient carbon dioxide utilization technologies while simultaneously producing valuable products.
Relevance	Global warming caused by the massive emission of carbon dioxide (CO_2) from the burning of fossil fuels is attracting worldwide attention. In order to preserve the environment and ensure sustainable development of society, effective methods of reducing CO_2 emissions are required. To solve this problem, it is necessary to develop economical, environmentally friendly and technologically advanced methods of utilisation. The program is highly relevant both from the point of view of scientific novelty, and from the point of view of solving the global climate problem and the formation of a sustainable economy. It corresponds to global trends in the field of decarbonization and the development of "green" technologies, and has strategic relevance, as it is aimed at a comprehensive solution to the global environmental problem through the creation of scientifically sound, technologically advanced solutions. It combines fundamental research and applied potential, contributing to the formation of a sustainable, environmentally responsible and resource-efficient future.
Goal	Development of new innovative materials and high-tech technologies that reduce the concentration of carbon dioxide in the Earth's atmosphere through the use of various chemical processes in which CO_2 acts as the main reagent to produce valuable industrially important products.
Tasks	• Development of new, regenerable bifunctional materials that simultaneously capture CO_2 and convert it into synthetic natural gas. Determination of effective technological modes of the processes of CO_2 adsorption and its conversion into synthesis gas. To establish the scientific aspects of the influence of physico-chemical characteristics (structural, textural and phase features, etc.) of bifunctional materials on their sorption and catalytic activity in the studied process. • Development of a cost-effective and highly efficient photocatalyst based on $SrTiO_3$-doped Al, capable of reducing CO_2 to chemical fuels under the action of ultraviolet and visible light. • Creation of a gas diffusion electrode modified with Cu-In, Cu-Ag catalyst for the electrochemical reduction of CO_2 to C_{1+} and C_{2+} products (methane, methanol, ethylene, ethanol, etc.). Investigation of the selectivity of the gas diffusion electrode being developed in relation to C_{2+} products at CO_2RR. • Development of new highly efficient magnetic composites based on iron compounds with various carriers in and without a vortex electromagnetic field for the hydrogenation of CO_2 to form hydrocarbon products. Investigation of the effect of process conditions and the composition of iron-containing catalysts on the

	hydrogenation of carbon dioxide with the formation of industrially important products.
Expected and Achieved Results	- New regenerable tandem materials have been developed to capture CO_2 and recycle it into synthesis gas. - An effective method for the preparation of bifunctional materials has been determined. The modes of retraining of bifunctional material for research in the process of CO_2 capture and its utilization in synthesis gas have been established. - A photocatalyst based on strontium titanate ($SrTiO_3$) was synthesized by a low-cost chemical precipitation method followed by calcination to obtain nanoscale $SrTiO_3$ powders with high purity; - A photocatalyst based on SrTiO3-doped Al was synthesized by the molten flux method to obtain $SrTiO_3$@Al nanopowders with improved photocatalytic properties; - A study of the physico-chemical properties, composition and surface morphology of the obtained $SrTiO_3$ samples, as well as modified $SrTiO_3$@Al; - Optimal conditions for electrodeposition of nanostructured bimetallic catalysts Cu-In, Cu-Ag have been found. The kinetics and mechanism of electrochemical nucleation of bimetallic systems: Cu-In, Cu-Ag have been studied. - Magnetic composites based on iron with various carriers have been obtained by chemical deposition methods and in the vortex mode of an electromagnetic field for CO_2 hydrogenation. The compositions and technological parameters of the processes, the influence of the magnetic field are optimized. - 1 article has been published in peer-reviewed scientific publications indexed in the Science Citation Index Expanded by the Web of Science databases, and (or) in peer-reviewed scientific publications with a CiteScore percentile in the Scopus database; 2 abstracts of conferences and a patent application "Method for obtaining lithium orthosilicate from sand", Ergazieva G., Myltykbaeva L., Mambetova M. etc. - Effective technological regimes of the process of adsorption of carbon dioxide and its utilisation into methane (temperature, volumetric reaction rate, CO2: H2) ratio will be established. - The dependence of physicochemical characteristics (morphology, structure, phase composition, etc.) of bifunctional materials with their adsorption and catalytic abilities will be revealed. - The results of testing the stability of bifunctional materials during multiple cycling of the process will be obtained. - The photocatalytic activity of the obtained $SrTiO_3$@Al photocatalyst for the photocatalytic reduction of CO_2 into chemical fuel will be investigated. - The effect of a sublayer of an ionic liquid based on

