Brief information about the project

Name of the project	AP14972836 «Electrochemical deposition of nano-structured catalysts from ionic liquids: electrode kinetics, new procedures and application prospects»
Relevance	To achieve a sustainable future, it is essential to explore cost-effective and eco-friendly methods for producing nanostructured materials that facilitate the conversion of renewable energy. As society transitions towards a carbon-neutral economy, the development of advanced nanotechnologies for energy conversion through electrocatalytic systems becomes increasingly critical. Thus, the creation of new techniques and strategies for controlling the synthesis of nanostructured materials with specific properties in an environmentally responsible manner is vital for decarbonising industrial processes. The electrochemical CO_2 reduction reaction (CO_2RR) offers a sustainable solution for closing the human-induced carbon cycle and transforming electricity derived from renewable sources, such as solar and wind power, into chemical energy in the form of raw materials and fuels. The conversion of CO_2 into more reduced products, such as C_{2+} hydrocarbons and multi-carbon oxygenates, is highly relevant due to their broader applications and higher energy density.
Purpose	Investigation of electrochemical deposition of bimetallic catalysts based on indium and copper from ionic liquids and development of an electrochemical method for synthesis of nanostructured catalysts
Objectives	I. Investigation of the kinetics of electrochemical reduction and electrochemical nucleation of indium, copper and Cu-In from ionic liquid [Hbet][Tf_2N] by electrochemical methods. II. Electrochemical deposition of copper and its alloys from ionic liquids based on [Tf_2N] resistant to water and air. Determination of the electrochemically active surface area of bimetallic catalysts. III. Preparation of gas-diffusion electrode modified with nanostructured catalysts based on indium and copper. Determination of activity of the obtained catalysts for electrochemical reduction of carbon dioxide.
Expected and achieved results	**Expected Outcomes:** –The kinetics of electrochemical reduction of indium, copper and their alloys from betaine bis-(trifluoromethylsulfonyl)imide ionic liquid will be investigated. – Copper and indium based bimetallic catalysts will be prepared by electrochemical deposition from different ionic liquids, and the electrochemical active surface area of the resulting catalysts will be determined. – A gas diffusion electrode modified with indium and copper based catalysts will be obtained. The selectivity of the gas diffusion electrode for the conversion of CO_2 into valuable products will be investigated. The following articles are also expected to be published: - at least 2 (two) articles in journals from the first three quartiles of the impact factor in the Web of Science database or having a CiteScore percentile of at least 50 in the Scopus database.

	Results achieved: The article "Electrochemical behavior of In-DTPA complexes: anodic dissolution, cathodic reduction, and electrochemical nucleation" was published in Journal of Solid State Electrochemistry (Q3) with a percentile of 68 on CiteScore in Scopus database. DOI:https://doi.org/10.1007/s10008-023-05638-z https://link.springer.com/article/10.1007/s10008-023-05638-z
Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles	Project leader: PhD, Avchukir Khaisa Scopus Author ID: 57207207777 https://www.scopus.com/authid/detail.uri?authorId=57207207777 Researcher ID: P-5738-2017 https://www.webofscience.com/wos/author/record/P-5738-2017 ORCID: 0000-0001-6612-0775 https://orcid.org/0000-0001-6612-0775
List of publications with links to them	1. Bekey, A., Badavamova, G. L., Vacandio, F., Avchukir, K. Electrochemical behavior of In–DTPA complexes: anodic dissolution, cathodic reduction, and electrochemical nucleation //Journal of Solid State Electrochemistry. – 2023. – T. 27. – №. 12. – C. 3439-3451. DOI:https://doi.org/10.1007/s10008-023-05638-z https://link.springer.com/article/10.1007/s10008-023-05638-z
Patents	–

