Appendix 12a

REVIEW

of dissertation for the acquisition of:

educational and scientific degree " **doctor** "	X
scientific degree **"Doctor of Science"**	
	the true is indicated by the sign "X"

Author of the dissertation:

		Venetsiya	Nikolaeva	Garova	
academic position	scientific degree	name	middle name	last name	workplace

Topic of the dissertation:

Anodic behaviour of zinc

Scientific area:

4	Natural sciences, mathematics and informatics
code	name

Professional area:

4.1	Physical sciences
code	name

Scientific specialty:

Structure, mechanical and thermal properties of condensed matter

The review was written by:

Assoc. Prof.	Dr.	Ruzha	Georgieva	Harizanova	UCTM
academic position	scientific degree	name	middle name	last name	workplace

1. Completion of the provided documents:

A) The dissertation and the competition documents are in full compliance with the Regulations.	4 points	**X**
B) The documents are complete but do not fully comply with the requirements of the Regulations.	2 points	
C) The documents are not completed in accordance with the requirements of the Regulations.	0 points	

		one of the answers given is marked with the sign "X"

Missing documents and violated standards must be described if response C is marked.

2. Meeting the minimum requirements under the Regulations:

A) The candidate meets the minimum requirements	20 points	X
B) The candidate doesn't meet the minimum requirements	0 points	
		one of the answers given is marked with the sign "X"

It must be filled in if answer B is marked. The publication activity of the candidate is analyzed. The response of the results achieved (quoted) is analyzed.
The candidate, eng. Venetsiya Nikolaeva Garova has published the results presented in the PhD thesis in 3 scientific works – 2 are in impact factor magazines and 1 is a chapter in a book. She has presented the results from her dissertation at 3 international and 2 university conferences. The research of eng. Garova has also found response in the scientific community – two of her publications have already 4 citations. The candidate complies with and even exceeds the minimum requirements of the Regulation – she has 55 points in Appendix 5a.

3. The relevance of the topic of the dissertation:

A) The topic is relevant and new (there are no known results on the topic by other authors)	8 points	X
B) The topic is relevant and results from other authors are known	6 points	
C) The topic is not relevant, but results from other authors are known	2 points	
D) The topic is not relevant and no results from other authors are known	1 point	
E) The topic does not correspond to the level of dissertation	0 points	
		one of the answers given is marked with the sign "X"

The evaluation of the relevance of the dissertation must be substantiated
The submitted dissertation is dedicated to the investigation of the anodic behaviour of zinc, the thin films' growth kinetics and the study of the thin films characteristics as a dependence on the preparation conditions. A thorough literature survey has been made and the results from it reveal that the relevance of the proposed investigation topic is determined by the possibility to apply the prepared thin films as battery anodes, galvanic anticorrosion coatings, for the production of zinc salts, nanoparticles, as part of different electronic components, for the construction of supercapacitors, gas sensors, for the production of hydrogen by photocatalytic splitting of water as well as for implants in medicine and as biodegradable structures.

4. Knowledge of the problems, subject of research in the dissertation:

A) The doctoral student knows in detail the achievements of other authors on the topic of the dissertation	8 points	X
B) The doctoral student is partially familiar with the achieved results on the topic of the dissertation	4 points	
C) The doctoral student has no prior knowledge of the status of the problems in the dissertation	0 points	
		one of the answers given is marked with the sign "X"

The evaluation must be substantiated if answer C is marked.
The candidate demonstrates an excellent knowledge of the contemporary state of the investigation on the topic of her dissertation which is well illustrated in the detailed literature survey supplied and it has contributed to performing of the scientific investigations at a very high level. As a result from the deep knowledge of the respective scientific field, new and interesting data has been obtained and the results have been published in specialized journals and presented at scientific forums.

5. Type of research:

A) Theoretical	4 points	
B) Applied	4 points	
C) Theoretical with application elements	4 points	X
D) It does not correspond to the level of dissertation	0 points	
		one of the answers given is marked with the sign "X"

The level of research must be substantiated if answer D is marked.
The research in the dissertation is of both fundamental and applied interest – it concerns the preparation of thin anodic films with potential for a wide range of practical applications for which the kinetics of layer growth has been studied and the main characteristics have been estimated, respectively a hypothesis about the thin film growth mechanism is formulated.

6. Objectives of the research:

A) Realistic and of scientific and / or applied interest	8 points	X
B) Realistic, but not of scientific and / or applied interest	3 points	
C) Unattainable (unrealistic)	0 points	
		one of the answers given is marked with the sign "X"

Objectives must be specified. The type of the set objectives must be justified.
The research objectives are clearly formulated – they concern the study of the anodic behaviour of zinc in water-borate electrolytes and water solutions of sodium hydroxide as well as the characterization of the structure, phase composition and microstructure of the obtained layers. Aiming

the fulfilment of these objectives, the following specific goals of the investigation have been formulated: 1) Investigation of the kinetics of anodic behaviour of zinc in water-borate electrolytes and water solutions of sodium hydroxide in dependence of the current density, the composition and the concentration of the forming electrolyte as well as the temperature at which the process occurs. 2) Studying of the obtained thin films by X-ray diffraction, Infrared reflectance spectroscopy, Raman spectroscopy, X-ray photoelectron spectroscopy and Scanning electron microscopy combined with Energy dispersive X-ray spectroscopy and Atomic force microscopy. 3) Tracing of the zinc dissolution by means of optical emission spectroscopy with inductively coupled plasma.

