

REPORT

on the competition for the occupation of the academic position "Professor" in professional direction 4.2 Chemical sciences, scientific specialty "Physical Chemistry", for the needs of the Institute of Physical Chemistry, IPC-BAS, "Academic Rostislav Kaishev", announced in SG No. 99/13.12.2022

Scientific organization: Institute of Physical Chemistry "Academic Rostislav Kaishev" - BAS.

Candidate: *associate professor, Dr. Maria Hristova Petrova - Nikolova*

Reviewer: Professor, Dr. Branimir Ivanov Banov, Member of the Scientific Jury.

1. General characteristics of the candidate's research and applied scientific activity

In her authorship report, associate professor *Dr. Maria Petrova - Nikolova* has shown and proved authorship and co-authorship in a total of 39 publications, 29 of which are referenced in SCOPUS. According to the Certificate of Fulfillment of Minimum Requirements of the Institute of Physical Chemistry-BAS, "Acad. R. Kaishev" filled out by the candidate, she participated in the current competition with 29 publications. Five publications (Q2) are accepted as equivalent to habilitation work (indicator "B") with a total number of points 100 (5x20) out of the required 100, and another 12 publications, outside of these, are included in indicator "D" and only of them collect a total of 240 points with the minimum required for the entire "D" indicator - 220. Here are also included publications from Q3-3, Q4-4, SJR – 2 and of course 3 Patents, which form the total number of 453t. The result is eloquent on every single indicator. Thus, according to formal criteria, the works presented exceed the requirements of the IPC-BAS Regulations and those set by LDASRB. It makes an impression that a large part of the publications in-group "D" are with Q2 -12, but this is easily explained by the fact that the candidate's research work is scientifically applied. This also explains the publications in magazines with an industrial and applied focus. The presence of three issued patents shows that the author has a sense of the key elements in the conducted research, which allows her to correctly assess the complexity and direction of the conducted research and find the right scientific and technological solutions. This, in turn, guarantees her great citation index, which is reflected in the noted 437 citations in world literature.

Thus, the total number of points for the various indicators can be summarized as follows:

B – required 100 - collected 100

D – required 120 - collected 874
E – required 150 - collected 400
Total required 490 collected 1827

The achieved result repeatedly exceeds the set requirements and unequivocally shows that the candidate covers all the necessary indicators, exceeding them (in most cases 2-3 times). All the publications presented are in the subject of the institute and in the scope of the given competition, which does not raise doubts about the qualities of the candidate.

2. Basic scientific and scientific-applied contributions

In recent years, the preparation of dispersed materials that combine the properties of metals and non-metals has been the subject of intensive research. The incorporation of dispersed particles into the metal matrix through the process of chemical deposition leads to the production of a new generation of materials with new chemical and physical properties. Of particular interest are materials with solid dispersed particles included in them.

One of the most common metal coatings obtained chemically is copper, which is due to the high electrical and thermal conductivity of copper. Coatings with particle sizes of 3-125 μm have been obtained from various finely dispersed powders, including diamond and BN deposited on metallic or non-metallic substrates. It has been established that, depending on the size of the embedded particle, preliminary treatment of the latter is necessary - including metallization. Based on the conducted experiments and accumulated experience, a laboratory technology was developed for embedding similar materials in a nickel matrix. [45,46,49,51,52,55]*. Accumulated experience has allowed chemical deposition of nickel and copper phosphor coatings on hard metallic and non-metallic substrates. The conditions and ways of realizing such samples and their application in the modern industry are considered. [60, 70]*.

Science and applied research are focused on real objects from the industry - ABS. A special technology has been developed that allows the creation of a strong "mechanical" connection of the pad with the base, which guarantees excellent adhesion and a strong coating. Achieving these excellent characteristics, however, requires enormous work and insight into the chemistry of the process, because of invaluable years of experience. [32-37,41,42,57]*.

