OPINION

of **dissertation** for the acquisition of educational and scientific degree "**DOCTOR**"

with author **mag. eng. DIMITAR VASILEV GEORGIEV**

topic of the dissertation **"RESEARCH ON THE PRODUCTION OF ELECTRODES AND DIELECTRICS FOR SUPERCAPACITORS USING HIGHLY POROUS SILICATE AND CARBON MATERIALS"**

Scientific field: **5 "Technical sciences"**

Professional field: **5.10 "Chemical technologies"**

Scientific specialty: **"Technology of silicates, binders and refractory non-metallic materials"**

prepared the opinion: **assoc. prof. PhD eng. Silviya Igorova Lavrova-Popova, UCTM-Sofia**

(determined by Rector Order № UD-54 / 15.03.2022 for a member of the scientific jury)

1. Satisfaction of the minimum requirements, according to the Regulations for the terms and conditions for acquisition scientific degrees and holding academic positions at the University "Prof. Dr. Asen Zlatarov "- Burgas

The prepared dissertation meets the requirements set in the Regulations, namely: Group of indicators A: 50 points - Dissertation for the acquisition of educational and scientific degree "Doctor" and Group of indicators D: 30 points. From the group of indicators D, the doctoral student has presented scientific publications in refereed and indexed journals, as well as in non-refereed journals with scientific review and / or in edited collective volumes. The sum of points on this indicator is 42.32 points, which satisfies and even exceeds the minimum requirement.

2. Actuality of the dissertation topic

The actuality of the presented dissertation stems from the growing need for capacitors with extremely large capacity, fast charge, long life and resistance to sudden temperature changes. Increasing attention is being paid to environmental protection and in this connection is the ecological focus of the production of graphene electrodes and the lack of toxic substances which are used in the production of conventional batteries.

It is noteworthy that in developing his dissertation, the doctoral student has used modern approaches to analyze the materials obtained. Also of interest is the developed software product, allowing the introduction and accumulation of a database of physico-chemical and capacitive characteristics of the materials used in structures, as well as the possibility of mathematical modeling and optimization of the plates.

3. General information about the dissertation

The dissertation consists of an introduction, theoretical part, experimental part, conclusions, contributions, publications and patents in connection with the dissertation and used literature. It is written in 144 pages and 218 literature sources are cited.

In order to achieve the assigned goal in the dissertation, four main tasks are set, namely obtaining graphene and proposing appropriate ways for its application on the surface of the electrodes; obtaining electrically conductive paint, through which to attach the obtained graphene to the electrode of the supercapacitor; synthesis of barium titanate and its introduction into the electrode coatings; and finally to design an experimental capacitor based on the developed components and to measure its capacity. The tasks formulated in this way outline a serious and in-depth scientific research, generated by the needs of practice.

4. Contributions to the dissertation

The contributions correspond to the obtained results and have a scientific and applied character. A total of five contributions have been formulated, of which the developed high-voltage technology for graphene production and its application as a surface coating on a metal substrate, is particularly impressive, for which the research team received a patent with № 112894 / 18.03.2019, in which the doctoral student eng. Dimitar Georgiev participates. The other contributions of the dissertation are:

- cheap and environmentally friendly technology for graphene production is proposed, through a combined effect of electrolysis and ultrasound;

- an innovative electrically conductive solder was obtained, necessary for laying and attaching the active ingredients on the surface of the electrodes;

- experimental capacitor cells are proposed;

- a software product has been developed for processing the experimental data and for optimizing the construction of the capacitor plates.

5. Evaluation of the author's publishing activity

As a result of the in-depth scientific and experimental work, the doctoral student participates in the author's team of a total of 6 scientific publications. Three of the scientific papers have been published in two editions, which are referenced and indexed in the world databases with scientific information (Scopus and Web of Science). These are the journals Journal of Chemical Technology and Metallurgy and Journal of the Balkan Tribological Association. The other three scientific papers have been published in unreferred journals with scientific review and in

edited collective volumes - Annual of Assen Zlatarov University, Burgas, Bulgaria and Proceedings of the University of Ruse.

6. Critical remarks and recommendations

I have no remarks on the research and analysis performed in the dissertation.

Grammatical and technical errors are noticed in the dissertation work. Also, a dot is used in some places, and a comma is used in others. One of the ways of writing the decimal point should be accepted. Time units also had to be written everywhere according to SI. The first two pages of the abstract book body are missing. I recommend the doctoral student to pay more attention to such details in the future.

These critical remarks do not in any way affect the quality of the results obtained in the development.

7. Conclusion and general evaluation of the dissertation

The scientific work developed by Mag. Eng. Dimitar Georgiev, contains research of high scientific value, and the issues discussed are especially actual. The structure and volume of the work meet the requirements of the Law for development of the scientific staff of the Republic of Bulgaria for awarding an educational and scientific degree "Doctor", on this basis I give a positive assessment of the dissertation on "Research on the production of electrodes and dielectrics for supercapacitors using high-porosity silicate and carbon materials" and invite the scientific jury to award the mag. Eng. Dimitar Vassilev Georgiev educational and scientific degree "Doctor" in direction 5.10 "Chemical technology" (Technology of silicates, binders and refractory non-metallic materials).

April 28, 2022.

Sofia

Member of the scientific jury:

Подпис заличен,
чл.2 ЗЗЛД

/assoc. prof. PhD eng. Silviya Lavrova-Popova/