

Brief information about the project

Name of the project	IRN AP25793577 "Electrocatalytic behavior of a carbon electrode modified with metal nanoparticles in the hydrogen evolution reaction at high current density"
Relevance	A highly efficient and stable HER electrocatalyst is crucial for achieving large-scale H₂ production. After decades of research, scientists have made significant progress in the development and characterization of new HER electrocatalysts. However, most of these HER electrocatalysts are studied at low current densities. Furthermore, the issue of electrocatalyst stability over long periods of time is a key aspect that must be considered in industrial production. Higher current densities indicate an accelerated and more complex reaction process, which in turn alters the conditions in the reaction system and, consequently, affects the catalytic activity and long-term stability of the electrocatalyst. Adapting the electrocatalysts being developed to high-current density conditions requires a thorough understanding of the fundamental mechanisms and factors limiting their activity.
Purpose	Investigation of the electrocatalytic behavior of a carbon electrode modified with metal nanoparticles towards hydrogen evolution reaction under high current density conditions
Objectives	1) Fabrication of a carbon carrier from shungite and surface modification with metal nanoparticles; 2) Study of the morphological and structural characteristics of the manufactured electrodes; 3) Electrochemical study of the modified electrodes, including a detailed determination of all hydrogen evolution reaction parameters; 4) Optimization of the carbon carrier modification conditions to enhance its electrocatalytic properties for efficient operation under high current density conditions.
Expected and achieved results	1) Carbon electrodes modified with metal nanoparticles will be manufactured; 2) The morphological, structural, and electrocatalytic characteristics of the manufactured electrodes will be studied; 3) The mechanism of the hydrogen evolution reaction on the manufactured carbon electrodes at high current densities will be studied; 4) The fabrication conditions for the modified carbon electrodes will be optimized for stable operation under high current densities. The morphological and structural characteristics of the obtained samples were studied using SEM, EDAX, and BET. The analysis revealed that the specific surface area of the materials ranged from 350 to 550 m²/g, and their structure was characterized primarily by micropores.

	Based on the obtained data, carbon electrodes with diameters of 3, 4, and 5 mm and an active layer thickness of approximately 100 μm were fabricated. The electrochemical cell was assembled, and auxiliary electrodes were prepared to ensure stability and reproducibility of measurements.
Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles	Dinara Aktaykyzy Abduakhytova Web of Science ResearcherID: GYA-5917-2022 ORCID: 0000-0002-4316-0755 Scopus ID: 57344630000 Mikhail Kasymovich Nauryzbaev Web of Science Researcher ID - A-7137-2015 ORCID: 0000-0002-6781-6464 Scopus ID: 6506602038
Usage	The fundamental knowledge gained during the project regarding the mechanisms of hydrogen exchange reactions could stimulate additional research projects and developments. If the characteristics of the manufactured electrocatalysts prove satisfactory, this will pave the way for their commercialization and enable their use in electrochemical hydrogen production.
Priority compared to real-world alternatives	
List of publications with links to them	
Patents	not planned