

Reviewed habilitation thesis: *Development of ultrafine-grained biodegradable magnesium alloys with tailored microstructure*

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Reviewer: doc. Ing. Pavel Novák, Ph.D.

The reviewed habilitation thesis submitted by RNDr. Petr Minárik, Ph.D. deals with the processing of candidate biodegradable alloys based on magnesium by severe plastic deformation (ECAP technology) and their characterization. The topic is selected very well, because these materials now undergo a significant development and there is an implant based on magnesium alloy already commercially available. There are two groups of the alloys described in the thesis – the aluminium-containing alloys (Mg-Al-RE and Mg-Li-Al-RE) and the aluminium-free ones (Mg-Y-RE). I do not understand so much, why the aluminium-containing alloys have been considered for biodegradable implants, because it necessarily means that aluminium will be dosed to human body. And the fact that aluminium potentially causes the Alzheimer's disease is known for decades.

The thesis is written in the form of a review of a selection of own papers of the author (9 papers). The papers were published in very good journals, such as *Materials Characterization*, *Materials Science and Engineering A* and *Applied Surface Science*. The Introduction contains the basic facts known about the magnesium-based biodegradable alloys and justifies, why these materials are selected. It also introduces the ECAP processing for the production of ultra-fine grained materials. The other major parts of the thesis are divided according to the studied groups of magnesium alloys (“Alloys containing aluminium” and “Magnesium-based aluminum-free alloys”). The presented results are analysed and the possible ways are presented in the part “Conclusions and future perspectives”. The text is written concisely, easy to read and almost free of mistypes and grammar errors.

In addition to the selection of 9 own papers, referenced as PM1 – PM9 throughout the text, there are also citations of 57 papers, where some of them were also published with the participation of the author. I have to mention that the check by Turnitin system found high similarity of the thesis with the published works (42 %). It is natural, because the commented work reviews the papers already published by the author and contains, of course, the same results. Therefore I do not consider the result of the similarity check as a problem in this case.

I have following questions and comments to the content of the submitted habilitation thesis:

- 1) page 15: “*The results obtained in the LAE442 alloy were very promising and the subsequent in vivo testing was planned. However, in the meantime, the opinion that aluminum shall not be used in the biodegradable magnesium alloys became too strong within the scientific community.*” The fact that the aluminium is not suitable alloying element for biodegradable implants was clear right from the beginning, because there were many studies about the possible harmful effects of aluminium many years ago, e.g. in the book “*Aluminium and Alzheimer's Disease*”, published by Elsevier in 2001 (<https://www.sciencedirect.com/book/9780444508119/aluminium-and-alzheimers-disease#book-description>). The situation of biodegradable implants is completely different from the case of long-term implants made of titanium alloys, which contain aluminium, but due to almost negligible corrosion rate it does not dissolve in human body.

- 2) page 17: “*Achieving a very high mechanical strength in this alloy may not look important for biodegradable purposes, but the contrary is true. The higher mechanical strength enables to reduce the volume of the potential implant.*” It is natural that the mechanical properties of the implants are of a high importance, because the human skeleton is a load-bearing structure of the whole human body. What are the general requirements on mechanical properties of a material used for fixtures in traumatology? Do your materials meet them?
- 3) In referenced paper PM1, there is a description of the corrosion behaviour done by Electrochemical Impedance Spectroscopy. The electronic circuit scheme used for interpretation is rather complex. What is the meaning of individual members of the scheme?
- 4) The particular role of the author of the thesis on the papers PM1 – PM9 is not presented in the thesis. Could the author describe it?

The submitted habilitation thesis of RNDr. Petr Minárik, Ph.D. meets the requirements imposed on habilitation theses and shows the ability of the candidate to do and to manage the excellent research, and therefore I recommend accepting this thesis as a habilitation thesis.

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