

OPINION

on the defense of the dissertation titled:

“Synthesis and Characterization of Electrochemical Nickel-Based Coatings Ni-M, where M = W, Mo, TiO_x”,

for the award of the educational and scientific degree "PhD", in the professional area 4.2 Chemical Sciences, scientific specialty "Electrochemistry (including chemical

Author of the dissertation: Marina Hristova Arnaudova

Reviewer: Prof. Dr. Antonia Stoyanova, Institute of Electrochemistry and Energy Systems – BAS

1. General Characterization of the Candidate's Research and Applied Scientific Work

The present dissertation addresses a significant and timely scientific topic related to the development of novel electrode materials for hydrogen production via water electrolysis—a key process in the global transition toward a low-carbon economy and sustainable energy technologies. The research conducted by the candidate focuses on the electrochemical synthesis and characterization of nickel-based coatings alloyed with transition metals and their oxides (W, Mo, TiO_x), which exhibit good electrocatalytic activity and high corrosion resistance at significantly lower cost compared to noble metal-based catalysts.

The dissertation is the result of thorough and systematically conducted research in the field of electrochemistry. The candidate demonstrates methodological precision, scientific maturity, and the ability to define and execute clearly formulated research objectives in the context of some of the most current challenges in modern science.

The research covers both the theoretical foundations of electrochemical deposition of multicomponent alloys and the application of a modern set of physicochemical, electrochemical, and spectroscopic techniques for the characterization of the obtained materials. The experimental approach is well-targeted and justified, with a clearly traceable logical connection between the objectives, methods, and results. The doctoral candidate shows deep understanding of the subject matter, a high level of competence in analyzing experimental data, and the ability to critically interpret findings within the context of existing scientific literature.

The dissertation is well-structured, comprising six logically developed chapters across 98 pages, and is illustrated with 40 figures, 14 tables, and 30 equations. A total of 80 bibliographic references have been used, including both classical and recent publications in the field. The candidate's scientific activity is further validated through a number of publications in reputable international journals and participation in scientific forums, attesting to her active engagement in contemporary scientific discourse and her contributions to the development of the chosen research area.

2. Main Scientific and Applied Contributions

- Novel nickel-based electrode coatings alloyed with W, Mo, and TiO_x were developed via electrochemical synthesis under optimized conditions. The resulting materials exhibit controllable composition and morphology suitable for hydrogen energy applications.

- High electrocatalytic activity of the synthesized coatings toward the hydrogen evolution reaction was established, particularly for coatings containing molybdenum. These materials represent effective and cost-efficient alternatives to noble metals for alkaline water electrolysis.
- Systematic corrosion studies were conducted in both acidic and alkaline environments, revealing that NiW and NiWTiO_x coatings show the highest resistance. Their stability is attributed to the formation of protective tungstate phases. By combining catalytic efficiency with corrosion stability, these materials present themselves as promising candidates for use as electrodes in hydrogen production.

3. Reflection of the Candidate's Scientific Publications in Bulgarian and International Literature

The results presented in the dissertation have been published in several scientific articles in renowned international journals and conferences. One of the publications falls within Q1 and another within Q2 quartiles, thus meeting the quantitative criteria for awarding the doctoral degree. Although most publications are from earlier years, with only one published in 2024, this does not diminish their significance or contribution to the advancement of research in electrochemical nickel alloys and their applications in hydrogen energy.

The achievements related to the dissertation have been presented at seven scientific events, and the scientific publications have already received notable recognition—one of them has been cited 35 times, and the most recent one (2024) has already received 7 citations. This is an excellent outcome for a doctoral dissertation and further highlights both the relevance of the topic and the high scientific value and impact of the results obtained.

4. Critical Remarks and Recommendations

I have no critical remarks regarding the content of the dissertation. I recommend that the candidate, in her future research, deepen the analysis of electrochemical impedance spectroscopy under various modeling conditions and extend her investigations to include the long-term stability of catalysts under real operational environments. It would also be valuable to explore the applicability of the developed materials in other electrochemical systems—such as supercapacitors or sensors.

The abstract has been prepared according to the requirements and fully reflects the results and contributions obtained in the thesis.

5. Conclusion

The submitted dissertation meets all the requirements of the Law for the Development of the Academic Staff in the Republic of Bulgaria and the internal regulations of the Institute of Physical Chemistry – BAS in terms of volume, scientific and applied value, publication activity, and originality of results. The dissertation demonstrates independent research work and excellent command of both the applied methods and the theoretical foundations.

Based on the above, I recommend that the Scientific Jury award Marina Hristova Arnaudova the educational and scientific degree PhD, in the professional field 4.2 Chemical Sciences – Electrochemistry, including chemical power sources.

Sofia, 03.07.2025

Reviewer
Prof. Antonia Stoyanova