



REVIEW

by Prof. Dr. Eng. Mara Kandeва-Ivanova on dissertation for obtaining an educational and scientific degree "DOCTOR" field of higher education 5. Technical sciences, professional field 5.10. Chemical technologies, doctoral program 02.10.12. Technology of silicates, binders and refractory non-metallic materials

AUTHOR of the dissertation: Mag. Eng. DIMITAR VASILEV GEORGIEV

TOPIC of the dissertation: RESEARCH ON PREPARATION OF ELECTRODES AND DIELECTRICS FOR SUPERCONDENSATORS USING HIGHLY POROUS SILICATE AND CARBON MATERIALS

FOUNDATIONS for preparation of the opinion: Order № УД-37 / 28.02.2022г. of the Rector of the University "Prof. Dr. Asen Zlatarov" - Burgas for appointment of a scientific jury and decision of the scientific jury with record №1 / 11.03.2022 from the first meeting of the scientific jury.

The opinion was written in accordance with the requirements of: Law on the Development of the Academic Staff of the Republic of Bulgaria (LASRB); Regulations for application of the Law for development of the academic staff of the Republic of Bulgaria (PPZRASRB); Regulations on the terms and conditions for acquiring scientific degrees and holding academic positions (PURPNSZAD) at the University "Prof. Dr. Asen Zlatarov" - Burgas.

1. Brief biographical data

Dimitar Vassilev Georgiev completed his higher education in University "Prof. Dr. Asen Zlatarov" - Burgas, where he obtained a Bachelor's degree (2003), then at the same university he obtained two Master's degrees in "Materials Technology and Materials Science" (2005) and "Oil and Gas Technology" (2010). From 2019 Mag. Eng. D. Vassilev is enrolled as a doctoral student at the University "Prof. Dr. Asen Zlatarov" - Burgas with the topic of the dissertation "Research on the production of electrodes and dielectrics for supercapacitors using high-porosity silicate and carbon materials."

Dimitar Georgiev's work experience in the period from 2003 to now is in "Lukoil Neftochim AD" Burgas, where he holds various positions.

D. Georgiev has very good computer skills, machine skills and is fluent in English.

2. General description of the presented materials

Dimitar Georgiev presented all the necessary documents in accordance with the requirements of the Law on the Development of Academic Staff in the Republic of Bulgaria and the relevant regulations for its implementation, as follows:

- Order № УД-37 / 28.02.2022 of the Rector of the University "Prof. Dr. Asen Zlatarov" - Burgas;
- Dissertation for awarding the educational and scientific degree "Doctor";
- Abstract of a dissertation for the award of educational and scientific degree "Doctor";
- CV;
- Copies of publications included in the dissertation.

3. Relevance of the problem developed in the dissertation in scientific and scientific-applied terms

The presented paper is dedicated to current research and applied topics related to the creation of new effective coatings for constituent components of supercapacitors with application in the electric vehicle industry. The main goal is focused on obtaining and researching innovative coatings for electrodes using silicate and carbon materials via harmless methods, based on which to make an experimental supercapacitor.

The set goal is met by solving four tasks, which include theoretical analysis, experimental work, in-depth analysis of the results and conclusions.

Scientific and technological research in recent years in the field of materials science, hybrid automotive and many applications of similar developments prove the dissertable nature of the developed topics.

4. General characteristics of the dissertation

The dissertation is presented in a volume of 144 pages, including 218 literary sources, of which 1 in Bulgarian and the rest in Latin; 69 figures to the text and 15 tables. The structure of the dissertation is built according to the requirements and includes: Introduction; Theoretical part, which is a literary review on the topic of the dissertation; Experimental part, in which the goal and tasks of the dissertation are formulated and seven points in which the materials, methods, equipment, research techniques and research results are described; Conclusions related to the production of graphene by ultrasound, graphene coating using high-voltage technology, graphite paint, barium titanate-based dielectric and experiments conducted with an experimental capacitor cell; Scientific and applied contributions; Publications and patents; Literature.