7.Methods of research:

A) Adequate to research and set objectives	8 points	X
B) Partially appropriate, enabling part of the scientific objectives and / or applications to be achieved	4 points	
C) Inappropriate methods	0 points	
		one of the answers given is marked with the sign "X"

Methods must be specified. The type of methods used is justified.
For the preparation of the thin ZnO films the anodic polarization of zinc in galvanostatic regime in water-borate electrolytes and in water solutions of sodium hydroxide as a dependence on the current density, the composition and the concentration of the forming electrolyte and the temperature at which the process is initiated is investigated. The structure, phase composition and the morphology of the obtained layers have been studied by means of X-ray diffraction, IR spectroscopy, Raman spectroscopy, X-ray photoelectron spectroscopy, scanning electron microscopy combined with energy dispersive X-ray spectroscopy and atomic force microscopy. The dissolution process is investigated by using optical emission spectroscopy with inductively coupled plasma.

8. Contributions of the dissertation:

A) With lasting scientific and / or applied response, they form the basis for new research and applications	20 points	X
B) They are of significant scientific and / or applied interest, complete and / or summarize previous research	16 points	
C) They are of scientific and / or applied interest	12 points	
D) Lack of significant contributions	8 points	
E) Lack of contributions	0 points	
		one of the answers given is marked with the sign "X"

Contributions must be specified. The type of results achieved must be justified.
The contributions of the submitted dissertation are of both fundamental and applied interest as the anodic polarization of zinc in galvanostatic regime is still not thoroughly investigated and may be summarized as follows: 1. Studying of the anodic polarization of zinc in galvanostatic regime. 2. Establishing the kinetics of the induction periods observed when attempting the anodization of zinc at a constant current density.

3. Manifestation of the fact that the kinetics of the registered induction periods differs from the same process in case of other valve metals. 4) Raising a hypothesis regarding the mechanism of formation and thin film growth onto the electrode.

9. Evaluation of the compliance of the dissertation summary with the dissertation:

A) Full compliance	4 points	X
B) Compliance of the main parts	2 points	
C) Lack of compliance of the main parts	0 points	
		one of the answers given is marked with the sign "X"

The evaluation must be substantiated if answer C is marked.
The Summary of the thesis reflects exactly and in a concise form the main results, conclusions and contributions of the dissertation.

10. Participation of the doctoral student in the achievement of the results of the dissertation:

A) The doctoral student has at least an equal participation	8 points	X
B) The doctoral student has secondary participation	5 points	
C) The participation of the doctoral student is unnoticeable	0 points	
		one of the answers given is marked with the sign "X"
Critical notes must be provided if one of the items B or C is marked.		

11. Critical notes:

A) Lack of critical notes	8 points	X
B) Critical notes of a technical nature	7 points	
C) Critical notes that would partially improve the results achieved	4 points	
D) Significant critical notes	0 points	
		one of the answers given is marked with the sign "X"

Critical notes must be provided if one of the answers C or D is marked.

12. Conclusion

A) The evaluation of the dissertation is **POSITIVE**	This evaluation is assigned to a total number of at least 65 points	X

B) The evaluation of the dissertation is **NEGATIVE**	This evaluation is assigned to a total number below 65 points	
		one of the answers given is marked with the sign "X"

To be filled in at the request of the reviewer
Eng. Venetsiya Garova has a score of 100 points which exceeds the minimum of 65 points imposed by the Regulation. The results from her investigation have been published in 2 articles in IF magazines and in 1 chapter in a book referred in the international databases and have been presented at many scientific forums. The obtained data and experiments performed in order to establish the practical applicability of the prepared materials determine the significance of the carried out investigation for enlarging the number of potential, highly effective materials with an application as battery anodes, anticorrosion coatings, for the production of zinc salts, preparation of nanoparticles, in different electronic components, gas sensors, for the synthesis of hydrogen by photocatalytic water splitting as well as implants in medicine and as biodegradable structures. My evaluation of the dissertation thesis is "**POSITIVE**" and I would recommend to the Scientific Jury with conviction to vote with "Yes" for awarding the educational and scientific degree **Philosophy Docto**r to **eng. Venetsiya Nikolaeva Garova.**

21.03.2025	The review was written by:	
date	**Assoc. Prof. Dr. Ruzha Harizanova**	signature