OPINION

in a defense of the thesis in a professional field 4.2. Chemical sciences for the scientific specialty "Electrochemistry (including chemical current sources)" on the topic "OBTAINING AND CHARACTERIZING Ni-P COATINGS ON DIFFERENT TYPES OF SUBSTRATES" from the Institute of Physical Chemistry "Academician Rostislav Kaishev" at BAS – Sofia, PhD student Eng. Vesselina Petrova Chakarova. Member of the scientific jury Prof. Dr. Anton Angelov Momchilov.

Eng. Vesselina Petrova Chakarova has completed her higher education at UTCM with a specialty in "Inorganic Chemical Technologies" as a Bachelor and "Electrochemistry and Corrosion" as a Master.

The preparation of metal coatings by chemical method is an alternative to the electrochemical preparation of metal coatings, the latter process requiring the use of electricity. Chemical metallization allows the production of two- and three-composite coatings. They are characterized by uniformity of coating, good tribological properties and good corrosion resistance. This allows their wide use in various fields, one of which is the production of hydrogen. Therefore, over the years, intensive work has been carried out to develop and improve processes for the deposition of transition metal phosphides and composite coatings. This thesis is a methodical study of the deposition processes of the Ni-P binary system and composite with co-deposited dispersed particles, and it has contributed to the field.

This thesis is written on 111 pages and contains 64 figures (mostly with sub-figures) and 35 tables. 120 literature sources are cited, many of which are used in Results and Discussion.

In the introduction part, the conditions that influence the obtaining of the coatings, as well as the properties of the latter, are considered. The properties of embedded dispersed particles of diamond, BNi and SiC are also examined. The conditions for chemical nickel plating of various studied materials are considered. 95 literary sources are cited.

The aim of the thesis is clearly formulated and the tasks to be performed are in accordance with the fulfillment of the purpose.

The careful selection of the pretreatment of the chemical deposition objects and the solutions used in the experimental part shows the knowledge of the overall process of chemical nickel plating. The selected physical (EDS, SEM, TEM, etc.) and electrochemical research methods correctly characterize the studied objects. The interpretation of chemical deposition processes and the use of research methods show the good skill of the PhD student.

The research and discussion carried out are in accordance with the tasks set. It makes a pleasant impression that after the completion of each task, conclusions were drawn from the research. Conclusions correspond to the interpretation of the results. The literature used in the analysis of the results in each part is also given, which is a very good structuring of the "Results and Discussion" section.

The abstract adequately reflects the main results of the dissertation.

The main scientific and applied scientific contributions are as follows:

The composition and operating conditions of a base solution to be used for the research were selected. Composite Ni-P coatings with three types of particles – diamond (D), boron nitride (BN) and silicon carbide (SiC) – of different sizes have been successfully deposited. The conditions for obtaining depending on the size of the particles have been established. In sulfate and chloride

environments, coating with higher P content has been shown to have better corrosion resistance. It was found that Ni dissolves preferentially and the surface is enriched in P. Composite coatings with small diamond particle size showed a lower corrosion rate in sulfate media than Ni-P coatings, while coatings with cBN particles as well as SiC showed no difference in corrosion behavior in sulfate media. The concentration of the reducing agent or the pH of the solution changes the P content, morphology and phase composition of the coating. The electrochemical activity at low current densities depends on the conditions of obtaining the coatings, while at high densities, the HER rates for alloys with a high P content converge.
The main part of the results in the dissertation work are reflected in three publications in international journals with an impact factor. Two more publications are in Bulg. Chem. Comm., one of which is with IF. In total, they are in the quartiles Q1 – Q4. The results have been reported at 11 scientific forums. The works with the participation of the doctoral student have 50 citations, 8 of which are in the publications included in the dissertation. I believe that the above fully covers the requirements for the defense of a dissertation work by the ZRAS and the Regulations of the IFC - BAS.

I have some remarks about Bulgarian language, which I will not comment on.
I have two remarks about on the essence of the work:
- Terminological: Abstract, p. 5, "phase composition" is written "Speeded up voltage", and in the dissertation the exact term "Accelerated voltage" is used.
- I cannot accept the first paragraph in the conclusions of section "3.2.2. OER in alkaline environment" as a conclusion.
My questions are more out of curiosity and for clarification:
- Exp. Part, section 4.3 Why are chemical Ni-P coatings compared only with electrodeposited Ni coatings, and not with Ni-P?
- Why is the deposition time in the "f" mode for D particles 5 h, and for cBN particles in the "f" mode 1 h??
- Fig. 18, b: Ra and Rz of SiC 7/10 are greater than or equal to those with SiC 50/60. Since the mass removed from SiC 7/10 is negligible, can it be concluded that SiC 7/10 does not affect the limestone? The initial roughness of the limestone is not given, which is the basis for the question.
- Is there a reason for the difference in phosphorus content in the corrosion test in acidic and neutral environments (Figs. 20 and 22)?

CONCLUSION

The PhD thesis, in terms of volume and quality of execution, represents a serious scientific study on the co-deposition of composites and their application in various fields. This gives me reason with conviction and pleasure to recommend to the esteemed members of the Scientific Jury to vote for the award of the educational and scientific degree "PhD" in professional field 4.2. Chemical Sciences, scientific specialty Electrochemistry (incl. chemical power sources) to Eng. Vesselina Petrova Chakarova.

Prepared the opinion: