

Review Report on PhD Thesis

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

Academic year: **2019/2020**

Student: **Hua Tan**

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

Field of study: **Advanced Materials**

Supervisor: **Assoc. prof. David Salamon, Ph.D.**

Reviewer: **Ing. Zdeněk Chlup, Ph.D.**

PhD thesis title: **Extremely fast sintering of advanced ceramic materials**

Topicality of doctoral thesis:

The selected research field of densification of advanced ceramic materials for the submitted thesis is of scientific interest for decades. The development in technology opens new possibilities to densify ceramic materials at high pressures, with the assistance of various fields and as well with high heating rates. The fundamental knowledge allowing further theoretical modelling of such processes for various materials is up to now rare and incomplete.

Meeting the goals set:

The author of the thesis has defined four goals and accordingly he focuses individually on each of them in the chapter Results and discussion. It can be therefore stated that goals were met.

Problem solving and dissertation results:

The author dedicated 20 pages to the literature research where most of the current knowledge is summarized. The designed experiments are appropriate to fulfil goals. The wideness of the experimental part needs a good organisation of experiments as well as consequent evaluation of data. Also, the observation of phenomenon during fast sintering process requires implementing of solutions which indirectly reports about it (e.g. to add dopant into the observed ceramic). Obtained results are of great interest what is documented by publications in well-recognised journals. However, some enhancement will be still possible and appreciated especially in the interpretation of obtained results where some statements are not fully based on the evidence (for example statements ... composites possess much fewer pores... or ...grain size of the boron carbide composites is slightly bigger... without any quantification – page 78).

Importance for practice or development of the discipline:

Obtained results and knowledge will be utilised in the manufacturing processes to obtain optimal microstructure with the application of optimal sintering conditions for a given material. It was recognised that the right pulse arrangement and application of the mechanical load at the appropriate moment for rapid heating of the sintered component is essential to reach dense and homogenous fine-grained microstructure. Also, the correct determination of temperature during the sintering process is crucial and is dependent on the material. The sintering properties can be significantly changed or adapted by doping. These aspects can accelerate sintering process with lowering of energy consumption compared to the conventional or not optimised process resulting in a more environmentally friendly manufacturing process. From the scientific point of view, the advancement in knowledge is indisputable and presented work explained some unclear parts of rapid sintering.

Formal adjustment of the thesis and language level:

The presented thesis is in the majority formally correct and the level of language is high without obvious stylistic and grammar mistakes even though some typos are present (litter influence- page 71), not correctly written units (g.cm³- no upper index page 82). There is a space to improve it by unification and arrangement of presented graphs and micrographs. The picture labels and axes captions should be readable (not like Fig. 5-6). The units are not conveniently displayed and therefore the standard arrangement should be used with spaces included (e.g. Temperature [°C] or (°C) rather than Temperature/°C see Fig. 5-1 and others). Missing indication, what the values inside the graph mean, can be found in Fig. 5-55. Figure caption, table captions or chapters titles on the previous or following page than a figure, table or chapter text, respectively are the common issue (see Figure 5.30, Table 5.2, chapter 5.2.1 as an example).

There are many places with large white spaces on the page. These are just formal issues which do not affect the scientific quality of the work. On the other hand, the nonsense statements (e.g. microstructure of fracture surface Fig. 5-37 or Microstructures and densities 5-22) are also sometimes present and they affect the scientific quality. The terminology is not proper in some cases (e.g. indentation fracture toughness should be used instead just fracture toughness). From the scientific view, the discussion of the presented results is rather descriptive and not given extensively in the context with existing literature. This is in contrast with published papers where the author demonstrated his ability.

Formal and practical quality of the PhD Thesis (Short Thesis) should be significantly improved as well as extent which is limited by internal standard No. 61/2017 of BUT to 30 pages. The current version is 71 pages long and did not contain mandatory CV. This should be corrected and submitted for review again.

Questions and comments:

1. Can you explain reasons for selection of Evans formula for the indentation fracture toughness calculation? Is the chosen approach valid for all investigated materials?

2. How comparable are results from various hardness measurements in general, i.e. applied load, type of indenter (explain also for the load used in the work HV1 and HV5)? How are presented results compared with the literature data? What means well-polished surface as preparation requirement?
3. How was the relative density calculated in all materials? Is the relative density affected by the processing? How does the density correlate with resulting properties?
4. What “future” sintering approach will be prospective from the quality, and quantity of production as well as the energy consumption point of view?

Conclusion:

In my opinion, when all above-mentioned comments and remarks are taken into account, the reviewed thesis fulfils all requirements posed on theses aimed for obtaining a PhD degree. This thesis is ready to be defended orally, in front of the respective committee.

In Brno, date 5.5.2020

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Ing. Zdeněk Chlup, Ph.D.