For industrial application, a new salt based on PdSO_4 and a low-concentration complexing agent operating in a wide range of 20-50mg/l Pd has been developed and proposed, which guarantees a 30% higher micro hardness than that of ordinary NiP coatings and replaces the traditional PdCl_2 activator. [37]* A protocol for chemical deposition of copper dispersion coatings for the industry was also successfully developed, which was reflected in [pat.1, 40, 54]*.

The imposition of increasingly strict norms regarding the chemical reagents used is particularly relevant in the electroplating industry. For this, a large series of researches is directed to this section and covers the development of environmentally friendly electrolytes for copper deposition with the reducing agent formaldehyde or ($\text{NaH}_2\text{PO}_2 \cdot \text{H}_2\text{O}$). The work is extremely rewarding and the candidate has described his research in a series of 7 theses and one patent. [58,59,61,62,65,66,67 pat.3]*. The processes of chemical copper deposition on a matrix of nano porous anodic aluminum oxide were studied. The optimal compositions and modes of operation of the copper electrolyte were established [63, 59]* and a comprehensive model describing the kinetics of formation of complex Al-O-Ag coatings was proposed.

The widely used 3D printers with industrial application. Wide ranges of 3D-printable polymers such as (PET), (ABS), poly lactate (PLA), polyethylene terephthalate with glycol (PETG), which can be chemically metallized, have been investigated. Activators of the metallization process based on colloidal Pd/Sn, at different temperatures and reducers such as (CH_2O and NaH_2PO_2) were selected. [68]*

In another large series of studies, the preparation of nickel/phosphorus dispersion coatings on a flexible PET substrate of different types of dispersions: SiC, ZrO_2 , hBN and cBN [50, 53, 56, 69]*. From the conducted research, it was concluded that the resulting nickel and cobalt dispersion coatings can be used as an alternative to hard chromium plating and thus avoid the use of the highly toxic Cr^{6+} .

In order to apply copper dispersion coatings in various areas, the following types of systems have been studied - SiO_2 , Al_2O_3 and TiO_2 , SiC and graphite, [43, 44, 47, 48, 53]*. Based on these studies, a technology was created for obtaining copper coatings with included different types of nano disperse powders on a flexible substrate made of non-woven textiles. Uniform in thickness, coatings with decorative and excellent technological and electro technical characteristics were obtained.

3. Reflection of the candidate's scientific publications in Bulgarian and foreign literature

The works of associate professor Dr. Maria Petrova - Nikolova have found a deserved reflection in the international literature with 437 citations according to data from Scopus. The applicant's Hirsch index (**h**) is **10**. The candidate's publications, all published after 2005, when he was awarded an associate degree, have so far received over 430 citations. Among the most cited works included in the competition, publications with more than 20 citations deserve to be noted. These are works [40 – 46 (from Scopus list)] with 367 citations. There is another large group of works with over 15 references. These works [25, 47-49 (again from the Scopus list) form 68 citations. The topic is extremely interesting and current, especially in the field of nano disperse composites, coatings and catalysts, both on metallic and non-metallic

substrates. The latter turn out to be extremely interesting objects for research and are of great industrial interest.

4. Critical notes and recommendations to the candidate's scientific works

I have no comments or recommendations for the candidate's works, the topics are current and developed in the direction of knowledge and development of technology.

Conclusion

In terms of its volume, quality and scientometric indicators, the candidate fully meets the recommended requirements for occupying the academic position "**Professor**" at LDASRB (art. 24, paragraph 1, item 4) and the Regulations of the Institute of Physical Chemistry, IPC-BAS "Academic Rostislav Kaishev", to acquire scientific degrees and occupy academic positions.

The materials presented for review give me the full reason with conviction to express my **positive opinion** on the considered application and to recommend to the Honorable Jury to award *Associate Professor Dr. Maria Petrova - Nikolova* the academic position of "**Professor**" in professional direction 4.2 Chemical sciences, "Physical Chemistry" for the needs of the Institute of Physical Chemistry, IPC-BAS "Acad. Rostislav Kaishev".

Sofia, 24.04.23

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/Prof