The content of the abstract, presented in 50 pages, corresponds to the content of the dissertation, adequately reflects the main results and is designed according to the requirements.

The chosen research methods are adequate to the goals and objectives of the dissertation, which I believe have been successfully completed and is therefore reflected in Contributions.

5. Degree of knowledge of the state of the problem and creative interpretation of the literary material

In the dissertation work an analytical and systematic study of the specialized literature on the topic of the dissertation is made. An in-depth analysis of the basic values of electrical circuits,

capacitors and supercapacitors, basic materials for supercapacitors, structures and properties of graphene, electrically conductive pastes and paints, perovskite, barium titanate is made. This part of the paper has a volume of 46 pages, which I consider sufficient to draw the necessary conclusions. It gives an idea of the student's high degree of knowledge of the subject matter, its analysis and interpretations.

6. Contributions to the dissertation

The presented scientific and scientific-applied contributions in the dissertation can be referred to: "Proving with new means significant new aspects in existing scientific problems and theories", "Obtaining and proving new facts".

I accept the essence and the presented formulations of the contributions in the dissertation work as follows:

- Cheap and environmentally friendly technology for graphene production through a combined effect of electrolysis and ultrasound has been proposed.
- A technology has been developed for coating graphene on a metal aluminum base using a high voltage generator. Experiments with high-voltage, electric arc graphene deposition on a polymer substrate have also shown very good prospects for creating flexible electrodes for supercapacitors. The proposed technology can be used to improve the efficiency and capacitive characteristics of capacitor electrodes. Based on this, a patent was issued with № 112894 /18.03.2019.
- An innovative electrically conductive solder was obtained, which is necessary for laying and attaching the active ingredients on the surface of the electrodes. Cheap and harmless materials are offered for its production, as it has good adhesion properties and allows to prepare paints and pastes with low specific resistance.
- On the basis of the developed innovative coatings and the used electrolytes, a construction has been proposed and experimental capacitor cells have been made, on which their specific capacity has been determined.
- A software product has been developed for processing the experimental data obtained from the research and for optimizing the design of the capacitor plates.

7. Evaluation of the dissertation publications and personal contribution of the doctoral student

The results presented in the dissertation are formed in eight scientific publications and one patent. Six of the publications are in English, three of which have been published in Scopus. The doctoral student does not have a separate publication. Two of the publications in which D. Georgiev is the lead author have been presented at scientific sessions for students, doctoral students and young scientists "Natural and Technical Sciences", held in 2019 and 2020.

The careful analysis of the research in the dissertation, the topic and the authors of the publications shows that the indicated contributions in the dissertation work are a personal merit of the doctoral student Mag. Eng. Dimitar Georgiev under the guidance of his supervisors Prof. Dr. Irena Markovska-Minova and Assoc. Prof. Dr. Dimitar Rusev. The results of the dissertation have the necessary popularity at the national and international level.

The presented number of scientific publications and patents fully meet the requirements for the defense of a doctoral dissertation.

8. Questions, notes, recommendations

I believe that the proposed dissertation is generally a completed scientific work in which the goals and objectives are met. I do not know the doctoral student personally, but from a careful reading of the dissertation I would say that Mag. Eng. Dimitar Georgiev is a well prepared young scientist with very good skills in conducting physical experiment, analytical, processing and summarizing the results.

I have no significant remarks related to the dissertation.

Conclusion

The presented work has the volume and qualities of a dissertation for the award of educational and scientific degree "Doctor", and meets the requirements of the "Law on the Development of Academic Staff" in the Republic of Bulgaria and the Regulations for its implementation.

I give a positive assessment of the dissertation on "**Research on the production of electrodes and dielectrics for supercapacitors using highly porous silicate and carbon materials**" and I recommend to the esteemed scientific jury to award the Mag. Eng. DIMITAR VASILEV GEORGIEV educational and scientific degree "DOCTOR" in the field of higher education 5. Technical sciences, professional field 5.10 Chemical technologies, doctoral program 02.10.12. Technology of silicates, binders and refractory non-metallic materials.

Подпис заличен

Чл.2 от ЗЗЛД

04.05.2022

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