REVIEW

by

Member of the scientific jury: Anton Angelov Momchilov, PhD, Prof.
Competition for academic position "Professor", Scientific direction 4.2., Chemical sciences, Speciality "Physical chemistry" at the Institute of Physical Chemistry, Bulgarian Academy of Sciences, published in SG number 99/13.12.2022
CANDIDATE: Maria Christova Petrova - Nikolova, PhD, Assoc. Prof.

1. GENERAL CHARACTERISTIC OF THE RESEARCH AND APPLIED RESERARCH ACTIVITIES OF THE CANDIDATE

Assoc. Prof. Maria Petrova has presented a total of 70 publications from her scientific activity. They are on one of the main priorities of the Institute: innovative materials and technologies based on chemically and electrochemically prepared metallic, alloy and modified polymer coatings with protective, decorative and electrocatalytic properties. 39 scientific papers were submitted for the competition. The papers were mainly published in foreign journals with the following distribution: one in a Q1 journal, 17 in Q2, 3 in Q3, 4 in Q4, 2 with SJR and 2 without SJR and IF. The remaining 10 were published in non-refereed journals and in full text in edited proceedings of symposia, congresses and conferences. She has issued 3 patents and a printed handbook in German language. The scientific activity is presented in accordance with the requirements of Art. 29, par. 1, 5 of the ZRASRB and IFC Rules, defined in Appendix No. 1. Assoc. Prof. Petrova fully covers them. The indicator points of E, D and D are from two to seven times above the minimum.

2. MAIN SCIENTIFIC AND APPLIED SCIENTIFIC CONTRIBUTIONS

For the first time, chemical copper dispersive coatings with a wide range of dispersoid sizes - diamond and BN (alphahexagonal (hBN) and cubic (cBN) boron nitride with sizes from 3/7μm to 100/125μm) were obtained from trilonate electrolyte on a flexible substrate of PET [45, 46, 49, 51]. A hydrodynamic regime and processing of the dispersed particles with a surfactant (NaLS) has been defined for the inclusion in a copper matrix of dispersed particles with sizes up to 20/28μm.

Metallization of cBN grains (unmetallized and pre-metallized with Ti) with nickel and cobalt was carried out to obtain abrasive tools by high-temperature sintering [52].

A laboratory technology has been developed for chemical deposition of dispersive coatings based on a nickel matrix with dispersoid diamond particles (with sizes from 3/7μm to 225/300μm), which can find application in the production of efficient flexible polishing tools [55].

Scientific research on the chemical deposition of nickel/phosphorus and copper dispersive coatings on solid (non-metallic and metallic) substrates has led to innovations in the pretreatment of non-metallic substrates [60, 70]. It is shown that during the swelling process a partial dissolution and roughening of the samples takes place, possibly also a relaxation of the internal stresses.

It was found that when using acetone, the deposited chemical copper and nickel-phosphorus coatings were uniform over the entire surface of the polymer samples without cracking and with the best adhesion. Nickel/phosphorus dispersive coatings with TiO_2 nanoparticles (30nm and 60nm) and diamond microparticles (14μm – 20μm) have been successfully obtained by chemical deposition [32 - 37, 41, 42, 57]. The dependence of the coating on the pH of the solution was established. Ni-P/D coatings have been shown to dissolve more uniformly than Ni-P coatings, retain their amorphous nature, and have a lower corrosion rate. Work on the preparation of NiP- and dispersed NiP-coating with nanodispersoids on various metal substrates (Al, Fe, Ti, Ni, Cu) as well as on microstructures [37, 41].

The preparation of coatings on a metal substrate [32, 33, 34, 35, 37, 41] has shown that pre-activation with a palladium salt is only necessary on copper substrates. Original methods were used for chemical metallization of Al, Fe, Ti, Ni metal substrates with a new generation activating solution based on palladium sulfate and a complexing agent. A technology has been developed

with application in the production of printed circuit boards and in particular in the deposition of the final two-layer Ni/Au coating.

For the chemical deposition of copper dispersion coatings on an ABS substrate [40, 54, patent 1], a copper electrolyte composition [patent 1, 40] has been developed that has a constant deposition rate with time and allows a significantly faster increase in the deposition rate.

A new environmentally friendly electrolyte containing no reducing agent (formaldehyde) (pH 12 - 13) was developed, the composition of which was published in patent 3 of 2021. The resulting layers are formed of copper (I) oxide and are uniformly distributed over the surface of the dielectric.

A slightly alkaline copper electrolyte composition (pH 9 and formaldehyde-free) [62, 66], with an autocatalytic deposition process with the formation of layers of several μm, has also been developed.

A comprehensive model was proposed describing the kinetics of formation of complex Al-O-Ag coatings on technically pure AA1050 aluminum [59].

Chemical metallization of 3D printed PLA and PLA flex samples [68] was found to be preferable using an alkaline base as a pickling solution. It accelerates metal deposition and slightly reduces the phosphorus content of the Ni-P coating. Cu and Ni coatings on 3D printed samples obtained from 4 copper and nickel electrolytes were obtained and investigated. It was found that the standard technology for metallization of injection-molded ABS-polymer samples can also be applied to the 3D-printed ABS samples.

NiP dispersion coatings on a flexible PET substrate were obtained from electrolytes optimized in composition and mode of operation with different types of dispersoids: SiC [53], ZrO_2 [50], hBN and cBN [56]. It is shown that the resulting nickel and cobalt dispersion coatings can be used as an alternative to hard chrome plating, i.e. poisonous 6+ chromium is avoided.

Chemical plating solutions have been developed for maximum deposition rate. It has been established that chemically deposited copper coatings are significantly morphologically and structurally different from electrochemically obtained ones [43, 44, 47, 48, 53, patent 2]. A technology has been created for obtaining nanodispersed copper coatings with dispersoid graphite, SiO_2, Al_2O_3 and TiO_2 on woven and non-woven textiles as protective screens against electromagnetic interference [47].

In summary, methods have been developed for the production of a new generation of chemically deposited Ni and Cu coatings with dispersed particles with the necessary chemical, physical and mechanical properties for manufacturing of various products with industrial applications.

3. **IMPACT OF THE CANDIDATE'S SCIENTIFIC PUBLICATIONS IN THE BULGARIAN AND FOREIGH LITERATURE**

489 citations from all publications were observed in Scopus, with 437 citations appeared after holding the academic position of "associate professor".

CONCLUSION

The scientific indicators and the results of the candidate's activity exceed the requirements of ZRASRB and the Regulations of IFC-BAS, therefore, with full conviction, I propose to the Honorable Scientific Jury to propose to the Scientific Council of IFC to elect Associate Professor PhD. Maria Hristova Petrova - Nikolova to the academic position of "Professor" in the professional direction "4.2 Chemical Sciences", scientific specialty "Physicalchemistry" for the needs of the "Electrochemistry and Corrosion" section of the Institute of Physical Chemistry "Academician Rostislav Kaishev" at the BAS.

Date: This review is prepared by: