

## OPINION

in a competition for the academic position of associate professor in a professional field 4.2. Chemical sciences for the scientific specialty "Electrochemistry (including chemical current sources)" on the topic "Electrochemical preparation of hybrid coatings on metal substrates" announced in Government paper 62 / 27.07.2021 from the Institute of Physical Chemistry "Academician Rostislav Kaishev" at BAS - Sofia with the only candidate Ch. Assistant Professor Dr. Nelly Boshkova from a member of the scientific jury Prof. Dr. Anton Angelov Momchilov.

### 1. General characteristics of the research and scientific-applied activity of the candidate.

- The presented publications of the candidate are in the subject of the competition. The investigations are in the field of obtaining coatings for protection of low carbon steels from corrosion. Some of the publications describe protective coatings based on zinc alloys and optimize the conditions for their obtaining [12, 14, 20, 32, 34, 38, 39, 41]. Multilayer protection systems based on them have also been obtained [31]. Their better corrosion resistance than that of zinc has been shown in tests in a model corrosion environment. Physicochemical methods were used to study the resulting protective layers [17, 23, 28 and 34]. The good corrosion resistance of Zn-Mn coating (11 wt%) as a sublayer of multilayer protective coatings with a last coating of Zn-Mn (11 wt%) or conversion film is also shown [14, 19, 25, 29, 31].
- Hybrid coatings of zinc and its alloys with built-in various polymer particles have been developed and the conditions for their obtaining have been studied. It is interesting that the polymer particles are of the core-shell type, and that their preliminary stabilization supports the electrochemical deposition of the hybrid coating. The size and shape of the embedded particles were studied. [17, 20, 23, 25, 28, 34, 36, 38, 39, 40, 41]. The anticorrosive properties of these composite coatings have been studied [23, 25, 28, 29, 36].
- Zinc alloy composite coatings have also been obtained by electrochemical deposition. The influence of the inclusion of polymer particles in Zn-Co (1-3 wt.%) And Zn-Mn (11 wt.%) Alloys was studied. Corrosion studies show different behaviors in the two alloys described in [20, 31, 34, 38].
- Another direction is the production of zinc composite layers with the inclusion of nanocontainers and corrosion inhibitor. They are constructed layer by layer with the inclusion of the inhibitor. Alpha-hematite, kaolinite, ZnO are embedded in the core of the nanocontainers and benzotriazole and safranin inhibitors are used. The results are described in publications [5, 13, 16, 18].
- Zinc hybrid coatings with embedded polymer modified particles of ZnO, CuO, PANI, carbon spheres and carbon nanotubes have been created. Corrosion studies have shown increased protective properties of composite coatings compared to conventional zinc coatings [4, 5, 9, 10, 11, 15, 26, 35].
- Nitrogen-containing heterocyclic di-cation compounds have been synthesized and their corrosion inhibitory effect on steel and galvanized steel has been shown [8].
- The protective ability of different types of chromate passivating films based on conversion solutions containing  $Cr^{3+}$  compounds on galvanic and composite zinc coatings was evaluated [12, 14, 19, 21, 25, 29, 30, 32].
- Sol-gel coatings of  $ZrO_2$  (top, surface layer) and  $TiO_2$  (sublayer) were obtained. Polymer modifications demonstrate increased protective properties under external polarization conditions compared to the unmodified titanium layer [1, 2, 3, 6 and 7].

- Corrosion monitoring of austenitic (18Cr10NiTi) and low carbon (38GN2MFA) steels used at Kozloduy NPP was performed. Potentiodynamic studies were performed in conditions close to the water chemical regime used in the plant. The results are reflected in publications [22, 33, 37].
- Apparatus and methodology for the production of metal and oxide nanoparticles, as well as for the regulation of their size have been developed [24].

## 2. Main scientific and applied scientific contributions.

Protective coatings of zinc alloys as well as multilayer protection systems with very good corrosion resistance have been obtained. The better corrosion resistance of the alloys is explained by the production of a corrosion product with very good corrosion resistance (solubility  $10^{-14.2}$ ). Hybrid coatings of zinc and alloys with various polymer particles embedded in them have been created. A model is given explaining the incorporation of electroneutral polymer nanoparticles into the coating. Another model explains the increased corrosion resistance of the coating. A conversion solution based on trivalent chromium has been developed, which improves the protective properties of the composite coating / passivation film system. The study of the steels from Kozloduy NPP has established the beneficial effect of monoethanolamine as a mixed inhibitor. An electrode is designed to simulate corrosion processes in cracks. Corrosion products have been identified in the heat exchangers, which are favorable from the corrosion point of view. Apparatus and methodology for obtaining metal and oxide nanoparticles have been developed, allowing control of their size.

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

The published results have been very well reflected in the scientific literature - 80 citations, 58 of which are on papers outside those of the dissertation. It is noteworthy that one of the articles is 22 citations and the other three are 10 citations each.

## 4. Critical remarks and recommendations to the scientific works of the candidate.

I have no critical remarks about the candidate. I recommend the candidate to continue the work on obtaining nanoparticles with controlled size, which can find applications in different areas.

## 5. Conclusion

The materials filled in the NACID table cover the requirements of IFH for associate professor. In the meantime, another publication of the candidate has been published in a magazine with Q2. The achievements of the candidate's work give me reason to confidently propose to the esteemed Scientific Council of IFH to elect Assistant Professor Dr. Nelly Boshkova to the academic position of Associate Professor on this topic.

11.11.2021, Sofia

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