

06/11/2025

To Whom It May Concern,

REVIEW

by the Foreign Scientific Supervisor regarding the doctoral dissertation submitted for the degree of Doctor of Philosophy (PhD) in the specialty 8D07102 – Chemical Engineering

I, PhD Netanel Shpigel (Israel), serving as the foreign scientific supervisor for Zhumadil Kairgali Muratuly, have reviewed his dissertation entitled: "Development of technology for the synthesis of aluminized titanium carbides as the main precursor for obtaining 2D MXene materials", completed at the Al-Farabi Kazakh National University.

The presented work addresses a relevant issue in materials science: the development of synthesis technology for Ti_3AlC_2 and Ti_2AlC MAX phases using raw materials of Kazakhstani origin, and the subsequent application of these phases to produce MXene materials.

The research is characterized by a high degree of scientific novelty, as it aims to optimize synthesis processes and obtain precursors with high phase purity. This is of significant importance for further developments in the fields of nanomaterials and functional coatings.

The author has demonstrated a deep understanding of the subject matter and the ability to apply modern physicochemical analysis methods (XRD, SEM, etc.) to conduct a comprehensive assessment of the relationships between synthesis conditions and the properties of the resulting materials. The high level of literature review and the clear definition of the research aims and objectives deserve special mention.

My scientific collaboration with Zhumadil K.M. and the "Electrochemical Production Technologies" laboratory, where he works under the supervision of PhD F.I. Malchik, covers not only this topic but also related areas involving the development of nanostructured electrode materials and MXene systems for electrochemical applications.

Joint publications confirm the author's active scientific engagement, initiative, and high research potential.

The results presented in the dissertation are original and hold practical significance. The work is executed at a high scientific level, is logically cohesive, and meets the requirements for PhD dissertations.

Based on the above, I believe that the dissertation work of Zhumadil K.M. merits approval for the pre-defense and subsequent admission to the defense for the degree of Doctor of Philosophy (PhD) in the specialty "8D07102 – Chemical Engineering".

Sincerely,

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