	imidazolium and pyridinium on the selectivity of electrochemical reduction of CO_2 to C_{1+} and C_{2+} products (methane, methanol, ethylene, ethanol, etc.) will be studied. A simulation model of a gas diffusion electrode for the electrochemical conversion of carbon dioxide has been developed to optimize the conditions of electrolysis. - A gas diffusion electrode with copper-based nanostructured bimetallic catalysts for electrochemical CO_2 reduction will be developed. The sensitivity and selectivity of the obtained gas diffusion electrode with respect to C_{2+} products were determined. - The morphology, phase state, structure, particle size, and oxidative state of the metal of the obtained iron-based magnetic composites in and without a magnetic field will be studied, and the magnetic properties of the obtained magnetic composites will be studied. - The effect of various transition metal carriers on the activity and selectivity of CO_2 hydrogenation will be investigated. - The effect of pressure and temperature on the hydrogenation of carbon dioxide with the formation of hydrocarbon products will be investigated. Over the entire period of the program's implementation, it will be prepared and published: 1) at least 6 (six) articles and (or) reviews in peer-reviewed scientific publications in the scientific field of the program, included in the 1st (first), 2nd (second) and (or) 3rd (third) quartile by impact factor in the Web of Science database and (or) having a percentile by CiteScore in the Scopus database is at least 50 (fifty). 2) at least 7 (seven) articles in journals recommended by the CQAFSHE . 3) at least 1 (one) monograph or textbook in foreign and (or) Kazakhstani publishing houses recommended by the academic council and (or) the scientific and technical council of the applicant's organization; 4) at least 1 (one) patent in foreign patent offices (European, American, Japanese) or at least 1 (one) foreign or international patent included in the database Derwent Innovations Index (Web of Science, Clarivate Analytics) or at least 3 (three) intellectual property objects (patent; for applications in the field of information technology - an author's certificate) registered with the National Institute of Intellectual Property of the Republic of Kazakhstan.
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Publications list with links to them	1. Zh. Kuspanov, A. Serik, A. Tattibay, A. Baratov, U. Abdikarimova M. Bissenova, A. Yeleuov, Ch. Daulbayev. Investigating And Investigating and correlating the photocatalytic activity of synthesised strontium titanate nanopowder with calcination temperature // Environmental Technology & Innovation. – 2024. – Vol. 36. – p. – 103852. https://doi.org/10.1016/j.eti.2024.103852. WoS IF = 6.7 Q1. Percentile SCOPUS – 97 %. 2. Ergazieva G.E., Galymzhan A. Kuramynda magnesium bar compositterdin fazalyk kuramyna olardy sintesdeu jagdailarynyn aserin zertteu. Materials of the IX International Student Scientific and Practical Conference on "CHEMICAL PHYSICS AND NANOMATERIALS", dedicated to the memory of the three-time Hero of Socialist Labor, corresponding member K.I. Shchelkin-2025-P.46 3. Ergazieva G.E., Kyzyr B. Lithium compositerin belsendirudin ontaily zhagdailaryn anyktau.Materials of the IX International Student Scientific and Practical Conference on "CHEMICAL PHYSICS AND NANOMATERIALS", dedicated to the memory of the three-time Hero of Socialist Labor, corresponding member K.I. Shchelkin-2025-P.48

Patent information	1. Filed patent application " Method for obtaining lithium orthosilicate from sand", Ergazieva G.E., Myltykbaeva L.K., Mambetova M., etc.