

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:

		Ina	Stoyanova	Karadashka-Radeva	University of Chemical Technology and Metallurgy, Sofia
academic position	scientific degree	name	middle name	last name	workplace

Topic of the dissertation:

Synthesis and characterization of As ₂ Se ₃ -based chalcogenide systems

Scientific area:

4.	Natural Sciences, Mathematics and Informatics
code	name

Professional area:

4.2	Chemical sciences
code	name

Scientific specialty:

Inorganic chemistry

The review was written by:

Prof.	PhD	Zara	Petkova	Cherkezova-Zheleva	Institute of Catalysis, Bulgarian Academy of Sciences
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
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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.

Eng. Ina Karadashka-Radeva has submitted all the necessary documents according to the requirements of the Law for the Development of the Academic Staff in the Republic of Bulgaria, the Regulations for its implementation and the corresponding rules for the implementation of the law in the University of Chemical Technology and Metallurgy (UCTM) , Sofia.

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 presented materials and results by the candidate, Eng. Ina Karadashka-Radeva exceed the minimum requirements of the Law for the Development of the Academic Staff in the Republic of Bulgaria, the Regulations for its implementation and the corresponding rules for the implementation of the law in the UCTM - Sofia, as of the required 80 points she received 105 points in total.

The results obtained in the dissertation thesis are summarized in three scientific papers published in peer-reviewed and indexed scientific journals (Web of Science and Scopus), as follows: journal "Inorganics" with IF 2.9 (Q2) - 20 pts, "Journal Physics and Chemistry of Solids" with SJR 0.7 (Q2) - 20 pts and "Journal of Chemical Technology & Metallurgy" with SJR 0.19 (Q3) - 15 pts.

The results of the dissertation work have been presented at four scientific conferences. Two of them are international: "XIV Conference of Chemists, Technologists and Environmentalists" October 21 – 22, 2022, Banja Luka, Republic of Srpska; two are national conference with international participation: 09.2023 - 27.09.2023, Nessebar, Bulgaria and IX SCIENTIFIC POSTER SESSION of CTMU, 11.11.2022, respectively.

9 citations have been presented on the scientific publications of the candidate and 7 of them were found in the Scopus system. The H-factor of the candidate is 1.

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	
B) The topic is relevant and results from other authors are known	6 points	X

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
<p>The topic of this dissertation is actual and the PhD student presents new results on it. Amorphous semiconductors have been extensively studied in regard to their application in optics and optoelectronics due to their good optical characteristics, chemical stability and simple preparation technology. Chalcogenide glasses, investigated in this dissertation, have been characterized by transparency in the mid- and far-infrared region, thus being suitable for fabricating elements for optical devices. The inclusion of As₂Se₃, Ag₂Te, CdTe and GeTe in the glass matrix directly influence the possibility of glass formation in the studied samples: Ag₂Te - As₂Se₃- CdTe; As₂Se₃ - Ag₂Te - GeTe; As₂Se₃ - GeTe – CdTe, in parallel changing and improving their functional properties toward new applications of these materials.</p> <p>A large number of references (200 in total) have been cited in this thesis. ¼ of them are issued at the last 5-10 years, which is also an indication of the relevance of the studied topic.</p>

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.
<p>A detailed literature review has been conducted on the topic of the dissertation by the candidate, citing a total of 200 literature sources and covering studies from a wide time span. A thorough study of the problem and a good ability of the PhD student to analyse the scientific literature and previous studies on the topic have been demonstrated.</p> <p>The dissertation contains 139 pages, 63 figures and 20 tables.</p>

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 presented dissertation includes theoretical and laboratory studies with high application potential. Chalcogenide glasses with important practical significance, $\text{Ag}_2\text{Te} - \text{As}_2\text{Se}_3 - \text{CdTe}$; $\text{As}_2\text{Se}_3 - \text{Ag}_2\text{Te} - \text{GeTe}$ and $\text{As}_2\text{Se}_3 - \text{GeTe} - \text{CdTe}$, have been prepared by direct three-step monotemperature synthesis. The regions of glass formation in these systems were determined. The performed physicochemical and functional studies are of a good scientific quality. Various theoretical and experimental approaches have been applied to obtain and analyze the reported results.

