Review report of the dissertation thesis

Thesis title: *Powder Metallurgy of Hybrid Materials for Advanced Applications*

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Reviewer: *prof. Ing. Pavel Novák, Ph.D.*

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1. Actuality of the chosen topic:

Powder metallurgy methods are becoming more and more important for nowadays industry, especially in series production of small net-shape parts and in processing of high-grade materials. Additive manufacturing, which is also used in one part of the thesis, is – of course – of high importance. Therefore I can state that the topic is actual.

2. Selected methods of dissertation thesis processing:

The dissertation thesis is written in the form of an original text. The length of the text is 127 pages and it contains 70 figures and 19 tables. The organization of the text is a bit unconventional. The thesis begins with common introduction ("Theoretical background"), "Aims of the thesis" and "Experimental methods". After that, the thesis is rather the collection of four almost independent case studies ("Architectured Titanium-Aluminum Composites", "Blended Elemental Powder Metallurgy of Ti-5Al-5V-5Mo-3Cr Alloy", "Blended Elemental Powder Metallurgy of Ti-Nb-Zr-O Alloys" and "Outlook: High-Throughput Characterization of RCCA"). Each of these chapters has its own description of experiments, results, discussion and even summary. Even though the individual parts have a lot in common, there is no comprehensive discussion and mutual comparison of the prepared materials in terms of their structure and properties.

Experimental program is interesting and well designed for each of the particular case studies. The experiments were realized at high scientific level and well described in the thesis.

3. Achieved results:

The main results of the thesis are in fact successfully prepared innovative materials – a composite of aluminium and titanium alloy, prepared with the use of additive manufacturing and FAST/SPS and the titanium alloys produced from elemental powders and, of course, the results of their detailed characterization. The results show the possible new capabilities of FAST/SPS process, such as the above mentioned preparation of composites, but also the combination of sintering and heat treatment in one process.

4. Benefits for the further development of science and technology:

The thesis tests innovative ideas for the use of powder metallurgy equipment, such as infiltration of 3D printed preform in SPS device or combination of the sintering process with

heat treatment in one step. These ideas can in the future find a way to industry, if considered properly.

5. Fulfilling the aims of the thesis:

All declared aims of the thesis were fulfilled without reservations.

Questions and comments:

1. What is the advantage of the combination of additive manufacturing and SPS sintering in comparison with common infiltration of the preform by the molten alloy in the case of the studied Ti alloy/Al alloy composite?
2. In the thesis, the possibility of the combination of SPS and heat treatment of a titanium alloy is presented. Is the heat treatment in SPS/FAST device comparable with common standardized heat treatment? I mean especially uniformity of the heat distribution in solution annealing step and the achievable cooling rate after it.
3. Is the heat treatment in SPS/FAST device advantageous for the industrial use? As far as I know, the manufacturers tend to minimize the sintering time, creating high-throughput SPS presses, which can sinter one sample in seconds, and hence can be directly mounted to the production line for series products. And in such a line, there is not a big problem to integrate the continuous furnaces and increase the productivity.

Submitted dissertation of Jiří Kozlík on the topic "*Powder Metallurgy of Hybrid Materials for Advanced Applications*" meets the conditions set for doctoral dissertation theses, therefore I recommend the work for defence and propose the award of the academic title "PhD.".

Prague 09/08/2023

prof. Ing. Pavel Novák, Ph.D.