Review Report on PhD Thesis

Faculty: **Central European Institute of Technology**
Brno University of Technology in Brno

Academic year: **2019/2020**

Student: **Ing. Michaela Remešová**

Doctoral study program: **Advanced Materials and Nanosciences**

Field of study: **Advanced nanotechnologies and microtechnologies**

Supervisor: **prof. Ing. Jozef Kaiser, Ph.D.**

Reviewer**:** **Ing. Jan Kudláček, Ph.D.**

PhD thesis title: Research and development of a technology of hard anodization of nonferrous alloys

Topicality of doctoral thesis:

The dissertation is focused on a very current topic related to the surface treatment of non-ferrous metals. Specifically on the issue of hard anodic oxidation of light metals, which are most often used in industrial practice. The doctoral thesis reflects current trends and focuses on the use of dispersed particles to improve the tribological properties of oxide layers based on Al, Mg and Zn.

Meeting the goals set:

The main goal was to create anodic oxidized layers with dispersed particles of Al_2O_3 and PTFE to improve mechanical and tribological properties. Within the solution of the dissertation, seven partial goals were set, which lead to research and scientific knowledge in the field of anodic oxidation of non-ferrous metals.

Problem solving and dissertation results:

In the theoretical work, the author objectively and briefly describes the issue of anodic oxidation of selected alloys and metals, specifically Al, Mg and Zn alloys. In particular, the issue of anodic oxidation of Zn-based materials has not yet been sufficiently studied. The work correctly deals with new technologies in the field of plasma anodic oxidation. The practical part is devoted to hard anodic oxidation of aluminum alloy AA1050, zinc alloy ZnTi2 and pure magnesium. Proposed solutions and scientific contribution is fully presented with goals. The largest part of the scientific work is devoted to the Al alloy,

which is appropriately chosen in the context of application in technical practice. Experimental lever was focused on the modification of the parameters of technological process parameters in relation to the formation and properties of the oxide layers themselves (mechanical and chemical pretreatment, voltage, current density, temperature, electrolyte composition, dispersion of monodisperse particles, thickness, hardness and tribological properties). To evaluate the established parameters were appropriately used measurement and evaluation methods and analysis (X-Ray diiffraction, SEM, TEM, Ball-on-disc Vickers measurement, Raman spectroscopy). The results of the dissertation are in several cases in accordance with foreign research and in most cases bring new knowledge in solving the problem, which could contribute to the optimization of the process of formation of oxide layers in industrial practice. To a lesser extent than in the case of Al alloy, the experimental work also deals with the formation of anodic layers in Mg and Zn alloy. There was done primarily verify the possibility of creating a composite oxide layer containing dispersed particles. Even so, the goals were fulfilled.

Importance for practice or development of the discipline:

The results of the dissertation are in several cases in accordance with foreign research and in most cases bring new knowledge in solving the problem, which could contribute to the optimization of the process of formation of oxide layers in industrial practice. However, current research is primarily focused on knowledge in the field of plasma electrolytic oxidation.

Formal adjustment of the thesis and language level:

In solving the dissertation, the student demonstrated the ability of independent research work, which is a very good basis for further experimental work in the field of anodic oxidized layers of non-ferrous metals. Appropriately connected the accumulated theoretical knowledge with the experimental work itself. The proof is the correct interpretation of the results in the context of literary sources. There are several inaccurate terminological expressions and minor grammatical errors in the thesis, which, however, are minimal and do not reduce the level of the submitted dissertation. Within this dissertation, the results of own publishing activities were used and therefore the work meets the condition of originality and novelty of the problem.

Questions and comments:

Comments below are only minor remarks, and inconsistencies associated with the problem, but may not be explicitly discussed in the final defense:

p.11 - Anodic oxidation in tartaric acid missing.
p.23 - Etching - correctly in the technological process would be pickling.
p.25 - Is it true that these electrolytes are environmentally friendly?

p.52 Table 11 - for more informative experiment would be good to establish parameters for comparison and make it more easily comparable.
p.65 Fig. 34 - There would be appropriate to include a table with measured values of the friction coefficient because of the figure shows that the sample consists Al13 and Al22 - have the same values and thus are not visible influence of dispersion PTFE particles.
p.84 - Miss the explanation why experiments of tribological properties as with Al were not performed.
p.85 - Table 20 - for more informative experiment would be good to establish parameters for comparison and make it more easily comparable.
p.87 - Miss table thickness measurements of the oxide layers
p.95 - Miss table thickness measurements of the oxide layers
p.101 - There is no explanation why PTFE was not added to the electrolyte.
p.102 - Miss table thickness measurements of the oxide layers
p.105 - Miss the explanation why experiments of tribological properties as with Al were not performed.

Questions to be addressed during the final defense presentation:

1. Explain the size ratio between the diameter of an anodic pore and its length?

2. Explain the difference in the process of etching versus pickling during anodization Al?

3. Explain what is the effect of the temperature of the process of hard anodic oxidation of Al alloys on the parameters of the formed oxide layer?

4. Try to assess what impact they might have dispersion particles on the tribological properties in your prepared alloy oxide layers ZnTi9 in the context of oxidic coatings Al and Mg alloys?

5. What can be another method of forming composite layers during the anodizing process?

Conclusion:

The student demonstrated independence in solving current problems of hard anodic oxidation of ferrous metals and properly used scientific methods to achieve its goals. In my opinion, the reviewed thesis fulfills all requirements posed on theses aimed for obtaining a Ph.D. degree. This thesis is ready to be defended orally in front of the respective committee.

In Jaroměř, date31.8.2020

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Ing. Jan Kudláček, Ph.D.