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 scientific objectives of the dissertation are realistic and important for both science and practice. They are formulated in details and can be summarized as a study on the possibility of synthesizing new multicomponent chalcogenide glasses from the three-component systems: $\text{Ag}_2\text{Te} - \text{As}_2\text{Se}_3 - \text{CdTe}$, $\text{As}_2\text{Se}_3 - \text{Ag}_2\text{Te} - \text{GeTe}$ and $\text{As}_2\text{Se}_3 - \text{GeTe} - \text{CdTe}$. The area of glass formation, their structure and physicochemical properties, as well as the possibilities of their application in practice have been studied. The solubility of chalcogenide glass samples in aggressive media was also an object of this investigation.

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.

The methods used for the analysis of the materials are in line with the objectives and planned research activities of the thesis. Different characteristics of the synthesized chalcogenide glasses were determined using numerous methods, as follows:

- phase composition and structure of the synthesized samples - by X-ray diffraction;
- characteristic temperatures for the obtained materials were determined by thermal analysis: glass transition temperature - T_g , crystallization temperature - T_{cr} , melting temperature - T_m ;
- elemental composition and oxidation state of some of the samples were determined by photoelectron spectroscopy;
- composition, dispersity, morphology, oxidation state of metal ions and their interaction with the surrounding, as well as other characteristics of the synthesized materials were determined using Electron Microscopy, Fourier Transform Infrared Spectroscopy, Electron Paramagnetic Resonance, etc.
- Investigation of the influence of the composition of the samples on the physical properties of the glasses - density (d), microhardness (HV), modulus of elasticity (E), compactness (C).
- Study of the concentration dependences of the thermomechanical characteristics - modulus of elasticity (E), average minimum volume of the microvoids (Vh) and the energy for their formation (Eh).
- The solubility of some of the samples was also investigated.

8. Contributions of the dissertation:

A) With lasting scientific and / or applied response, they form the basis for new research and applications	20 points	
B) They are of significant scientific and / or applied interest, complete and / or summarize previous research	16 points	X
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 dissertation contains original contributions that are of significant scientific and applied interest, completing previous research investigations. These contributions can be characterized as novelty for science and extension of existing knowledge of applied nature. The following major contributions should be mentioned:

- New chalcogenide glasses of the type $Ag_2Te - As_2Se_3 - CdTe$, $As_2Se_3 - Ag_2Te - GeTe$ and $As_2Se_3 - GeTe - CdTe$ have been obtained for the first time and the glass-forming regions for these systems have been determined. As_2Se_3 was used as a glass forming agent and $GeTe$ as a modifier to expand the glass forming area and stabilize the glass structure. The appropriate conditions to enhance the transmittance of the glasses in the mid-IR region of the spectrum (up to 400 cm^{-1}) were found.
- The dissolution kinetics of samples of the synthesized chalcogenide glasses in an aggressive acidic environment was investigated for the first time.

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"
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The evaluation must be substantiated if answer C is marked.
The abstract is in full compliance with 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.
The doctoral student has at least an equal participation in achieving the results of the dissertation, as the multidisciplinary nature of the research assumes co-authorship.

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.
I have no significant criticisms of the dissertation.

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"
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To be filled in at the request of the reviewer
<p>The submitted documents and materials, the analysis of their significance, as well as the achieved scientific and applied contributions, meet all the requirements of the Law for the Development of the Academic Staff in the Republic of Bulgaria, the Regulations for its implementation and the corresponding rules for the implementation of the law in the University of Chemical Technology and Metallurgy, Sofia. The candidate in this competition has submitted a dissertation and a sufficient number of scientific works required for the defence of the " doctor" degree.</p> <p>My overall assessment of the dissertation is positive. The candidate received a total score of 94 points with a minimum required total score of 65 points according to the Requirements.</p> <p>Based on this evaluation, I recommend the members of the scientific jury to award the educational and scientific degree " doctor" in 4.2 Chemical Sciences (Inorganic Chemistry) to Eng. Ina Karadashka-Radeva.</p>

	The review was written by:	
Date 02.07.2024	Zara Cherkezova-Zheleva	Signature