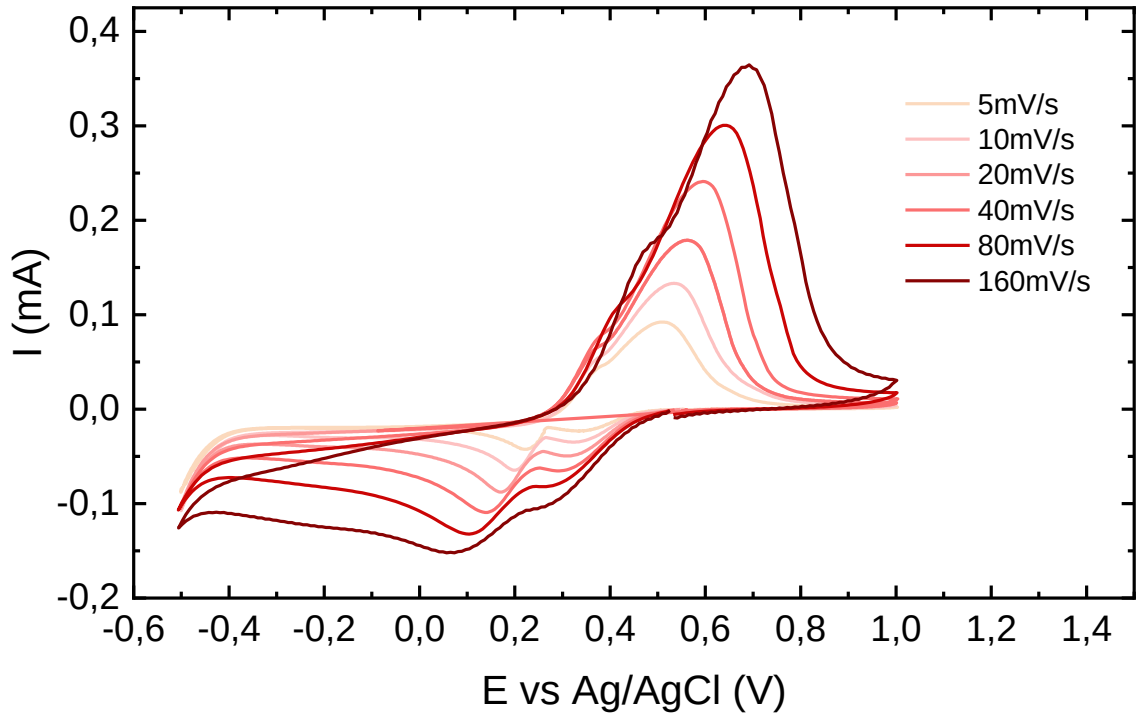

Figure 1. CVs performed at 100 ˚C on a GC electrode in 0.1 M Cu-[Hbet][Tf_2N] complex salt at various scan rates

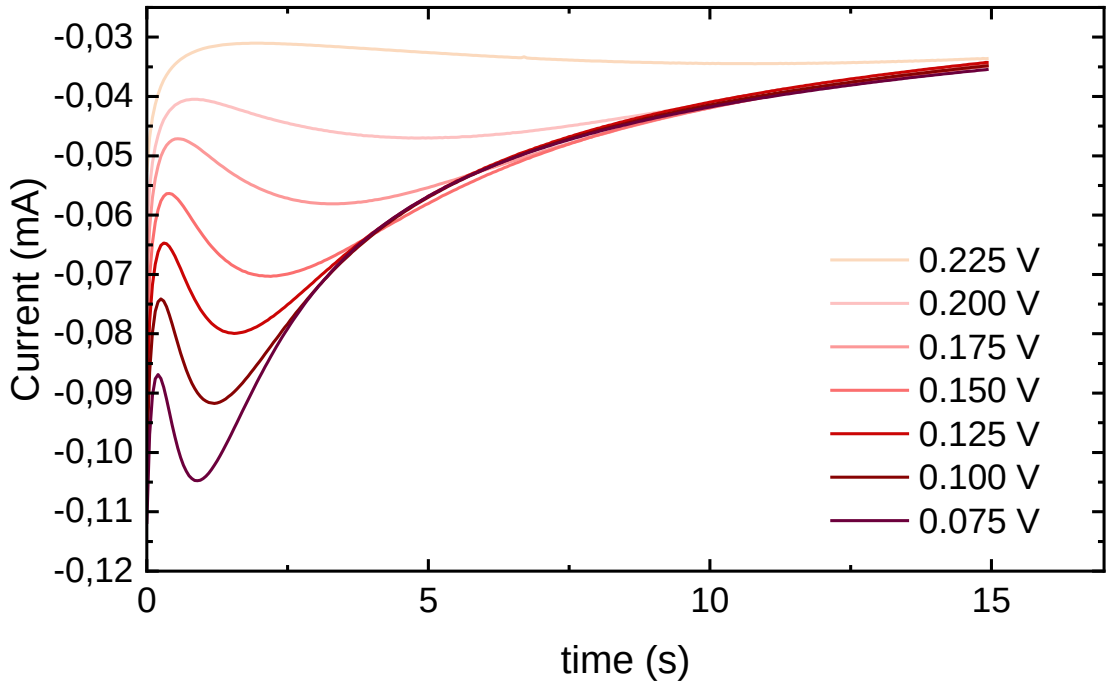

Figure 2. Potentiostatic current transients of Cu electrodeposition in 0.1 M Cu-[Hbet][Tf_2N] IL solution

Within the framework of this project from June 14 to July 14, 2023, Avchukir K. underwent an internship under the supervision of a foreign scientific advisor, PhD Sergey Cherevko at Helmholtz-Institute Erlangen-Nürnberg for Renewable Energy (HI-ERN), Erlangen, Germany.