Opponent Opinion of Doctoral Dissertation

Mr. M.Sc. Dariusz Solek

on topic

Analysis of the DC01 Steel’s Surface Depending on the Resistance to Corrosion and the Adhesion of Metallic Layers to the Metal Structure of Medical Equipment

Doctoral Study Programme: P2346 Mechanical Engineering
Field of Study: 2303V002 Manufacturing Technology
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Opponent: doc. Ing. Stanislav Lasek, Ph.D., FMME, VSB-TU Ostrava

Dissertation discusses the corrosion resistance of galvanic coatings with the requirement for anti-bacterial effect of the equipment in hospitals and similar facilities. The author states coating technology and compares the properties of the produced galvanic coatings (Fe // Ni / Ni / Cr, Fe // Ni / Cr, Fe // Ni / Cu and Fe / Cu) on low carbon steel DC01 and RSt37 2 NBK.

Within the literature review (chap. 2) author provides basic knowledge in the field of electrochemical corrosion, the main types of corrosion and accelerated laboratory testing of atmospheric corrosion of metals and coatings. In the chapter "Surface coating of metallic materials" (sec. 3) there are given the geometrical characteristics and surface roughness parameters. Adequately are described the mechanical and chemical methods of pretreatment of surfaces before electroplating (sec. 4). The following describes the general characteristics and properties of the electrolytic coating, and more properties galvanic coatings of copper, nickel and chromium (chap. 5). Literary review contributed also to the formulation of objective (chap. 6, p. 46): „The purpose of this scientific paper is to analyse the surface layer steel DC01 depending on the corrosion resistance and adhesion of metal coating on medical equipment. The assumption is looking at the choice of metallic coating, which when used for the best medical equipment will protect them from corrosion‘. To solve the task and meet objective there were prepared samples of two steels which were used four galvanic coatings and selected three test physiological solutions for corrosion tests. Author appropriately describes the methods used for testing of steel surface and galvanic coatings with references to the relevant standards, usually PN-EN (ch. 7).
In the experimental part (sec. 8) are given results of samples testing (steel DC01 protected coated Ni / Cr), taken from the part of the bed (bed side rail), which was corroded and there were also detected bacteria. For the experimental work were prepared samples of plate-shaped discs (Ø14,6 x3,0 mm) of steel. DC01 and tubes (Ø 28 x 2.5 mm) from RSt37-2 NBK, which were verified on the chemical composition, surface topography and 3D curves share material. It is important chapter 8.6 of galvanic coatings (Fe // Ni20d / Crr Fe // Ni10b / Crr Fe // Ni3s / Cub and Fe / Cus), which lists the conditions and parameters of the electrolytic deposition of various coatings and/or layers.

Their topographical characteristics, thickness and microanalysis results are well documented in the chapter. 8.7 to 8.9. There are also important electrochemical corrosion tests (chap. 8.10), in which are compared the measured values of the parameters (corrosion potential, polarization resistance, etc.), polarization curves were measured in a physiological solution - Ringer's solution, artificial blood plasma, artificial saliva. Here it may be noted that the polarization resistance Rp should be according to the standard determined from polarization curves measured in narrow potential range (e.g. £cor ± 50 mV). With the current (i) at the potential of £ = -750 mV, as corrosion parameter, I have not met during electrochemical tests.

The results of potentiodynamic methods are not clear and conclusive, it would also be necessary to test more samples and the effect of disinfectants, which may contain hypochlorite or chlorine with oxidizing effect and induce a pitting or crevice corrosion.

The main results obtained are then compared and discussed briefly in Chap. 9. In conclusion, the author notes that in terms of corrosion resistance and antibacterial effects, the best coating is a smooth and glossy Cu or Ni + Cu one.

Dissertation has a total of 125 pages, a review of literature has 39 pages, the experimental part of 60 pages and 98 references to literature and other sources of information (standards). Figures, tables, and photos are appropriately incorporated into the text and generally have a good quality.

I am not competent to assess the level of English. I believe that in many cases had to be a different word order (e.g. page 64, "the coating double layer", or p. 77 "coating measurement thickness"), several links missing prepositions. Name of abbreviations NSS, ASS, CASS has to be somewhat different, for example. NSS - neutral salt spray. On p. 11 is “speed” of corrosion, p. 36 “you” can obtain, on p. 42 reaction without an arrow, p. 57 not be Fig. 15 but Fig. 25 or 26. The word "imposition", should be deposition (p. 46 and others).

The number of the author's publications related to theme work is sufficient. Since 2011 a total of 27 articles were published, of which 7 as the first author, mostly in Polish magazines focusing on biomaterials and corrosion.

Dissertation importance for practice or science development: Increasing resistance of galvanic corrosion coatings and improved antibacterial effects of equipment for hospitals. Expanding our knowledge of galvanic (combined) coatings Ni, Cr and Cu on steel parts.
Questions for the defense:

1. As the values of the surface roughness of the base material and the coating affect the corrosion resistance of the products?
2. What are the values of micro-hardness coatings tested within the thesis?
3. How can we use Faraday's law to calculate or predict the thickness of the applied coatings?

Conclusion

Doctoral thesis of Mr. M.Sc. Dariusz Sołek is related to the corrosion resistance and antibacterial properties of steel parts protected by metallic electroplating coatings composed of nickel, chrome and/or copper. It contains a reasonable amount of initial results (in particular surface topography, thicknesses of coatings, the polarization curves and corrosion parameters), some of which have been published. Dissertation is properly organized and well prepared graphically, I should comments to English and partly to use of potentiodynamic polarization method. The whole dissertation has contributed to the expansion of knowledge in the field of galvanic coatings used to protect steel components.

Theses meets the requirements for a dissertation and conditions provided by applicable law, therefore, assessed doctoral dissertation I recommend for defense.

Ostrava-Poruba, 5 June, 2015

[Signature]

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